A SYSTEMS THINKING APPROACH TO THE PLANNING OF RURAL TELECOMMUNICATIONS INFRASTRUCTURE

By

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PREFACE

The research work reported in this thesis was carried out in the School of Mathematics, Statistics, and Information Technology, University of Natal, Pietermaritzburg, South Africa, from 1999 to 2001, under the supervision of Professor D. Petkov.

These studies represent original work by the author and have not otherwise been submitted in any form for any degree or diploma to any University. Where use has been made of the work of others it is duly acknowledged in the text.

RESEARCH PAPERS BASED ON THIS WORK

1. Andrew, T. and Petkov, D. (2002). "Critical Systems Thinking Applied to Rural Telecommunications Infrastructure Planning", Accepted for the Proceedings of The World Congress of the Systems Sciences and International Society for the Systems Sciences 46^{th} Annual Meeting, Wilby, J. & Allen, J. K. (eds.). Shanghai, PRC. 2 - 6 August 2002.

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I have come to realise that my greatest fortune in life is my family. My wife Lorna has been infinitely patient and unselfishly supportive while I spent *most* of the last three years on this project. I am forever indebted to her. My children have likewise been accommodating. My parents have always been a source of strength and this is an appropriate opportunity to thank them for their sacrifices they made in ensuring my early educational, and spiritual well being.

> *"By wisdom the Lord laid the earth's foundations, by understanding he set the heavens in place; by his knowledge the deeps were divided, and the clouds let drop the dew."*
>
> *Proverbs 3:19 (NIV)*

I am indeed privileged to be part of the Lord's creation. Everything I have I owe to Him.

Theo Andrew
December 2001

ABSTRACT

The research reported in this thesis is concerned with the provision of telecommunications infrastructure to rural areas in developing countries. The primary focus is to improve the current practice in the planning of such infrastructure. An in depth analysis of the critical issues that characterise rural telecommunications in developing countries revealed that the rural telecommunications system is not just a technological system but a complex system of people and technology interdependent on other systems/subsystems. A systems approach lead to a conceptual model of The Rural Telecommunications System as an open complex sociotechnical system. Consequently the planning of rural telecommunications infrastructure requires an approach that addresses such complexity.

Critical systems thinking was chosen as the overall systems thinking approach for the development of a systemic planning framework for rural telecommunications infrastructure, that accommodates the system of problems inherent in the complex sociotechnical rural telecommunications system. The framework was built on the principles of Multimethodology and consists of Interactive Planning as a general orientation, mixed with Interpretive Structural Modelling and Critical Systems Heuristics. The framework is enhanced by the inclusion of current techniques from Systems Engineering practice, and softer techniques such as rich pictures. A case study based on the Mapumulo rural area in KwaZulu Natal was used for the practical validation of the framework.

TABLE OF CONTENTS

Page

TITLE PAGE........ i

PREFACE........ ii

RESEARCH PAPERS BASED ON THIS WORK........ iii

ACKNOWLEDGEMENTS........ iv

ABSTRACT........ v

LIST OF TABLES........ xii

LIST OF FIGURES........ xiii

CHAPTER 1 1

INTRODUCTION

1.1 Background to the research problem........ 1

1.1.1 The imbalance of telephone distribution in South Africa........ 2

1.1.2 On the need for a different approach to rural telecommunications........ 4

1.2 Goals of the research........ 7

1.3 Scope, assumptions and delimitation of the research........ 8

1.4 Research methodology........ 10

1.5 Importance of this research........ 14

1.6 Overview of thesis........ 15

CHAPTER 2 18

THE CURRENT STATE OF AFFAIRS IN RURAL TELECOMMUNICATIONS WITH A PARTICULAR FOCUS ON SOUTH AFRICA

2.1 Governance, regulation, and management of the communications sector in South Africa........ 18

2.2 The telecommunications network and service providers in South Africa........ 22

2.3 Unpacking the term "rural telecommunications"........ 25

2.3.1 What is a rural area?........ 25

2.3.2 A perspective on the South African demographics........ 28

2.4 Development as a purpose for providing rural telecommunications........ 30

2.5 Telecommunications Access: A right or a privilege?........ 37

2.6 Rural telecommunications services: Supply versus demand........ 39

2.7 Implications of technological factors on rural telecommunications service 43
2.8 Impact of physical factors and parallel infrastructure on rural telecommunications 47
2.9 The implications of sociological and cultural factors on telecommunications 49
2.10 The implications of political and regulatory factors on telecommunications 52
2.11 Traditional approaches to rural telecommunications planning 56
2.11.1 International engineering recommendations on rural telecommunications... 56
2.11.2 Rural telecommunications planning in KwaZulu Natal, South Africa........ 59
2.12 Concluding remarks on current practices in rural telecommunications planning 62

CHAPTER 3 64
TOWARDS A SYSTEMS THINKING APPROACH TO RURAL TELECOMMUNICATIONS PLANNING
3.1 A general conception of systems 64
3.2 The rural telecommunications system 70
3.3 The rural telecommunications system as a socio-technical system 74
3.4 The complex nature of the rural telecommunication system 79
3.4.1 Multiple perspectives on complexity 80
3.4.2 Recognising complexity in a system 82
3.5 A conceptual overview of planning 85
3.5.1 General definitions and concepts of planning 85
3.5.2 Some general categories of planning 87
3.5.3 The nature of planning 89
3.5.4 Orientations to planning 91
3.6 A synthesis of the arguments thus far: Further considerations on the nature of the rural telecommunications system 94
3.7 Some conclusions regarding the possible appropriate systems approaches suitable for the purposes of this research 98

CHAPTER 4 104

TOWARDS METHODOLOGICAL PLURALISM FOR THE DEVELOPMENT OF THE SYSTEMIC FRAMEWORK FOR RURAL TELECOMMUNICATIONS INFRASTRUCTURE PLANNING

4.1 The salient principles of the planning framework.................................. 104

4.2 On the nature of key paradigms relevant to systems practice in dealing with societal systems.. 108

4.3 The various paradigms that the framework needs to embrace and the issue of paradigm incommensurability... 112

4.4 Pluralism in systems practice... 115

4.5 On the relevance of a multimethodology approach to complex problem solving as planning for RTI... 120

4.6 A multimethodological framework for the planning of rural telecommunications infrastructure.. 124

4.6.1 The appropriateness of Interactive Planning as a dominant systemic methodology within the planning framework.................................... 125

4.6.2 Methods and techniques for the formulation of the mess phase 128

4.6.2.1 Stakeholder analysis, critical systems heuristics, and rich pictures – towards formulation of the mess.............................. 129

4.6.3 Ends planning.. 135

4.6.4 The leverage phase: means planning, resource planning, implementation and control.. 137

4.6.4.1 Interpretive Structural Modelling/Interactive Management as an appropriate methodology for the leverage phase......................... 139

4.7 The complete framework for planning of RTI and its justification from a validation and legitimatisation point of view.. 141

4.7.1 On the validation of the framework.. 145

4.7.2 On the legitimisation of the framework.. 148

CHAPTER 5

IMPLEMENTATION OF THE FRAMEWORK: A CASE STUDY ON THE MAPUMULO RURAL AREA IN KWAZULU NATAL

5.1 The structure and process of the workshops... 150

5.2 A profile of the Mapumulo area in KwaZulu Natal 152
5.3 Workshop One: Trial implementation of the 'formulation of the mess' phase of the framework 153
5.3.1 Discussion and analysis of the formulation of the mess process and its outputs 155
5.4 Workshop Two: Trial implementation of the ends planning/idealised design of the framework 161
5.4.1 Constrained idealised design for the Mapumulo area 166
5.4.2 Unconstrained idealised design for the Mapumulo area 168
5.4.3 Analysis of the constrained and unconstrained design 169
5.5 Workshop Three: A meeting with stakeholders from the Mapumulo area... 174
5.5.1 A review of the results of the 'formulation of the mess' phase of the framework with the local community 176
5.5.2 A review of ends planning with the local community 182
5.5.3 Evaluation of the third workshop 183
5.6 Some overall remarks on the first three workshops 185
5.7 Workshop Four: Trial implementation of the leverage phase of the planning framework with rural telecommunications planners 188
5.7.1 The purpose of the fourth workshop 188
5.7.2 The use of Interpretative Structural Modelling for the means planning 189
5.8 Evaluation of the rural telecommunications planning framework and workshops held with Telkom SA planners 194
5.9 Reflections on the case study and some lessons learned 198

CHAPTER 6 **206**
CONCLUSION OF THESIS
6.1 How were the goals of the research achieved? 207
6.2 The theoretical and practical contribution of this research 211
6.3 Concluding remarks and directions for possible further research 213

REFERENCES **215**

APPENDIX A 233

ANALYSIS OF SOME TRENDS IN THE EVOLUTION OF SYSTEMS THINKING METHODOLOGIES THAT ARE RELEVANT TO THIS RESEARCH

A.1 General Systems Theory, Tektology, Cybernetics 233

A.2 Hard Systems Thinking 236

A.2.1 Systems Engineering 237

A.2.2 Systems Analysis and Operational Research 240

A.2.3 Further discussion of hard systems theory 243

A.3 Soft Systems Thinking 246

A.3.1 Social Systems Design 247

A.3.2 Appreciative Systems Theory 249

A.3.3 Strategic Assumption Surfacing and Testing (SAST) 251

A.3.4 Unbounded Systems Thinking 254

A.3.5 Checkland's Soft System Methodology 256

A.3.5.1 A Description of the methodology of SSM 256

A.3.5.2 Some of the techniques used in SSM: Rich pictures, CATWOE analysis, root definitions and conceptual models 260

A.3.5.3 Some criticisms of SSM 262

A.3.6 Ackoff's Interactive Planning 263

A.3.6.1 Operating principles of Interactive Planning 265

A.3.6.2 The five phases of Interactive Planning 266

A.3.6.3 Some criticisms of Interactive Planning 271

A.3.7 Warfield's Interpretative Structural Modelling and Interactive Management 271

A.3.7.1 Some criticisms of ISM/IM 277

A.4 Critical Systems Thinking 278

A.4.1 Total Systems Intervention 280

A.4.2 Critical Systems Heuristics 283

APPENDIX B

'FORMULATION OF THE MESS' WORKSHOP 287

APPENDIX C
'ENDS PLANNING/IDEALISED DESIGN' WORKSHOP......................... 296

APPENDIX D
RURAL TELECOMMUNICATIONS PLANNING WORKSHOP HELD WITH MAPUMULO COMMUNITY REPRESENTATIVES................. 306

APPENDIX E
TRIAL IMPLEMENTATION OF THE LEVERAGE PHASE OF THE PLANNING FRAMEWORK FOR THE MAPUMULO AREA........................ 311

APPENDIX F
QUESTIONNAIRE FOR THE EVALUATION OF THE RURAL TELECOMMUNICATIONS PLANNING FRAMEWORK AND WORKSHOPS HELD WITH TELKOM SA PLANNERS.. 324

APPENDIX G
PLAN OF THE INTERVIEWS WITH TELKOM'S AREA PLANNERS AND SUPPORT DEPARTMENTS - BOTH URBAN AND RURAL, HELD IN MARCH 2000... 327

LIST OF TABLES

Page

Table 1.1, Tele-density (the number of fixed main lines per 100 people) for some African countries in 1998. Source: (ITU, 2000) 2

Table 4.1, Principles that underpin the planning framework for rural telecommunications infrastructure 106

Table 4.2, Problem contexts according to their complexity and the stakeholder views, after Jackson & Keys (1984), Flood & Jackson (1991) 118

Table 4.3, Different possibilities for combining methodologies (Adapted from Mingers and Brocklesby, 1996) 122

Table 4.4, Relevant critically-heuristic boundary questions to support stakeholder management. Adopted from Ulrich (1983, 1996) 134

Table 5.1, The main categories of stakeholder groups that were identified by the participants. A more detailed list is shown in Appendix B 157

Table 5.2, Summary of systems pertaining to the RTS, resulting from the constrained design that participants would like to see in the Mapumulo area. A more detailed account is found in Appendix C 167

Table 5.3, Summary of core technologies that are required to support the systems mentioned in the constrained design, Table 5.2. A more detailed account is found in Appendix C 167

Table 5.4, Summary of systems pertaining to the RTS, resulting from the unconstrained design that participants would like to see in the Mapumulo area. A more detailed account is found in Appendix C 168

Table 5.5, Summary of core technologies that are required to support the systems mentioned in the unconstrained design, Table 5.4. A more detailed account is found in Appendix C 169

Table 5.6, Results of the stakeholder analysis undertaken by the Mapumulo community representatives during the telecommunications planning workshop 177

LIST OF FIGURES

Page

Figure 1.1, Elements relevant to any piece of research (Checkland and Holwell, 1998: 23)..... 10

Figure 2.1, Cultural protocol regarding telecommunications services..... 52

Figure 2.2, Network planning, functions and interfaces (Source, http,//www.itu.int/planitu/)..... 57

Figure 3.1, A general system..... 66

Figure 3.2, A rural telecommunications system showing the relationships between the subsystems and the emergent properties of the system..... 71

Figure 3.3, The traditional model of socio-technical systems (Following Pentland, 1996)..... 76

Figure 3.4, The enhanced socio-technical systems model according to Pentland (1996: 33)..... 77

Figure 4.1, Four paradigms for the analysis of the nature of knowledge and inquiry, and the nature of society (after Burrell and Morgan, 1989)..... 110

Figure 4.2, A scheme showing the four paradigms as proposed by Burrell and Morgan (1979) in relation to the assumptions in their approaches to social science... 111

Figure 4.3, The various components of Interactive Planning working in a systemic fashion, with respect to the planning of rural telecommunications infrastructure..... 126

Figure 4.4, An adaptation of Interactive Planning as a guide to the planning framework for rural telecommunication infrastructure..... 127

Figure 4.5, A systemic multimethodology framework for the planning of rural telecommunications infrastructure, showing the various phases in planning and the associated methodologies / techniques..... 142

Figure 4.6, The modelling –validating process (Landry et al, 1983)..... 146

Figure 5.1, Difference in expectations of infrastructure rollout between the application of the framework and the current way of planning..... 173

Figure 5.2, Graphical representation of priority structure of the means plan for the Mapumulo area. The numbers represent the means (Refer to Appendix E, DOC E6)..... 193

Figure A.1, The structure of an appreciative system adapted from (Checkland and Casar, 1986) & (Checkland, 1999)........ 250

Figure A.2, An assumption rating chart used in SAST........ 253

Figure A3, Seven stage model of SSM (Checkland, 1975, reproduced in Checkland & Scholes, 1990)........ 257

Figure A.4, The 'two-strands model' of SSM (Tsouvalis and Checkland, 1996: After Checkland, 1988b)........ 259

Figure A.5, An Interactive Planning cycle (After Ackoff, 1981)........ 267

Figure A.6, Types of inference according to Peirce (Warfield, 1994)........ 274

Figure A.7, A scale of belief (Warfield, 1994)........ 275

Figure A.8, Overview of the process and products of IM........ 276

Figure A.9, Three-phase process of TSI (Flood 1995)........ 281

Figure A.10, An overview of critically heuristic categories (Ulrich 1983: 258)........ 285

CHAPTER 1

INTRODUCTION

1.1 Background To The Research Problem

In just over 150 years this world has seen communications technology leap from the electric telegraph in 1844, to the telephone in 1875, to the transmission of a radio signal in 1901, to the first satellite transmission in 1957, to the digital exchange in 1960, to the modern mobile communication technology and its integration with computer technology that we experience today. A survey issued by the International Telecommunication Union in 1997 mentioned that the total world revenues for the telecommunications industry were $800 billion in 1996 (Lunsche, 1997). This report also predicted that this revenue would double by 2000. From the first telephone conversation in 1875 we have come a long way to approximately 840 million main telephones lines world wide in 1998 (ITU, 2000), (notwithstanding all the other communication technologies). However, this translates to approximately only 14.26 main telephone lines per 100 people in the world. Further, these rates are skewed in favour of the developed countries and urban areas in general. In 1998 the tele-density (number of fixed main telephone lines per 100 people) ranged from 2.24 in Africa to 37.26 in Europe (ITU, 2000). Over the last decade the telecommunications industry worldwide enjoyed healthy and growing profits with the most profitable year being 1996. Yet, during this same period millions of people were awaiting telephone lines with the average waiting time for connection exceeding several years. It is hard to believe that the problem is mainly due to the lack of financial resources.

Africa is regarded as the 'Dark Continent' even when it comes to telecommunications infrastructure. Africa has one eighth of the world's population but only 2 per cent of its telephone lines (McClelland and Berendt, 1998). Table 1 gives an indication of the wire penetration rates for some countries in Africa. It indicates the relative under-development of Africa's telecommunication infrastructure especially when one considers that the tele-density includes all the business lines as well. Certain African countries like Kenya, Botswana and South Africa are engaged in strategic development of their telecommunications infrastructure but even with the advent of technologies such as wireless local loops or cellular phones, Africa in general, has a long way to go in developing its telecommunications infrastructure.

Table 1.1. Tele-density (the number of fixed main lines per 100 people) for some African countries in 1998. Source: (ITU, 2000)

South Africa	12.47
Egypt	6.02
Morocco	5.47
Algeria	4.91
Zimbabwe	1.89
Kenya	0.99
Côte d'Ivoire	1.19
Nigeria	0.38
Ghana	0.75
Mozambique	0.40
Tanzania	0.38
Sudan	0.57
Ethiopia	0.28
Madagascar	0.31
Uganda	0.28

1.1.1 The Imbalance Of Telephone Distribution In South Africa

A healthy telecommunications infrastructure is universally accepted as a basic requirement for economic development and growth. Owing to historical reasons there is an imbalance in the quality of life between the developed urban areas and the rural areas in South Africa. It is therefore not surprising to find that the distribution of telecommunications infrastructure in South Africa reflects this imbalance. Although South Africa has the highest tele-density of just under 12.5 lines per 100 people in Africa according to Table 1.1, telephone services remain expensive and hard to access for most South Africans. It must be noted that according to the Telkom SA 2000/2001 annual report the wireline penetration rate was down to approximately 11.8 percent at 31 March 2001, due to commercial fraud and non-paying customers (Telkom, 2001). South Africa's tele-density is well above the African average, but this rate falls to less than one per 100 households in the historically black townships and rural parts of the country. The South African sole fixed telecommunications network provider, Telkom SA, has made great strides in rolling out basic infrastructure, but the average waiting time for a telephone line in rural KwaZulu

Natal is approximately three years (Smith *et al*, 2000). This is an imbalance due to South Africa's history that the present government is committed to addressing. It is often said that South Africa is a mixture of 'first world and third world', however the poverty is based largely in rural areas. In total, 51% of all households in South Africa are in rural areas, of which 69% (compared with 27% of households in urban areas) reside in poverty. The overall poverty share of rural areas i.e. the percentage of poor households in rural areas is 74% (Stavrou and Mhkize, 1997: 8). This report also shows that there is a high correlation between tele-density, tele-accessibility, and poverty amongst provinces in South Africa.

It is not surprising then that internationally recognised experts conclude:

> "Long regarded as the peripheral and uneconomic area into which (Telco) operators and service providers were loath to stray, rural communications may well turn out to be one of the biggest growth sectors of the 21st century. International investors are searching for new, untapped markets, while advances in wired and wireless technologies are producing more cost-effective solutions for providing rural access. One of the greatest challenges for the sector is Africa where 70 to 80 per cent of the population live in remote areas" (McClelland and Berendt, 1998).

Of course one could wish for a perfect telephone penetration rate throughout Africa for example, but would this be the same as saying that every citizen is enjoying the benefits of telecommunications?

Another problem is under-utilisation of existing modern infrastructure in some cases. In the second half of 1994 the author studied the tele-traffic patterns on TDMA (Time Division Multiple Access) radio-relay telephone systems installed in various rural areas in South Africa. These systems were installed in record time and at considerable expense for the first democratic elections in South Africa held in April 1994. Although the purpose of these networks was to facilitate the monitoring and reporting of the election process and results, these were also public facilities. However, the tele-traffic patterns on these systems over the latter half of 1994 showed undesirable usage. The only considerable usage was during the election period (Andrew, 1994). Here was an advanced engineering system provided at considerable cost but under-utilised during the five-month period of study. It seems that the original planning assumptions of those that implemented these networks do not provide an explanation for this.

1.1.2 On The Need For A Different Approach To Rural Telecommunications

Telecommunications has shaped societies in more ways than one. In fact with the emergence of electronic commerce, telemedicine and distance learning, telecommunications has the potential to spark a rural renaissance. However, inextricably linked to the economic imbalance in the urban/rural duality is the so-called 'information rich and information poor' gap. If these imbalances are going to be seriously addressed then one has to conclude that urgent attention has to be given to rural telecommunications by all its stakeholders. Whether the planning should cater for POTS (Plain Old Telephone Service, i.e. the traditional voice telephony) or POTS plus services is an issue that technology has now made easier to resolve. What is of crucial importance is that research has to focus on addressing the urban/rural duality in telecommunications services.

One of the key phrases that has been linked to the telecommunications policy environment in developing countries, including South Africa, is 'Universal Access', i.e. the availability of a telephone service at least within approximately one hour walking distance (Maitland, 1984; Telecommunications Act of 1996, South Africa). To give effect to this policy imperative, various actions have been taken by government and the telecommunications network provider. Telkom SA for example has embarked on a 'mass rollout' (of basic infrastructure) programme. However while these actions are necessary, the issues pertaining to development spin-offs from telecommunications usage are much deeper than just providing telephone access. The fact that undesirable low levels of tele-traffic are found on some of the existing networks tends to suggest that together with providing telecommunications access to rural communities one needs to, amongst other things, address the issue of actually encouraging the use of the telecommunications infrastructure. Tele-usability then should be as important a concept as tele-accessibility.

So the issue is not so much the massive rollout of infrastructure or the lack of it, rather: how does one plan and design rural telecommunications infrastructure so that all stakeholders benefit, especially when the challenges that the planners face are complex and multi-dimensional? Planners do not normally consider the indirect benefits, which are essential for development, of providing telecommunications to rural areas.

Research in technological communications has concentrated on the electronic mass media, i.e. point to multi-point communications. One reason for this is the natural progression from the print media (Hudson, 1984). Research in the area of telecommunications has and still focuses on the technological aspects. Telecommunications was and still is left largely to engineers, many of whom work on advancing and improving the technology. In comparison to this there has been little research, based mostly on case studies, on the social and economic impacts of telecommunications for developing countries or rural areas. According to Singh (1991: 9), "rural telephony has suffered from a research bias which has focussed on measuring the end result, the ultimate payoff, rather than trying to understand the process by which the benefits are accrued". The economic impact studies had more to do with finding a correlation and causality between telecommunications service and economic development especially for the developing countries. Further, in the context of the urban/rural duality rural telecommunications have been neglected for a variety of reasons, not least of which were financial insecurities. Therefore if research has to focus on addressing the imbalance in telecommunications services between developed/developing or urban/rural then different approaches than the traditional ones need to be investigated.

This thesis focuses on the planning of rural telecommunications infrastructure for it is the planning stage that can determine the appropriateness and effectiveness or the success or failure of a newly deployed rural telecommunications system. However, rural telecommunications planning practice traditionally focuses on the hard engineering aspects (ITU, 1989; ITU Study Group 2, 1997; ITU-D7, 1998). Implicit in the fundamental contention of this thesis is that the planning methodology has to cater for much more than the hard engineering aspects especially in the context of rural telecommunications for a developing country.

At a philosophical level of analysis the traditional rationale for providing telecommunications infrastructure to rural areas, and the subsequent planning approaches for deployment of this infrastructure, is based very much on a subject/object dualism type of observation. This type of dualism focuses solely on supposedly objective, linear, cause-and-effect relationships rather than holistic analysis (Midgley, 2000: 70). So while it has been shown that there is a definite correlation between the provision of telecommunications services and economic development, the telecommunications policy imperatives went only as far as demanding the roll out of some infrastructure. Although this is a significant and necessary step towards development this is insufficient to meet with the expectations regarding the spin-offs from this tele-access.

This research uses a broader, holistic approach for the planning of rural telecommunications infrastructure. It aims to address the shortcomings mentioned above. Instead of just deploying infrastructure according to traditional practices, it is necessary to treat the problem systemically. Systems thinking theory and practice are covered in chapters three and Appendix A, but for this section it will suffice to say that in the systems approach to a problem situation comprehensiveness is an ideal (Midgley, 2000: 36). Emphasis is placed on the relationships between elements of a system rather than the element itself.

So, why a 'non-engineering' approach to what is traditionally regarded as an engineering problem? The answer is simply that the ultimate purpose of any engineering activity must be to positively affect the lives of human beings, and when the human aspects are added to large scale systems such as rural telecommunications the planning issues become more complex. This research is based on the assumption that the deployment of technological infrastructure is a societal intervention (bringing about change). In general the successful deployment of telecommunications infrastructure does not depend solely on just one particular factor, but is affected by socio-economic, political, cultural, liberalisation, legislative, and technological imperatives at least. The decisions involved in the deployment of telecommunications infrastructure are related to a complex and messy problem and one needs to apply a holistic approach in order to obtain an effective solution. For example, how does one configure a telecommunications network when there are too many uncertainties regarding tele-traffic issues and too many human factors involved?

Therefore, the methods used to plan and develop rural telecommunications infrastructure cannot be purely technological in nature. Development planners are faced with the task of prioritising development projects and determining how to achieve them. It is therefore suggested that the principles developed in the suggested holistic approach to rural telecommunications planning could be applied to any infrastructure planning for rural areas.

> "The engineer is the key figure in the material progress of the world. It is his engineering that makes a reality of the potential value of science by translating scientific knowledge into tools, resources, energy and labour to bring them into the service of man...the engineer requires the imagination to visualise the needs of society and to appreciate what is possible as well as the technological and hard social understanding to bring his vision to reality" (Sporn, 1964 as quoted in Checkland, 1981).

While this public expectation of the role of the engineer or technologist embodies a rather grand vision even to this day, whether one has the necessary training or full capability to achieve all of this, especially 'the hard social understanding' is yet to be seen. Especially with those engineers and technologists who deal with infrastructure type technologies such as electrical power distribution and telecommunications services. The current trend, particularly when dealing with developing areas, is to consult with 'experts' such as social scientists, community facilitators and marketing specialists. However, this is not even the same thing as an integrated approach, let alone being informed by a holistic framework.

The framework developed in this thesis provides processes that do not fall within the traditional technology paradigms, but will help determine the potential for tele-traffic in a more plausible and accurate way. The complexity of the problem requires the use of a range of systems techniques taking into account the imperatives mentioned above, as certain techniques are more suited to particular aspects of a complex problem. The issue of mixing methods/techniques in a systemic intervention is investigated recently through other problems in the systems literature (see Jackson, 1991; Jackson, 2000; Midgley, 2000; Mingers and Gill, 1997). It can be noted that systems thinking has been used also in other engineering areas previously (e.g. Frank, 2002). However, to the best knowledge of the author the issue of rural telecommunications infrastructure planning was not treated before from the point of view of mixing different systems approaches.

1.2 Goals Of The Research

The main goal of the research is to develop a framework for the planning of telecommunications infrastructure for rural areas in developing countries. The context of the research will be predominantly South African and therefore the case study on the practical implementation of the framework will be based on a rural area within KwaZulu Natal, South Africa. KwaZulu Natal has a typical geographic and demographic profile in its rural areas that makes rural telecommunications planning a challenging exercise. Although generic in nature, the framework will have to cater for the distinctive features of different rural areas within a developing country like South Africa. All aspects, whether technological or not, that contribute to the success of the deployed rural telecommunications infrastructure system must be considered in this framework. Based on

preliminary investigations concerning this research it is envisaged that the systems approach will play the key guiding role in the development of the framework.
The main goal of the research will be pursued through the following sub-goals: -

- An investigation of the factors affecting the planning of rural telecommunications infrastructure, both locally within KwaZulu Natal and internationally. Included in this investigation will be systemic analyses of these factors and a critique of current approaches to the planning of rural telecommunications infrastructure.
- An investigation and analysis of suitable methodologies and techniques from the field of systems thinking that can be applied to rural telecommunications development that will possibly improve the current planning of rural telecommunications infrastructure.
- The development of a theoretical framework that will inform the planning of rural telecommunications infrastructure.
- The provision of an appropriate philosophical/theoretical justification for such a pluralist (mixing of suitable methods/techniques) approach to problem solving, especially within the systems thinking context.
- The application of the framework to a practical case study to evaluate the potential for its legitimacy and validity in terms of meeting the desired outcomes of telecommunications infrastructure in rural areas.
- Drawing conclusions for improvements of decision processes related to infrastructure development in rural telecommunications.

1.3 Scope, Assumptions And Delimitation Of The Research

During the course of this study the term ICT (information and communication technologies) has come to replace and represent a wider scope of services than those traditionally associated with telecommunications. This is due to the rapid advances in converging technologies for the simultaneous provision of video data and voice services. These recent advances do not have any significant impact on the results of this research as far as the appropriateness of the planning framework is concerned. Therefore whenever telecommunications is mentioned this will also imply information and communication technologies and services.

It must also be noted that the term telecommunications infrastructure in this thesis refers to the core technologies (both hardware and software) from a central exchange to the end user in the rural area, and all the support services that are required for the normal functioning of this infrastructure. This also implies telecommunications infrastructure that will support systems such as tele-medicine, distance or remote education and e-commerce. This research has therefore focussed on the fixed network.

This research covers relevant issues relating to the planning of rural telecommunications infrastructure. It will not deal with the issues of systemic evaluation of the state of such an infrastructure, as that requires separate research on its own. The work will concentrate only on the most suitable systems methodology approaches for the planning task. A complete and full treatment of systems thinking however is beyond the scope of this research.

The planning, design, deployment and commissioning of rural telecommunications infrastructure is a process that is dependant on many departments within the telecommunications network provider and operator (Telco) organisation, and also many other organisations and services external to the Telco. In terms of time scales, the process from conception of a project to the commissioning of the deployed infrastructure could take from several months to several years. To monitor and evaluate the impact of the rural telecommunications infrastructure could take a further three years at least. It is therefore not practical to engage in a comprehensive research project that will study the planning of rural telecommunications infrastructure from conception through to evaluation of that infrastructure. The scope of this thesis is to develop a planning framework for rural telecommunications infrastructure. The evaluation of infrastructure vis-à-vis the development aspects such as socio-economic development of the rural community requires a study on its own and therefore will not be covered in this thesis.

It will also not be possible to engage in a comprehensive practical trial and evaluation of the entire framework developed in this thesis, i.e. going through the tasks of conception through to commissioning. This will obviously be impractical given the time and financial constraints of such a study. Rather the overall aim will be to validate the appropriateness of the methodologies and techniques in terms of realising the emergent properties of the rural telecommunications system.

1.4 Research Methodology

In general, any piece of research according to Checkland and Holwell (1998) has the elements shown in Figure 1.1. There must be a framework of ideas (F) in which knowledge about the problem situation or area of concern (A) being researched is expressed. This framework of ideas is then embodied in a methodology (M) that promotes the use of various research methods and techniques that is appropriate to the framework of ideas for investigating the area of concern. Landry and Banville (1992) elucidate the relationship between the research goals, the research methodology and the research methods. According to Landry and Banville (1992) the rationale and process for any research is informed by the relationship among the research goals, the research methodology and the research methods. The research goals, in addition to determining the theoretical framework, also determine the research methodology and the research methods. The research methodology represents a collection of methods with a particular philosophical justification and a particular epistemology.

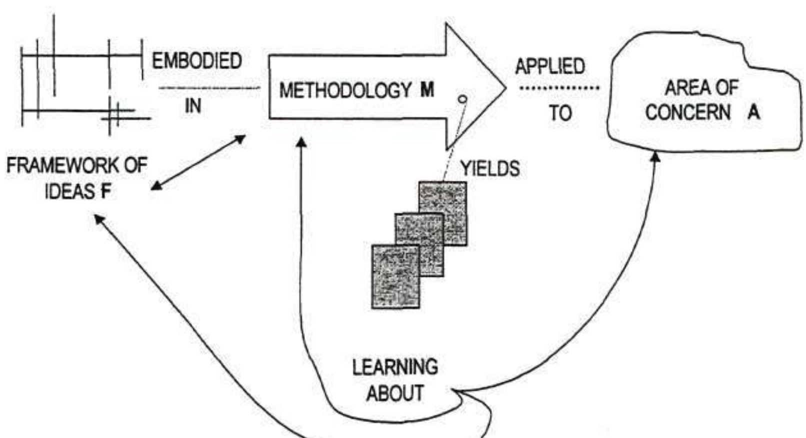

Figure 1.1. Elements relevant to any piece of research (Checkland and Holwell, 1998: 23)

This thesis is based on research whose goal was the development of an appropriate *systemic* framework for the *planning* of rural *telecommunications infrastructure.* Although the key words include 'planning' and 'telecommunications infrastructure', this research is not confined to the traditional discipline of telecommunications engineering or the traditional technology planning such as radio planning, which is based on a positivistic experimental ideal of research. During this research it became clear that an activity such as the planning of rural telecommunications infrastructure cuts across various disciplines, and the addition of the systems thinking approach to the planning meant that the research methodological approach had to cater for such diversity.

Gibbons *et al.* (1994) refer to the traditional positivist hypothesis testing research as Mode 1. The research bias here is very much towards the framework of ideas (F) in Figure 1.1. Mode 2 research (labelled as such by Gibbons *et al.*, 1994) is governed by the area of concern (A) rather than the framework of ideas (F). The elaboration by Jackson, (2000: 13-14) on Mode 2 research aptly describes the research process on which this thesis is based:

> "Mode 2 knowledge is produced to satisfy the demands of particular users. Research is organised around a particular A (area of concern) and is generated in negotiation with those who will find the outcomes useful. Because the research revolves around a real world A, it is unlikely that any single discipline will be able to provide a suitable F. Mode 2 research is therefore 'transdisciplinary'...more attention is given to the M (methodology) which becomes a kind of transferable problem solving capability".

Jackson (2000) further states that Mode 2 research must be more flexible in order to respond to the changing and transitory nature of the problem it addresses. Due to the fact that issues of real concern are tackled, Mode 2 researchers are more accountable to the public and the quality of the research is judged on a wider set of criteria than just the contribution to the development of a particular discipline.

The area of concern is the planning of rural telecommunications infrastructure for the benefit of all the stakeholders of that infrastructure. This thesis eventually leads to the position that the planning of rural telecommunications infrastructure is really planning for a rural sociotechnical system, which necessitates a transdisciplinary approach. While the final requirements of the planning framework developed in this thesis will be the quantitative deployment of telecommunications infrastructure, the framework itself is not restricted to a particular paradigm, and the general research approach to the development of the framework itself is qualitative in nature.

Qualitative research may be generally guided by positivist, interpretivist or critical epistemology (Orlikowski and Baroudi, 1991; Myers, 1997). The two fundamental requirements of a positivist research approach (usually followed in engineering), objectivity (observations independent of the observer) and experimental control were not well suited to the problem situation at hand. The problem at hand required more than a deep understanding of every aspect of telecommunications infrastructure planning and hence an interpretivist approach alone was considered as insufficient. The general orientation of this research followed critical systems thinking (Flood and Jackson, 1991, Jackson, 2000, Midgley 2000) in that the focus was on the improvement of the process of planning of rural telecommunications infrastructure. The key purpose of this improvement in planning being the creation of the preconditions for the improvement of the lives of rural communities in developing countries who are traditionally marginalised and disadvantaged.

During the initial investigations into the problem situation two main activities generated the preliminary information. An intensive literature survey was conducted on the following aspects: -

- The state of telecommunications services in rural areas both in developed and developing countries with particular focus on South Africa.
- The relationship between telecommunications and development and the drivers for telecommunications infrastructure deployment.
- The various role players and issues involved in the provision of rural telecommunications services
- The current approaches to the planning of rural telecommunications internationally and in South Africa.

In addition to the detailed literature survey several interviews were conducted with the relevant people from the public network operator. The questions that were discussed are reflected in Appendix G.

The analyses of the existing literature on rural telecommunications planning indicated the need for a systems thinking approach to the problem. Thus a framework of ideas (F) was gradually developed in continuous consultation with the telecommunications operator, other engineering experts through the South African Institute of Electrical Engineers and representatives of various rural communities involved in various projects involving the author at the Telkom-Ericsson Centre of Excellence in Rural Telecommunications at the M L Sultan Technikon in Durban. In moving towards the research goal of the planning framework, a detailed study of the various systems approaches and its underlying theory was conducted. Critical systems thinking was chosen as the overall systems approach for the development of the planning framework because the principles of the framework necessitated the need for a pluralistic framework that takes into consideration the need for improvement of rural telecommunications provision to the traditionally disadvantaged rural community.

Multimethodology, a recent strand in critical systems thinking (Mingers 1997a; 1997b) was used for the justification of mixing various methods and techniques embodied in the planning framework. These methods and techniques originally belong to interpretivist methodologies (Soft System Methodology (Checkland, 1981), Interactive Planning (Ackoff, 1981)) or slightly harder approaches as Interpretive Structural Modelling (Warfield, 1994) and quantitative techniques as well. It can be stated that these individual techniques, though having their own distinct paradigmatic features, were combined within the overarching critical systems thinking framework proposed in the thesis. As a result of the close continuous interaction of the author with the various stakeholders one can claim that this research had some of the features of action research (see Checkland and Holwell, 1998; Jackson, 1991: 244) but this line of thought is not explored further in greater detail here as the scope of the thesis had to be limited within a feasible time frame.

Finally, the case study method was used to describe the practical implementation of the proposed planning framework. It involved a number of planning meetings with selected key role players and several workshops with the relevant stakeholders who were involved in the experimental validation of the framework.

1.5 Importance Of This Research

To the best knowledge of the author the formulation of a comprehensive systemic framework for telecommunications infrastructure deployment is an open theoretical and practical problem. This research has found that there is no previously published enabling framework for the planning of rural telecommunications infrastructure that looks at a rural telecommunications system as a socio-technical system (Warfield, 1994). Only planning techniques for the technological issues, and general planning issues such as project planning are available.

This research has implications for several sectors. First and most obvious the telecommunications sector, including both the industry and the network provider and operator. The fact that this research project was approved and funded by the Department of Trade and Industry in South Africa, a telecommunications network provider (Telkom SA), a global player in telecommunications (Ericsson SA), whose representatives took active part in its implementation, is one indicator for the need for such work. Current planning approaches for telecommunications services in developing countries need improvement. This research is a step in that direction. It empowers the infrastructure providers to approach the planning issues holistically and more comprehensively. In particular the combination of both hard and soft approaches in this context is a novel approach to telecommunications infrastructure planning that promotes more successfully the purposes of engineering systems. This thesis is a result of a multi-disciplinary research project. This research strongly promotes the idea that rural telecommunications is about societal development and therefore cannot be restricted to the traditional hard paradigm. It is envisaged that this research project will lead to a greater appreciation of soft systems approaches in telecommunications engineering community and thus will promote further research in combining soft systems approaches with traditional approaches in that area.

Secondly, this research is important to government and society, more specifically the rural society and the rural community in a specific area of implementation of the framework. The planning framework will not only assist in realising government imperatives regarding information and communication technologies for rural areas but aims to develop a framework that can generate knowledge informing future policies.

Thirdly, this research has implications for related to systems thinking. The proposed combination of techniques from Soft Systems Methodology, Interpretive Structural Modeling, and Critical Systems Heuristics is a unique one and has not been applied before to the best knowledge of the author.

1.6. Overview of Thesis

The remainder of this thesis is structured as follows: -

Chapter two deals with the current state of affairs in rural telecommunications but with a particular focus on South Africa. An overview of the telecommunications scene in South Africa with respect to policy and regulatory issues, telecommunications network ownership and operations, and the level of sophistication of the technological infrastructure, is covered. One is able to discern from this section that although South Africa is generally regarded as a developing country the standard of its telecommunications networks rates similar to those in developed countries. However, there is a significant disparity in terms of tele-density in the rural areas.

The issues that differentiate rural telecommunications from urban telecommunications are then analysed. In particular the distinctive features of a typical rural area in a developing country like South Africa are mentioned, and development as a main purpose for the provision of rural telecommunications infrastructure, is argued. Also covered is a detailed account of the challenging issues that need to be considered in the provision of telecommunication services, such as technological, socio-cultural, and political and regulatory issues, and the conflicting priorities among these and the resulting dynamic forces that impact the planning of rural telecommunications infrastructure.

Chapter two also provides an analysis of the current approaches to rural telecommunications planning, both internationally and locally in South Africa. It was not practical to consider specific countries in the developed world. The selection of a particular country/ies alone would require a study on its own. However the International Telecommunication Union (ITU) is responsible for standardising procedures and technology specifications for the telecommunications industry (including network providers) world-wide and therefore the ITU recommendations and procedures were used as a benchmark for the analysis. Information on local planning practice was obtained via a structured interview process with planners from Telkom SA. The analysis shows the need for systemicity that will ensure a more comprehensive approach to the planning of rural telecommunications infrastructure.

Chapter three builds a case for the use of the systems approach to the planning of rural telecommunications infrastructure. Based on the analysis in chapter two, a heuristic model of a rural telecommunications system is proposed. It is shown that the rural telecommunications system is not the combination of the various pieces of technology that are part of the infrastructure as is commonly construed. It is a system that is interdependent on a range of subsystems and the technology infrastructure is just one albeit a necessary subsystem. The rural telecommunications system is classified as a sociotechnical system and therefore planning for a rural telecommunications system is actually planning for a sociotechnical system. The complex nature of this sociotechnical system is then established and it is proposed that one way of dealing with complex problems is to manage that complexity.

Chapter three also provides a conceptual overview of planning. Some general categories of planning are discussed and then a detailed account of planning philosophy by two significant contributors to the systems field is given. In particular, there are two concepts that stand out: Planning as the art of promoting improvement (Ulrich 1996), and Interactive Planning (Ackoff 1981). The chapter ends with several propositions that take the research closer to finding the most appropriate systems approaches for the framework.

Chapter four presents a systemic multi-methodology framework for the planning of rural telecommunications infrastructure. The seven principles that inform the framework are spelt out and the various systems, and sociological paradigms that are implicit in the principles of the framework are discussed. The issue of paradigm incommensurability is dealt with by showing how different paradigms can be accommodated, philosophically. Pluralism in systems practice is then investigated and multimethodology is chosen as a basis for the development of the framework. Chapter four closes with the theoretical validation and legitimisation of the framework.

Chapter five is a detailed account of the case study that was used as experimental validation of the framework in collaboration with the South African telecommunications network provider and operator, Telkom SA, and stakeholders from the Mapumulo community in rural KwaZulu Natal.

Chapter six concludes this thesis by showing how the goals of this research have been achieved, and points to possible further research agendas.

Appendix A provides an historical account of how the systems sciences have evolved over the years. The underlying philosophy and principles of the various systems approaches and their associated methodology/ies are covered. As mentioned in section 1.3, a comprehensive treatment of the systems sciences is beyond the scope of this thesis and therefore only those aspects that are needed to provide the necessary background to the framework are mentioned. In particular, General Systems Theory (von Bertalanffy, 1968), hard systems, soft systems, and critical systems theory (Flood and Jackson, 1991) are covered. A detailed account of the Soft Systems Methodology (Checkland, 1981), Interactive Planning methodology (Ackoff, 1981), Interpretative Structural Modelling (Warfield, 1976) and Critical Systems Heuristics (Ulrich, 1983, 1996) which are used in the framework, will be found in Appendix A.

Appendices B – G provide all the relevant information regarding the practical implementation of the planning framework.

CHAPTER 2

THE CURRENT STATE OF AFFAIRS IN RURAL TELECOMMUNICATIONS WITH A PARTICULAR FOCUS ON SOUTH AFRICA

2.1 Governance, Regulation, And Management Of The Communications Sector In South Africa

Prior to the establishment of Telkom SA in 1991 public telecommunications services in South Africa was the responsibility of the South African Posts and Telecommunications (SAPT) which legally monopolised all postal and telecommunications services. It operated a system characterised by internal cross-subsidies and shared many of the features of other national Posts, Telephone and Telegraph (PTT) and state owned enterprises. However, what was different about telecommunications in South Africa was apartheid. Historically, service was provided primarily to whites, and even when it came to remote or rural white farmers, the government subsidised the provision of services to these farms. In the late 1970s the relative neglect of the so-called non-white areas changed when the SAPT began extending services to Indian and Coloured areas and thereafter to Black areas.

South African telecommunications was beginning to be affected by the global forces of liberalisation, rapid advances in technology, political change, and a debt ridden and inefficient parastatal. Due to the political uncertainty with respect to nationalisation of state assets, the commercialisation route was chosen rather than privatisation, and thus the establishment of Telkom SA. The 1990s saw a major overhaul of the entire communications sector in South Africa, especially after the 1994 democratic elections. (See Gerber and Braun, 1998: 103 – 105)

There are now five major role players in the communications sector (including telecommunications and broadcasting) in South Africa that deal with the policy and regulatory environment:

- The Minister of Communications (Posts, Telecommunications and Broadcasting).
- The Parliamentary Portfolio Committee for Communications that oversees and prepares any communications bill or policy for approval by the National Assembly.

- The Department of Communications, which is the public service arm of the Ministry for communications. It is a policy making body for postal, telecommunications, and broadcasting services in South Africa.
- The South African Communications Regulatory Authority, which is appointed in terms of the South African Communications Regulatory Authority Bill. The function of this Authority is to regulate the telecommunications and broadcasting sectors.
- The Universal Service Agency whose role is to investigate and recommend ways to achieve universal service - whatever the agency defines it to be from time to time.

South Africa is a developing nation with approximately forty two million people and a per capita income of about US$ 3000. Twenty nine percent of the economically active are unemployed and forty six per cent of the population live at or below the subsistence level (Miller, 1999). Since the transition to an open democratic order in the last decade, there has been a rapid evolution of national policies to give effect to South Africa's national Reconstruction and Development Programme (RDP) goals, the overall goal being 'a better life for all'. Complementing the RDP programme is the government's Growth, Employment And Redistribution (GEAR) strategy whose two main objectives are the transformation of the economy to meet the needs of the new democracy, and gearing it for the competitive world economy.

In the context of these grand initiatives the telecommunications sector and more recently the information and communications technology sector is experiencing its fair share of rapid overhaul and evolution. There are some significant events, since the 1994 government elections in South Africa, which heralds this rapid overhaul and evolution. The establishment of the National Telecommunications Forum (NTF) in 1993 was a new experience in South African telecommunications policy formulation. The NTF, comprised of a range of stakeholders from government, business, labour, civic organisations, and academia. The members of the management board of the NTF were elected from amongst the stakeholder groups and there were several working groups formed to look at the relevant issues, such as governance, technology, regulation and telecommunications service to the under-served and rural areas. The NTF played a key role in the facilitation of the green and white paper that lead to the landmark Telecommunications Act 103 of 1996. (See Gerber and Braun, 1998).

In attempting to address the historical imbalances in the telecommunications sector due to South Africa's apartheid policy, the Act dealt with a number of issues such as the South African Telecommunications Regulatory Authority (SATRA), the frequency spectrum, telecommunications services, telecommunications equipment, vendors and technicians, universal service, some environmental issues, and human resource development. The new bill also sought to address the inefficient regulatory framework of the past by consolidating the numerous Acts pertaining to communications in general that existed. It must be mentioned that broadcasting was still being regulated by the Independent Broadcasting Authority (IBA), formed as a result of the independent Broadcasting Authority Act 153 of 1993. The formation of SATRA, the Universal Service Agency whose primary function is to promote and facilitate the goal of universal service, and the Universal Service Fund for the exclusive use of subsidies, is a significant step in that the regulation with respect to telecommunications now fell outside the control of the government, and the will to provide Universal Access was now taken seriously.

Recognising that technological and other developments in the fields of broadcasting and telecommunications are causing a rapid convergence in these fields, and acknowledging the subsequent need to establish a regulatory body to regulate broadcasting and telecommunications, the South African Communications Regulatory Authority Bill of 2000 led to a single Communications Regulatory Authority. The functions set out in the Independent Broadcasting Authority Act, 1993 and the Telecommunications Act, 1996 are now performed by this new authority.

During the Organisation for African Unity (OAU) summit in July 2001 African leaders adopted the New Africa Initiative (NAI), which puts information communication technology (ICT) at the forefront of continental development. South Africa has also realised the importance and dynamic nature of the ICT sector, and after intense consultative policy processes regarding the future of the telecommunications sector in South Africa the Minister of Communications announced the latest telecommunications policy directions in July 2001. The policy directions seek to promote amongst others, foreign and local investment, effective market competition, Universal Access, empowerment and skills development. The key areas include:

- The introduction of technology such as fixed-mobile that will prepare the envisaged second and third network operators for competition in a free economy. Currently there is only one fixed network operator in South Africa.
- A managed liberalisation of the market structure. The current owners of private telecommunications network will be licensed to carry public Teletraffic. It is also expected that a new frequency band will be allocated to the cellular network operators.
- The enhancement of the Universal Service Agency to facilitate also the evaluation, monitoring and implementation of Universal Access to telecommunications.
- A tangible facilitation of the education rate through a 50 percent discount for public schools on all calls to an Internet service provider including connection fees.
- The economic empowerment for the previously disadvantaged groups, especially women, by reserving 30 percent of all new licensees' shareholding for empowerment purposes.
- Consumer protection through the Independent Communications Authority of South Africa (ICASA).
- The establishment of Public Emergency Communication Centres designated as 112 emergency centres for the promotion of health, safety and security of all persons.
- An increased focus on under-serviced areas. The promotion of SMMEs (small, medium, and micro enterprises) as telecommunications service providers, including voice of the Internet, for Universal Access purposes.
- The issuing of broadband licences for purposes such as multimedia transmission or broadcast over fixed networks.

South Africa is noted for the way in which it develops policy in terms of process. The South African constitution is regarded as one of the most modern basic human rights–oriented set of principles. However, there are many weaknesses in the implementation of policy for the realisation of the constitutional goals, and one example pertains to the operational and planning practices of the telecommunications sector. While the objectives of Universal Access are to be admired, i.e. development, simplistic goals of massive roll out of telephone lines is not necessarily a good implementation of policy. It is envisaged that the contribution of this thesis would empower those responsible for the planning and deployment of telecommunications infrastructure, for a more appropriate implementation of policy.

2.2 The Telecommunications Network And Service Providers In South Africa

Telkom SA, which was formed as a company in 1991 from the previous Department of Posts and Telecommunications, owns and manages the current Public Switched Telephone Network (PSTN) as a monopoly. Until November 1996 Telkom's operating mandate stemmed from the Post Office Act of 1958 as amended. However, the Telecommunications Act of 1996 altered this protective licence. The South African Government has stated its intentions to liberalise the fixed telecommunications market in South Africa, beginning in May 2002. A clear route from exclusivity through a duopoly towards full liberalisation was spelt out. In May 1997 Telkom received three 25-year licences to operate the public switched telecommunication services (PSTS), radio communications, and the value added network services (VANS). The PSTS licence gave Telkom an exclusive right to operate local, national, and international telephony networks for five years.

During this protective period, however, Telkom is required to install 2.8 million new lines, including 120 000 payphones. Approximately 1.7 million lines must be installed in under–serviced areas. The government has made it clear that Telkom is to finance this expansion through a combination of retained earnings, borrowings either on the domestic or international money markets, or the sale of equity in the organisation. In addition, Telkom is to pay the state a settlement fee emanating from the break up of the previous Post and Telecommunications structure, whilst continuing to be a taxpayer. As a first step in raising revenue, Telkom sold 30 percent equity to SBC Communications and Malaysia Telecom.

According to Telkom's 2000/2001 annual report, all line rollouts for the first four years of its license have been met or exceeded. During this period Telkom has installed over 2.1 million lines taking the total to 4,961,743 as at 31 March 2001. Of these 1.4 million have been installed in under-serviced areas. However, at 31 March 2000 this figure stood at 5,492,838. The decline in 2001 is due to non-paying customers and commercial fraud, according to the 2000/2001 Telkom annual report. The wireline penetration rate was approximately 11.8 percent at 31 March 2001 (Telkom, 2001).

While lagging behind the developed world as far as teledensity is concerned, the Telkom infrastructure is sophisticated and well in advance of the rest of Africa and comparable to developed countries. According to the Chief Executive Officer's review in the Telkom annual report 2000/2001 "There is not a commercial communications technology in the world which is not available or being tested by Telkom for commercial use." At 31 March 2001, 99.6 percent of telephone lines had been digitised. A wide range of advanced communications services are offered. These are supported by technologies such as a fibre-based national network, ATM (Asynchronous Transfer Mode) backbone covering all metropolitan areas, high-speed data networks, IP (internet protocol) networks, ISDN (Integrated Services Digital Network), and wireless local loop (WLL) as access technologies. Currently ADSL (Asymmetrical Digital Subscriber Loop) technology, which enables expanded bandwidth at speeds of about 100 times the current rate, on the traditional copper lines, are being tested by Telkom. Telkom has also begun its network evolution to Packet Mode Architecture (PMA), which will be able to carry voice, data and video applications on demand. (See Telkom, 2001)

In addition to satellite technologies, Telkom also owns three undersea cables, which cater for voice and data traffic. These cables connect South Africa to various parts of Africa along the Atlantic, to Europe and to the Far East. A National Network Operations Centre (NNOC) proactively monitors and manages all the elements of the network in the country from a single location, which is comparable to the best in the world. Telkom is the first Communications Company in the world to provide prepaid fixed line services. (See Telkom, 2001).

In 1993 two public mobile cellular GSM (General Systems Mobile) network operators, Vodacom and Mobile Telephone Networks (MTN) were licensed in South Africa. In 2001 another cellular license was awarded to Cell-C. Competition will intensify further when the regulatory authority issue licences for the 1800MHz (900MHz is currently being used) radio frequency spectrum and third generation mobile communication technologies. Telkom SA does the fixed line switching for the mobile GSM operators. Vodacom had approximately 59 percent share of the mobile market in South Africa as at 31 March 2001, 79 percent of whom are pre-paid (Telkom, 2001). Cell-C was not in operation at the time of writing this thesis. One must take note that a considerable amount of the mobile GSM service is used by people who already have access to the fixed network, and therefore has not made a dramatic impact on rural telecommunications. Issues such as affordability and limited range of services compared to fixed line are inhibiting factors. To the best knowledge of the author at the time of writing this thesis there was no reliable data on the number of people that use the mobile service but do not have access to fixed line telephony.

In addition to the public switched networks other parastatals and private broadcasters and signal distributors have some self-provided telecommunications capacity. ESKOM is the sole power generation and Utility Company in South Africa. It has a network covering power plants, substations, and transmission lines, and their internal telecommunications network throughout South Africa. ESKOM has invested considerable resources into optimising their power networks for the transmission of data and voice, such as the rollout of optic fibre alongside the power lines. Transtel, the communications business unit of the transport parastatal Transnet has an extensive data network, including spare satellite transponder capacity. The public broadcaster, South African Broadcasting Corporation and its signal distributor, Sentech who are both parastatals have a considerable amount of communications infrastructure. In fact Sentech has been licensed to carry international tele-traffic for operators and service providers as of May 2002. Mnet, a private pay-television broadcaster and its signal distributor Orbicom, and eTV, a public broadcaster but a private company all own some communications infrastructure, but to a lesser extent than the parastatals. Finally, the South African national Defence Force also has telecommunications infrastructure for internal use, but details are kept secret. (See Hodge and Miller, 1996)

It can be concluded that South Africa as a developing country has telecommunications technology and the quality and variety of services associated with this technology, which is equivalent to that found in developed countries. However, the general telecommunications infrastructure is fragmented and separately developed by the respective owners without any co-ordination or consultation with each other. Furthermore, the resources have been concentrated on 'lucrative markets', and although there has been relatively substantial progress in terms of fixed line rollout to under-serviced areas, there is still a long way to go. Besides, the current planning approaches for rural telecommunications can be greatly improved or revolutionised to ensure that the rollout is most effective (see section 2.11 of this thesis). It is the author's observation that world–wide telecommunications operators seem to target the same market over and over again as new products develop. If the telecommunications market were to truly expand, then new markets have to be created or developed, and this is a wide open opportunity when one considers the number of people that do not have access to telecommunications.

2.3 Unpacking The Term 'Rural Telecommunications'

The word 'rural' conjures up different interpretations to people, depending on the country in question and the background of the interpreter. One might think of a rural area as being a predominantly agriculturally based area, which may not necessarily experience low economic activity as in certain developed countries. On the other hand low economic activity and remoteness might be criteria for an area being regarded as rural. One might also argue that in this day and age any 'densely populated' area without telecommunications infrastructure could be regarded as rural. Therefore, while one may have a general but clear notion of 'telecommunications', adding 'rural' to this word calls for an unambiguous explanation of what is meant by 'Rural Telecommunications' at least in the context of this thesis, and how it differs from any other telecommunications. The distinctive features of a rural area, however it is defined, will affect the planning of telecommunications infrastructure for that area.

2.3.1 What Is A Rural Area?

Although the word 'rural' conjures up different interpretations to different people, rural areas throughout the world tend to have similar characteristics. Populations are spatially dispersed, often increasing the cost and difficulty of providing rural goods and services effectively. Agriculture is often the dominant and sometimes the only economic sector in rural areas, and rural areas tend to be less developed, in general, than urban areas. Heymann (1987) specifies a comprehensive set of characteristics that defines rural areas, and while some of these pertain to any rural area some are typical of developing countries:

- Extreme climatic conditions, for instance countries on the equatorial belt experience high humidity and temperatures or extreme dryness combined with high temperatures.
- Difficult geographical conditions, for instance, steep mountains, deserts, swamps, and isolated islands.

- Isolated, sparsely and scattered settlements, limited number of population concentration points like villages or cities.
- Less developed infrastructure, for instance none or inadequate all-weather roads, public power supply, two-way communication facilities, and drinking water supply.
- Economy dominated by the agricultural sector. Service and the industrial sector of the economy are less developed.
- Natural wealth such as mineral resources or tourist attractions are often existing but hardly ever used.
- Low education and income level of inhabitants.
- Quality of life essentially reduced compared with the living conditions in the major cities.
- Tendency of migration of population from rural to urban areas.

Consequent to the specific economic conditions in rural areas the tax base is limited and therefore rural areas are seldom able to mobilise sufficient resources to finance their own development programmes. Furthermore, rural areas in general are often politically marginalized, leaving little opportunity for the rural poor to influence government policies. However, in certain developing countries such as South Africa the rural population forms a significant part of the electorate (due to the high rural population), but do not necessarily have adequate input and control into relevant government policies.

It is not surprising that the International Telecommunication Union (ITU) defines a rural area on similar lines to that mentioned above. The ITU-D Study Group 2, (1997) stipulates that a rural area will have one or more of the following characteristics, "lack of available power, poor geographic conditions, adverse topography, low population density, low level of economic activity, low income level, underdeveloped social infrastructure". These characteristics are then generalised into three kinds of factors that typify a 'rural environment': -

- **Economic and demographic factors** where the local economy is based on agriculture or fishing and where the population density is low with a lower average per capita income than the urban areas.
- **Geographic factors** where the rural populations are remotely located from the major urban centres and also isolated from each other by the nature of terrain.

- **Physical factors** such as under-developed transport and power distribution networks. Other physical factors include heavy rainfall and high groundwater levels.

For the purposes of rural telecommunications the study group defines a rural area as "comprising scattered groups of potential telecommunication users", which is isolated from the main switching centres by physical obstacles or financial constraints (ITU-D Study Group 2, 1997: 5-6). One must take note that rural telecommunications subscribers are not necessarily the same as remote subscribers. The latter is characterised by physical remoteness caused by either extreme distance or terrain and therefore may require special technologies such as satellite communication technologies. While the author does not disagree with the above definition of rural telecommunications and what constitutes a rural area, it does not fully cater for the South African context and other developing countries, especially with respect to the provision of telecommunications infrastructure.

Rural areas in under-developed countries are in a far worse condition in terms of general development and quality of life than rural areas in developed countries. Rural areas in certain parts of Africa including South Africa is plagued by low literacy, poor health conditions and below subsistence type economic activities. One of the dangers of formulating a generic description for rural areas is the unconscious tendency to oversimplify the problem by making too many assumptions and thus paying little attention to the extremes in rural conditions of different countries.

Although rural South Africa shares much in common with other countries, some features and development challenges are unique. The demographics of rural South Africa reflect past policies and the hurdles impeding efforts of rural people to maintain intact families. The legacy of the former homeland system is one of enduring planned and deliberate poverty. Because of the past policies, rural South Africa also has high-density population areas and dislocated settlements where people live in abject poverty. Many rural people live in these ghettos isolated from economic opportunities, necessitating high costs of transport for jobs and to accomplish basic tasks of daily life. Rural housing is often substandard or nonexistent, and many people are migrants working in urban areas. Many of them are still living in urban dormitories with attendant difficulties maintaining family and social ties. As a result, the rural-urban continuum takes a particular form in South

Africa. The level of interdependence between rural communities and distant large cities is higher than elsewhere, but there is a less organic linkage between rural areas and the towns near them. Present settlement patterns reflect the distortions and discrimination of the past, but forced removals under the old regime have made people reluctant to move as part of an officially promoted program. At the same time, the population is still quite mobile in search of better living conditions and jobs. ISRDS (2000).

It must therefore be noted that when it comes to the provision of telecommunications services to under-served areas the issues are not simply 'Urban vs. Rural' or 'Developed vs. Under-developed'. A more detailed treatment of the South African context in relation to telecommunications service will help to clarify this further.

2.3.2 A Perspective On The South African Demographics

One cannot obtain a deep and full understanding of the South African demographics without studying the political history and the effects of the Apartheid policies such as the Group Areas Act. However, the political history of South Africa is beyond the scope of this thesis and therefore attention will be focussed on a generic classification of the South African communities with particular emphasis on the under-provided communities with respect to telecommunications service. The under-provided communities can be categorised into four broad generic types according to settlement patterns (Williams *et al*, 1995):

A: **Metropolitan,** comprising entire functional-geographic settlements, such as those within the periphery of the main cities such as Pretoria, Durban and Cape Town.

B: **Smaller metropolitan,** comprising settlements around smaller cities and towns such as Port Shepstone and George.

C: **Non-metropolitan dense,** comprising mainly informal settlements on the periphery of metropolitan areas, and whose inhabitants do not derive a significant proportion of their income from agriculture.

D: **Non-metropolitan sparse,** being the traditionally true rural areas. These areas have low population densities and derive a significant proportion of their income from agriculture or from remittances from urban areas. They can be cluster settlements (traditional villages with a community nodal point), ribbon settlements (along major arterial routes) or sparse settlements.

It is understandable then why the Foundation for Research and Development in South Africa who administers, amongst other things, the Communication Systems Research Programme, defined rural communications to include affordable high penetration communications for under-provided communities with high population densities, located either in remote rural areas or on the periphery of developed urban areas, as well as remote low density communications for rural people (Williams *et al*, 1995: 3).

In its commitment to addressing the undesirable telephone penetration in the world, the ITU defines the concept of 'Universal Access', which recommends that all members of the population should be within one hour's walking distance to telecommunications service, in developing countries (Maitland, 1984). Universal service on the other hand implies the exclusive use of the local loop by the end user. However, the immediate implementation of the latter service is unrealistic when one considers the financial implications and priorities of developing countries.

Hudson (1999) brings another perspective on Universal Access. She considers Universal Access as a moving target depending on the context of the particular region or country. The definition of basic service, such as POTS (plain old telephone service), needs to be flexible taking into consideration changes in technology and user needs. Therefore goals should not be stated purely in terms of teledensity or a particular type of technology, but in terms of functions and capabilities, such as voice, data and Internet. In addition, information access is crucial for socio-economic development, and therefore Universal Access should not be measured only in terms of the number of individuals that have access to telephone services, but also in terms of the community and institutions such as schools, clinics, libraries, and community centres.

If Universal Access then is the primary goal of rural telecommunications then the urban – rural duality of telecommunications infrastructure implied by the ITU is just a small part of the problem facing Universal Access in South Africa. According to a recent survey, the current levels of penetration in rural and low income urban areas are under one percent whilst that of urban areas is 18 percent, the ratio of white to black ownership is 60:1, and the ratio of wealthy areas to poor areas (irrespective of demographic and geographic criteria) is 28:1. (Stavrou, 1995: 11). The survey further shows that the provision of telecommunication services among the provinces of South Africa is vastly skewed in favour of Gauteng and the Western Cape as an example. However, the scope of this thesis will permit only investigations into planning of rural telecommunications infrastructure for category D although the principles derived may also apply to the other categories.

2.4 Development As A Purpose For Providing Rural Telecommunications

Development as a concept, especially rural, has many connotations. One may view it as economic development while another party may view it as the modernisation of facilities and services or industrialisation. What is viewed by one country as development may be viewed by another country as exploitation. Therefore the issues pertaining to development in general, and then specifically to rural development will be clarified in the following sections.

(Goulet, 1978: xiii-xiv), in *The Cruel Choice*, gives three views of development. Development is synonymous with economic growth in aggregate terms where one measure of this is Gross National Product (GNP) per capita. This was the essence of the 'Dominant Paradigm' that guided many of the early international development projects. Although there is a tendency to move away from this view it still retains its influence. Rogers (1976) mentions the failed assumptions of this paradigm. Quality of life indicators were not considered important, as the common belief was that higher levels of income and employment would inevitably lead to an improved quality of life. Unfortunately the growing amount of wealth did not trickle down to the most needy but instead fell disproportionately on the already less needy. A second failed assumption was that the patterns of economic developments that characterised the more developed countries such as in Europe and North America formed the blueprint of development for the rest of the 'underdeveloped world'. Unfortunately industrial growth did not narrow the gap of the urban/rural duality in terms of economic development.

Secondly, development is seen as 'development = economic growth + social change'. This was first summarised at the start of the United Nations' First Development Decade (1960–1970). Over the years a number of initiatives regarding the development of both quantitative and qualitative indicators for the assessment of socio-economic development in a country, have been undertaken. Williams and Smith (2000) provide a comprehensive review of such initiatives. The organisations that were party to these initiatives include, the United Nations, the Organisation for Economic Co-operation and Development, the International Monetary Fund, and the World Bank.

Third, according to Goulet, development is viewed in terms of ethical values, which centres on the qualitative improvement in all societies and in all groups and individuals within societies. He proposes three values, which are goals of development, which are sought by all individuals and societies (Goulet, 1978: 87-91):

- Life Sustenance, whatever is produced or implemented in the name of development must ensure the sustenance of life.
- Esteem, self-worth and the yearning for recognition as a human being are intrinsic.
- Freedom, at least evident in an expanded range of choice.

It is also interesting to note that Ackoff (1981), in chapter two of *Creating the Corporate Future,* which is the seminal text on Interactive Planning used in this thesis, argues along similar lines that growth and development are not the same thing. Development is not a condition or state defined by what a person has. It is a process in which an individual increases one's ability and desire to satisfy one's own desires and that of others - an increase in capacity and potential. Development has more to do with the quality of life than standard of living.

Chambers and Conway (1992), similar to Rodgers' (1976) criticism of the 'Dominant Paradigm in development', have criticised the predominant worldview of development among professional developers that leads to so-called developmental projects. They highlight three significant problem areas that relate to production thinking i.e. the focus on production rather than entitlement; employment thinking i.e. the focus on jobs rather than the varies activities of the rural poor; poverty-line thinking i.e. the measure of deprivation predominantly in terms of income instead of earning potential. In response to this

Chambers and Conway (1992: 31-33) advocate some alternate principles to guide rural development that is based on capability, equity, and sustainability. These are principles have similar tendencies to the goals advocated by Goulet (1978). Hardaker (1997) elucidates these principles in the context of policy guidelines for sustainable agricultural and rural development (SARD) as shown below:

Enhancing capability:

The provision of enabling infrastructure and services including:

- Education for livelihood-linked capability
- Health, both preventive and curative to prevent permanent disability
- Bigger and better baskets of choices for agriculture, and support for farmers' experiments
- Transport, communications and information services (about rights, markets, prices, skills...)
- Flexible credit for new small enterprises

Improving equity

Giving priority to the capabilities and access of the poorer, including minorities and women, via:

- Redistribution of tangible assets, especially land, and land to the tiller
- Secure rights to land, water, trees and other resources, and secure inheritance for children
- Protection and management of common property resources and equitable rights of access for the poorer
- Enhancing the intensity and productivity of resource use, and exploiting small-scale economic synergy
- Rights and effective access to services, especially education, health and credit
- Removing restrictions, which impoverish and weaken the poor

Increasing social sustainability

Reducing vulnerability so that the poor do not become poorer by:

- Establishing peace and equitable law and order
- Disaster prevention

- Counter-seasonal strategies to provide food, income and work for the poorer at bad times of the year
- Prompt support in bad years and high prices for tangible assets people sell in distress
- Health Services that are accessible and effective in bad seasons, including treatment for accidents
- Conditions for lowering fertility.

The modern trend in sustainable rural development seems to fall in line with the principles similar to that advocated by Goulet (1978) and Chambers and Conway (1992) (see for example ISRDS (2000), Hardaker (1997), the Overseas Development Institute materials on their web site http://www.odi.org, and the Food and Agricultural Organisation of the United Nations on their web site http://www.fao.org). During the last twenty years, in a series of United Nations global conferences, concerns over major developmental issues such as those pertaining to education, social development, women, and the environment and development, were raised. A strategy of development based on seven international goals was formulated, which are to be achieved before 2015 in order to improve the quality of life in developing countries. The seven goals that are mentioned below call for development approaches that only modern trends in development can address: -

- Reduction by half of the portion of people living in extreme poverty by 2015,
- Universal primary education by 2015,
- Elimination of gender disparity in primary and secondary education by 2005,
- Reduction of infant and child mortality by two-thirds of the 1990 levels by 2015,
- Reduction of maternal mortality by three-fourths of the 1990 level by 2015,
- Access to reproductive health services through the primary health care system for all individuals of appropriate ages, including safe family planning methods by 2015,
- Reversal of trends of loss in environmental resources by 2015,

(See Udjo *et al*, 2000; OECD, 1998, 2000)

At a local level, the South African government has commissioned The Integrated Sustainable Rural Development Strategy (ISRDS) in 2000. The following excerpt from the document reflects the line of thinking of the decision makers with respect to rural development (ISRDS, 2000: 19).

> "Rural development is understood to be multi-dimensional, encompassing improved provision of services, enhanced opportunities for income generation and local economic development, improved physical infrastructure, social cohesion and physical security within rural communities, active representation in local political processes, and effective provision for the vulnerable. Rural development in this context is thus much broader than poverty alleviation through social programs and transfers. The concept places emphasis on facilitating change in rural environments to enable poor people to earn more, invest in themselves and their communities, contribute toward maintenance of the infrastructure key to their livelihoods; in short, to identify opportunities and to act on them. A successful strategy will thus make people less poor, rather than more comfortable in their poverty. This emphasis is complemented by specific measures to assist the vulnerable and relieve the burdens of poverty."

The vision of the ISRDS is to attain socially cohesive and stable communities with viable institutions, sustainable economies and universal access to social amenities, able to attract skilled and knowledgeable people, equipped to contribute to their own and the nation's growth and development. A successful strategy to achieve integrated sustainable rural development will reflect each of its three key elements: i.e., integrated, sustainable, and rural development. This vision is in keeping with the latest thinking in rural development.

The traditional methods of intervention in rural areas or the traditional professional rural development practice have also been critically reviewed in the last decade, and as a result of these criticisms newer approaches to rural development have emerged. These recent approaches have moved towards a recognition and appreciation of power relationships and cultural constraints within which participative processes can occur. Scoones and Thompson (1993, 1994) provide a critique and assessment of methods used in rural development practice in the context of rural people's knowledge. The approaches have changed over the years, from the traditional scientific approach that is underpinned by positivism where the professional role is defined in terms of "educating, directing and transforming, based on the assumption that rural people's knowledge is primitive and unscientific. In the popularist "farmer first" approach such as Farming Systems Research, intervention is viewed as a partnership and therefore participation is crucial. Finally, in the critical "beyond farmer first" approach such as Participatory Action Research, rural people's knowledge represent "varying frames of reference, the analysis of which requires the explicit addressal of power and need".

According to Pretty and Chambers (1994) current participatory approaches include methodologies based on systemic learning, multiple perspectives and group inquiry of the local context, facilitation of communication between stakeholders and consultants, leading to sustained action. One of the challenges in the development of the planning framework will be to ensure that the societal intervention through rural telecommunications infrastructure is carried out in line with latest trends as mentioned by Pretty and Chambers (1994).

In investigating the relationship between telecommunications and rural development the writings of Hudson and Parker(1975) are relevant. It is interesting to note that these authors regard the goals of development as questions of moral judgement rather than empirical research (Hudson and Parker, 1975: 1178). Economic development as a spin off from rural telecommunications, as an example, could be regarded as increased production and sales as an end in itself or as a means to improving the quality of life of the rural community. They advocate that any provision of technology or infrastructure that professes to aid human development must ultimately seek to improve the quality of life by addressing the earlier mentioned Goulet's goals of development. The goals of life sustenance, esteem, and freedom are interrelated and none can be given absolute priority over the others. This is far from a model of economic development that treats production as a final goal rather than a means to human development.

According to Freire (1970), development can be regarded as an awareness-action process. In order for people to change they must be aware of the alternatives. At one level, development is a "process" of building collective awareness through identification of common problems, information seeking about options, and organisation to implement solutions. At another, development is the "act of change" itself - the acquisition of new knowledge and skills, the adoption of new practices, the increase in production that leads to self-sufficiency. Communication is vital to the process of awareness and action by providing links between people with similar problems and a means whereby they can gain information and organise themselves. And once they have decided to act, communication provides the mechanism to keep their endeavours going.

It should be obvious that the deployment and development of infrastructure type technologies whether it be transport, electrical power distribution, or piped water in a particular rural area is intended for the development of that area. Rural telecommunications should be no different. Telecommunications provision can stimulate development as well as being a sign of development and is therefore an essential infrastructural component for development. However, Hudson (1984: 5) states:

> "As a development tool, telecommunications has been largely ignored by planners and theorists. It is generally grouped with public utilities and infrastructure, ranking far below roads, power supply, water, and sanitation as investment priorities. Yet telecommunications is a tool for the conveyance of information, and it is the lack of the consideration of the role of information in development theory that is perhaps more surprising".

This situation has not changed much since 1984, despite the increase in the literature especially those published by the ITU, about the impact of rural telecommunications on development. One reason for this slow change is that the current planning framework or methodologies for rural telecommunications has not changed much and if it has changed the changes are about new technologies and improved planning tools focussing on the technical issues.

It must be stated at the outset that simply rolling out massive amounts of infrastructure is not the most appropriate antidote to underdevelopment. Numerous studies have shown that telecommunications is necessary but not sufficient for rural development (Hudson, 1999). In other words telecommunications infrastructure by itself will hardly promote development. This is also clear from the Hardaker's (1997) elucidation of Chambers and Conway's (1994) principles to guide rural development, mentioned above. Nevertheless one cannot emphasise enough the significant role of telecommunications in rural development.

In attempting to develop a theory on the role of telecommunications in development, Hudson (1984: 15-32) proposes a series of hypotheses, which are subsequently substantiated in her research and those of the ITU. These are listed below:

- The effects of telecommunications use do not accrue exclusively to the users, but accrue also to the society and the economy in general.
- Telecommunications permits improved cost-benefits of rural social service delivery.
- Telecommunications permits improved cost-benefits for rural economic activities.
- Rural telecommunications permits more equitable distribution of economic benefits.

- A certain level of organisational development and complementary infrastructure is required for socio-economic benefits of telecommunications to be realised.
- Telecommunications use can facilitate social change and improved quality of life.

There can be no real human development then without attending to all aspects possible, with the aim of increasing the capacity and potential of the individual as insisted by Ackoff. There is no doubt that rural telecommunications can play both a direct and an indirect role in achieving these goals for the particular rural community. However, it must be noted that development consists of a desire and ability and therefore it cannot be given to or imposed on a person by another, by government or by the rural telecommunication network providers. Such development can only be encouraged or facilitated. The important question then arises: How can these development issues be taken into consideration in the planning and design of rural telecommunications infrastructure?

It must be noted that this research is about developing a planning framework for rural telecommunications in developing countries. It is not a study on rural development in itself. However, the essential features of rural development mentioned in this section are necessary to inform the development of the framework for rural telecommunications planning but further investigation of the link between planning of rural telecommunications infrastructure and rural development would require a separate study as it falls outside the scope of the thesis. The following sections will deal with other aspects of rural telecommunications.

2.5 Telecommunications Access: A Right Or A Privilege?

The controversial issue as to whether the access to a telephone is a right or a privilege deserves some attention in this section. This was a sensitive debate in South Africa especially since 1994. Certain sectors of the population such as civic organizations held the view that telecommunications access is a right while other sectors such as the network provider held the view that it is a privilege. After completing the 'Right to communicate' project the United Nations' (UN) Administrative Committee on Co-ordination (ACC) issued a *Statement on Universal Access to Basic Communication and Information Services* in April 1997. The statement concluded that the provision and utilisation of information and communication technology must receive priority by the UN in order to ensure sustainable human development (ACC, 1997).

Apart from the technology-focussed research in rural telecommunications, a variety of studies have been undertaken on the impact of rural telecommunications on social and economic development. Some references of these are provided in the next paragraph. The thinking has evolved from a position of uncertainty to a much clearer understanding of the benefits of providing telecommunications access. Wellenius states that:

> "The weakness in understanding the economic and social impact of telecommunications make it virtually impossible to justify telecommunications investment objectively in face of strong competition from other sectors for scarce resources, such as capital contributions by government or those obtained as credit and loans from multilateral organisations. The latter, in turn, have little objective argument in favour of sustaining an important telecommunications lending effort. The situation is made worse by the absence of input-output data showing the amount of telecommunications used by other economic activities." (Wellenius, 1976: 726)

However, the correlation between socio-economic development and a healthy rural telecommunications infrastructure is now more certain. Pioneering work conducted by Hardy based on 37 developing countries and 15 industrialised countries provides an empirical foundation for the belief that investments in telecommunications infrastructure lead to economic development (Hardy, 1980, 1981). He also established that the causality has an interdependent characteristic in that economic development also leads to more investment in telecommunications infrastructure. Cronin *et al* showed, in a study based in Pennsylvania, that there is an interdependent relationship between telecommunications infrastructure investment and economic activity and growth at the national, state, and urban and rural county levels (Cronin *et al*, 1995). China has shown that an additional investment of 100 million yuan in the post and telecommunications industry will increase national income by 1.38 billion yuan after 10 years i.e. an internal return rate of 45 per cent (Zhoa and Junjia, 1994: 215).

The ITU Study Group 2 mentions at least 10 benefits derived from investments in the telecommunications sector (ITU Study Group 2, 1997: 12-14). These include enhanced social well-being, improved efficiency of government programmes and services especially in the health and education portfolios, support for regional dispersion and, energy savings.

The controversial question then as to whether telecommunications access is a right or a privilege is not an issue at all. What has been established is that telecommunications access is vitally necessary for the development of almost all aspects of a country, state, or any rural area for that matter. The real issue then is how to ensure that maximum benefits are derived from the rural telecommunications infrastructure for all its stakeholders, bearing in mind Lewis' conclusion that the 'advantage of economic growth is not that wealth increases happiness, but that it increases the range of human choice' (Lewis 1962: 478). In other words how can the rural telecommunications infrastructure serve the goals of development as discussed in the previous section?

So the controversial debate whether telecommunication access is a right or privilege, which was high on the agenda of many telecommunications discussion forums in South Africa since 1994 detracts from the real issue. Granted that correlation between events is not the same as cause and effect, there is nevertheless sufficient evidence to show that there is a significant interdependence between the provision of telecommunications infrastructure and economic development and if one is serious about rural development or development in general in South Africa, then one has to give serious consideration to providing rural telecommunications services. However, one must take cognisance of the author's contention that a systemic planning framework for the provision of these services is vital for sustainable and beneficial rural telecommunications. The author believes then, that the debate is superfluous and perhaps political, instead, telecommunications access should be regarded as an absolute necessity by all stakeholders for the reasons discussed above.

2.6 Rural Telecommunications Services: Supply Versus Demand

Hardy (1980) and Hudson *et al* (1982) analysed the 'chicken and egg' correlation between telecommunications and economic growth and more recently Cronin *et al* (1991) conducted a detailed economic analysis of the US economy from 1958 to 1988, showing a direct link between telecommunications investment and the growth in the US economy. Nevertheless there is still the dilemma of investing in infrastructure in areas where the economies of scale are just not there for a desirable investment, from the point of view of the financier. The deployment of telecommunications infrastructure for the short-term and long-term benefit of both the subscriber and the provider requires scarce capital outlay. According to (Bowry, 1998: S2) there is an annual funding shortfall of around US$ 30 billion for the provision of basic telecommunications in the developing countries Raising this sum of money requires innovative solutions such as progressive liberalisation.

A major challenge to contend with is that the ratio of revenues to cost may be considerably lower because of higher costs and low population densities and, rural incomes are generally lower than the urban ones and so the people are less able to afford telecommunications services (Hudson, 1984). The tension arises with the Telcos having a pent up demand for more profitable services in urban areas and for international circuits. However, the suppliers of the financial resources that are required for the deployment of the telecommunications infrastructure are interested in the return on capital investments and the telecommunications infrastructure is expected to pay for itself, unlike roads and water. The return on investment is also directly related to the degree of risk and the policy or regulatory framework.

The cost of installing and maintaining rural services therefore are likely to be significantly higher on a per subscriber basis than cost of urban systems. The cost per installed line (if one is using copper or fibre) is inversely proportional to the density of lines per unit area and the income per circuit is lower than that of the urban areas. In KwaZulu-Natal, South Africa the cost for rural areas is at least three times more than that for urban areas (Smith *et al*, 2000). Therefore the cost of local switching equipment per access line served in rural areas is many times more than that in urban areas for the same grade of service.

On the other hand there is also the belief that a healthy supply of telecommunications infrastructure and a variety of services will create the desirable demand. This tension becomes even more difficult to resolve when one contemplates what range of services should be provided. Hudson (1984) suggests a possible solution. She asserts that the indirect benefits of rural telecommunications may more than justify the costs and begs that they be taken into consideration in planning and evaluation of rural telecommunications systems. "The indirect benefits in rural areas may be particularly important to consider because demand as shown by revenues may not accurately reflect need to communicate nor benefits derived from communications" (page 58). One simple example of this is the consumer surplus that results due to savings in transportation fares. However, Hudson admits that there is a problem of uncertainty in that even if planners are willing to consider the indirect benefits, it is not always easy to predict and quantify them. The caution of urban solutions spilling into rural areas is a double-edged sword. One has to make sure that appropriate technology and services are provided while the urban kind of competition should not be an expectation for rural areas.

Parker (1982) states:

> "The dominant feature of rural telecommunications needs is that they are basically the same as urban telecommunications needs. Just as urban want video, audio, and data services, so do rural people...[t]he differences between rural and urban telecommunications are not primarily in the nature of the service needed, but in the different environmental and social contexts of those needs."

On the other hand, Dillman and Beck (1990) imply that rural citizens are Information Age 'laggards', suggesting that the needs of the rural communities are very different to their urban counterparts.

Hudson (1999) cautions the myth that rural benchmarks must be lower than urban benchmarks. Too often planners believe that providing the bare minimum of services is a technically feasible, economically justifiable goal for rural areas. However, new technologies such as the wireless local loop, very small aperture terminals and digital subscriber loops together with the right kind of planning can reduce costs, increase reliability, and ensure a higher usability of service. This applies to both developed and developing countries. The United States Telecommunications Act of 1996, for example, demands that rural services and prices are to be reasonably comparable to those in urban areas. In the Philippines, which is a developing country, both industry and government have agreed on services comparable to that of the urban areas, such as digital exchanges, facsimile, and data services.

It must be noted that the views of Parker (1982), and Dillman and Beck (1988) are based on North American case studies. The South African demographics in the rural areas are typical of those in a developing country and therefore one needs to be cautious when applying those research results in a developing context. However, what is valid is that the traditional myths about rural communities may be just that – myths. If the policy makers and planners of rural telecommunications want to ensure the realisation of the goals of this infrastructure, then careful attention must be paid to the nature of the demand for services by the rural communities. Perhaps the view of Shields *et al* (1993) provides a clearer directive. Accepting that the socio-geographical context plays an important role in shaping the nature of telecommunications needs and behaviour, these authors suggest that there should be significant differences within rural areas. In other words users should be understood as being located somewhere along a rural-urban continuum rather than on one side or the other of a rural/urban dichotomy.

It is unfortunate that the emphasis in South Africa is on Universal Access only as far as the rural areas are concerned, in other words just a simple telephone service. While this aim will ameliorate the current situation with respect to telecommunications services, one must take cognisance of the increasing divide between the information rich and the information poor, and seriously consider the need for a wider range of services.

Jonscher (1987) showed the economic benefits of providing residential telephone services while Westerveld and Prasad conclude that "a small proportion of the total amount of subscribers (referring to rural areas) can be a large burden on the back of the public telecommunications operator" (Westerveld and Prasad, 1994: 70-71). However, Singh submits that the very possibility of rolling out a network in a rural area has repeatedly encountered a 'conceptual barrier', which has constricted innovative thought. (Singh, 1991: 197). To this end he has developed a Demand Aggregation Model to address the dispersed pockets of demand for the American context. (Singh, 1991: 234-274).

Hudson (1999) cautions against another myth that demand for telecommunications in rural areas is very limited. Such assumptions are due to the lack of reliable tele-traffic data and are therefore typically based solely on the lower population densities than that which are found in urban areas, coupled with the 'one-size-fits-all' fallacy that assumes all rural residents are likely to have lower incomes and therefore lower demand for telecommunications than in urban areas. Income is a useful predictor, but there are also many other factors that generate demand. Villagers in remote KwaZulu Natal may be very poor, but they may need to communicate with the 'outside world' regarding their arts and crafts or the fruits of their labour.

As rural and isolated people gain greater control of natural resources and demand more political autonomy, their needs for communication also increase. However, this is also true for national governments. In South Africa, since 1994 many remote election offices for governmental candidates were set up in deep rural areas so that during an election period, the results can be transmitted as soon as possible to a central office.

A common assumption amongst the telecommunications industry in South Africa is that many rural people do not have any money and therefore cannot afford to pay for the telephone service. Yet these very same people are prepared to purchase a prepaid cellular phone card, which works out far more expensive than a fixed phone service, on a call for call basis. Is the problem then really one of affordability or is it a more deep-rooted issue such as historical perceptions about the parastatal Telkom SA as being part of the 'apartheid's state machinery'. This needs to be investigated further.

The analyses in this section show the tensions that exist between so-called conflicting vested interests. While telecommunications is necessary for economic development, financial investors are sceptical about return on investments. The views of different respected writers in the telecommunications area on issues related to supply of and demand for telecommunications services within the context of financial resources were also mentioned. The resolution of these issues is no trivial task. A contention of this thesis is that an appropriate planning and design framework for rural telecommunications infrastructure deployment will contribute to the resolution of some of these issues.

2.7 Implications Of Technological Factors On Rural Telecommunications Service

Infrastructure technologies such as telecommunications, electricity distribution and those that relate to the built environment do not provide just modern conveniences, but play a major role in shaping societies. According to Nye (1990). "A technology is not merely a system of machines with certain functions; it is part of a social world...Put another way, each technology is an extension of human lives, someone makes it, someone owns it, many use it, and all interpret it". On the other hand societies determine the shape and emerging patterns of some of these technologies. The physical manifestations of the benefits of rural telecommunications technology may be easily quantified, but the real interactions between the technology and the communities it serves can only be understood as abstractions (Singh, 1991). He explains that at a 'higher level of abstraction' the different infrastructure technologies share a certain systemic quality to which the

American social system has repeatedly responded in a similar manner. The physical aspects of an infrastructure technology may be conceptualised as a network system comprising a range of interconnected subsystems (nodes), where changes in a particular subsystem or the connections (links) between subsystems induce changes or reconfigurations in the other parts of the system. And so the interconnections between the subsystems become more important than the subsystems themselves. The actual placement of the network in time and space is a function of the softer but vital issues or in Singh's words 'social-economic-political-cultural forces operating within society.'

On a practical level, because of the uniqueness of rural areas it will be impractical to find a technology that will provide the optimum solution for all rural areas. Although there have been great strides in the advancement in communication technology over the last decade, especially the so-called rural technologies, different rural areas have their own unique features and would therefore require their own unique solution. Therefore a primary challenge in designing a telecommunications service for rural areas is the choice of appropriate technologies that will provide the most efficient network and most effective system within the constraints of distance, physical terrain and low population densities. Decisions will have to be made as to whether the plain old telephone service (POTS) will be sufficient or POTS-plus needs to be available for a particular region. The grade of service for example, which is a policy issue, will determine the type of technology to be used.

Network providers have a tendency to standardise on technology. There are many practical reasons for this. However, certain rural conditions may call for a more appropriate technology that may not be in the standard selection. Very often, standardisation of technologies is done by a central office of the network provider, who is not familiar with the rural conditions elsewhere, and so the local planners have to concede to a less preferred technology. The author carried out an experiment with four telecommunications access technology specialists from a network provider, which dealt with the selection of technologies for a particular rural area using a MCDM (multicriteria decision making) technique. The consensus choice was a technology that was not on the standard list. (See Andrew *et al*, 2001)

Hudson (1999) cautions another myth. There is an implicit assumption by telecommunications planners that all rural customers have the same needs. Yet not only are individuals and families likely to have different communications needs from rural businesses and organisations, but these institutional users of telecommunications services may differ in their service requirements and traffic patterns. The growing debate of whether Internet access is a right for rural dwellers will have to be considered in deciding the capacity of the network and consequently the technology that needs to be used. Network operators who adopt a 'one-size-fits-all' approach may limit choices for rural customers and may inadvertently limit their own revenues.

Planners often assume that voice service is all that developing regions will ever need. While there may never be demand for a modem in every hut, demand for Internet access is likely to grow among government offices, small businesses, co-operatives, schools, and health centres. Due to the terrain in the rural parts of KwaZulu Natal radio-based access technologies – generically referred to as the 'wireless local loop', is a more appropriate technology than the traditional copper line. However, these technologies do not cater for broadband services. Fixed cellular also has insufficient bandwidth for accessing the Web (although global system for mobile communications (GSM) promises Internet access with the introduction of GPRS (general packet radio services) by the end of 2001).

Some comments need to be made about the GSM cellular service in South Africa. There was an expectation that this service would help solve the rural telecommunications problems with respect to Universal Access. The growth in the cellular market has been phenomenal, with revenues exceeding the forecasts by at least three times. However, does this mean that many rural dwellers have cell phones? The ITU (1998) World Telecommunications Development report raises two pertinent issues that have a bearing on the South African mobile cellular scenario. Cost is the main constraint that prevents cellular from being a viable alternative for first-time telephone users in developing countries. Apart from the monthly contract fee, the cost of cellular calls is at least three times that of fixed line calls. An interesting indicator is the 'substitution rate' – the ratio of mobile cellular subscribers to total telephone subscribers – which indicates the degree to which the mobile cellular is being used as an alternative rather than a supplement to the fixed line network. No reliable data could be found for the South African situation, but what is clear is that a high cellular teledensity does not necessarily indicate an overall high teledensity for rural areas, and considering the cost and the limitations on bandwidth, GSM cellular service is not the rural telecommunications answer.

The need to communicate 'mega-bandwidths' of information at the highest possible speed has resulted in a rapidly changing technology environment and a corresponding increase in the range of information services. The urgent calls for the convergence of technologies namely data, voice and video as an integrated package over the PSTN (Public Switched Telephone Network) has lead to the emergence of 'the next generation network' which is built on a packet switched architecture rather than a circuit switched topology. If the gap between the information rich and the information poor is to be progressively reduced, a major challenge is finding the right kind of technologies for the rural situation.

The use of sophisticated systems used in urban areas for serving low-density areas is not without challenges. Although systems need to be compatible with the rest of the conventional network maintaining a uniform installation could prove to be a disproportionally expensive exercise when one considers the low number of installations, lack of operating skills and parts replacement costs alone. Technology has to be backed up by appropriately skilled human resources, which are scarce in rural areas and the skilled persons do not readily re-locate from the lucrative urban areas. This raises a further challenge that the deployment of infrastructure technologies must be accompanied by the development of human resources and perhaps modular components for ease of maintenance by the local people.

A major problem in network design for rural areas or, in any area where there is a total lack of telecommunications service is the forecasting of telephone traffic and services as no historical data exists. According to Smith *et al* (2000) this usually requires an iterative process over a period of a number of years to come close to a reliable level. It is common to find in KwaZulu Natal that the rollout of services in certain areas have far exceeded the 'demand'. There is a high churn factor amongst the subscribers in the year after the provision of services. The churn factor relates to the number of people that was expected to subscribe to the telephone services but do not do so, and the number of people that drop out as subscribers compared to the subscriber base during a period. On the other hand as development increases in a particular rural area, the demand for services will grow. The technology therefore has to cater for a rapid increase in capacity as the demand grows.

This section highlighted the challenges that the technology specialists face when dealing with rural telecommunications. The technology is just not a means to an end, but contributes to a social intervention in a community. In addition, working in an uncertain environment, especially with regards to the parameters that are required for efficient and effective technology design, including the sustainable maintenance requirements, complicates the task of the rural telecommunications planners. The next sections highlight some of the challenges that really characterise the KwaZulu Natal region.

2.8 Impact Of Physical Factors And Parallel Infrastructure On Rural Telecommunications

The lack of basic parallel infrastructure such as readily available power, roads and transport will have a significant impact on maximising the benefits of the rural telecommunications infrastructure for rural development. It is unlikely that rural telecommunications as an infrastructure in itself will facilitate rural development and therefore investments in rural telecommunications infrastructure should be selective, evaluating the merits of each community. Once again a holistic approach is called for.

Lesser (1978) mentions the notion of complementarity between telecommunications infrastructure and parallel infrastructure which captures the essence of the intended argument:

> "This notion of complementarity between telecommunications and other infrastructure components may in turn mean that the economic development benefits of telecommunications are to be mainly realised only in combination with other infrastructure components. A corollary hypothesis might be that there is some minimum threshold level of each such infrastructure element which must be realised before the benefits of any one element can be fully maximised and that to expand one element, say transportation, beyond its threshold while leaving some other, say telecommunications, below its threshold, will produce a minimal, or zero, impact on growth." (See also Hudson, 1999).

The importance of the availability of a public power grid is just not for the supply of electrical power for the telecommunications equipment. The use of dielectric transmission medium, such as a fibre optics cable, which is not susceptible to electromagnetic interference for telecommunication signals, provides an opportunity for collaboration between power distribution utilities and the telecommunications network operator. The cables for the network could piggyback on the power grid rights of way, thus reducing the capital expenditure and utilising less natural and human resources. The power utility in South Africa, ESKOM, is currently investigating the feasibility of using their high voltage pylons for housing microwave antennas (Pretorius and Britten, 2001). This venture will result in a much more efficient outlay and utilisation of overall infrastructure. In addition, there will be less intrusion in the natural environment, due to the savings in radio infrastructure.

An efficient postal service is a soft infrastructure that is vital for the management of a telecommunications service. Allocating a physical address or a postal address to the inhabitants in rural areas in developing countries is not a simple issue. Apart from the geographical conditions, individuals frequently relocate, with the result that the network operator has difficulty in ensuring the receipt and payment of a bill. Recent advances in pre-paid phone cards for subscribers should help to resolve this problem, but the cost of such a service is high compared to the traditional system, at least for the time being.

The general topography and the remoteness of the rural area from the nearest exchange will certainly influence at least the roll out schedule and the choice of technology to be used. One of the key distinguishing features of rural areas is the topography of the land. KwaZulu Natal is noted for its hills and valleys, and mountainous areas. Even more interesting is the fact that rural communities tend to live in the valleys in one part of the province, and on the hills in another part of the province, depending on the climate. These differences have a major impact on radio planning. Other environmental factors such as lightning, fluctuations in temperature and wind speed, heavy rainfall or snow will directly affect the provision of telecommunications services.

Equally important is the impact that technology has on the environment. Environmental issues are receiving more mandatory considerations than ever before, especially in South Africa. The laying of cables into the earth or suspended from pole to pole, the erection of radio towers that generate radio and microwave frequency, and global warming all have an impact on environmental issues. A recent controversy about the impact of electromagnetic radiation from cellular telephones on human health adds to the environmental challenges. Although there are no conclusive results as to the effect of the radiation, one cannot wish this issue away. In a nutshell, the planning and development of a rural telecommunications infrastructure will not be successful if the relationship between this infrastructure and the corresponding environmental system is not considered.

2.9 Implications Of Sociological And Cultural Factors On Telecommunications

This section is inextricably linked to some of the issues discussed above but it is treated separately to highlight the importance of sociological and cultural factors in general, and also the social patterns as a result of technology. The importance of information in socio-cultural development was recognised by UNESCO's MacBride Commission, which stated: "There can be no genuine, effective independence without the communication resources needed to safeguard it." The gap between the information rich and the information poor is just not a quantitative issue of the amount of information available to rural areas, but is also related to the information communications technologies, and the necessary skills to utilise them effectively. Castells (1999: 1) elucidates the relationship between social development and technology:

> "Social development today is determined by the ability to establish a synergistic interaction between technological innovation and human values, leading to a new set of organisations and institutions that create positive feedback loops between productivity, flexibility, solidarity, safety, participation and accountability, in a new model of development that could be socially and environmentally sustainable".

Simpson *et al* (1998) reports on an interesting project that facilitated rural women's access to communication technologies to enhance women's empowerment and rural community development in Queensland, Australia. A key finding was the importance of appropriate social infrastructure in facilitating the enthusiastic adoption of communication technologies. A comfortable and supportive environment was essential to develop women's confidence and willingness to try new communication technologies. Far too often the under-utilisation of communication technology and services by first time subscribers are simply attributed to reasons other than socio-cultural, such as the lack of finances.

In relating people to technology Pentland aptly describes the possible influence on society:

> "The extent to which people are enabled by technology depends upon people's individual ability, willingness to accept, to use, to be changed by this

> technology...Today's technology can enable some people to 'get out of their boxes', to be free, to 'dance,' alone or with others. With this technology, people can be drawn together, closely, and yet remain as whole individuals...this technology can affect our humanness, it can give us back or add to our sense of self as well as enable, enhance our relationships or connectedness with others. At the same time, this technology can be used to distance us from others; it allows us to communicate on our own schedule, at our own direction; it can enable us to hide behind its protective screen." (Pentland, 1996: 12).

The development and usage of telecommunications infrastructure cannot be fully understood and planned without understanding the relationships between the individual societies and the infrastructure. For the development of telecommunications infrastructure is a very complex process, which involves and affects people, organisations and institutions at all levels of society. (Singh, 1991: 14).

Although the provision of a telecommunications network in a rural area may seem unprofitable, the immediate social benefits can justify such 'unprofitable investment', for information is always regarded as a change agent to any society. The value that will be added to the education and health sector and consequently to the standard of living of the residence cannot be measured purely in monetary terms. Significant work is being done by the Shoma Education Foundation in collaboration with the Department of National Education in South Africa, in providing training in new education methodologies to teachers in remote areas via satellite technology. Tele-medicine is another example of a primary value added service. However, just as in the days when the telephone started to replace the telegraph in America, education in the use of a telephone, especially to deep rural populations who have had no experience with technology, is absolutely necessary. Education is a 'soft' infrastructure, which is as important as the switches and fibre optics aspects of the information age (Singh, 1991: 177).

A working telephone in a rural village may not necessarily be accessible. Just as important is the physical location of the public pay phones for example. Hudson calls this the 'sociocultural distance', which refers to the difference between the social and/or cultural milieu of the user and the milieu of the facility. A person in a village may be apprehensive about using a telephone if it is in the police station or a politician's property (Hudson, 1975). In addition the public must be aware that the telephone exists, where it is located, and how to use it, especially when many people have never used a telephone before.

Certain undesirable behaviour poses an even greater challenge to the network operator. The theft of copper cables is posing a major challenge to the network planners. Telkom SA had 3 311 incidents of cable theft countrywide between April 1997 and February 1998. This translates to a loss of R 33.6 million (Bidoli, 1998: S13). Although this is 19% less than the previous year the possibility of this problem will be there and not just in South Africa. The consequences of these thefts are even more complicated when one considers the network provider's staff morale and the disruption in service. Suspension of telecommunications service due to late or non-payment is a costly and time-consuming exercise. In the city of Johannesburg alone in 1998, telephone services to 100 000 people were suspended each month. Although there are technological solutions to this problem, late or non-payment and non-usage of the service pose at least an investment risk.

Other issues to consider here are the tensions that are prevalent in a particular geographical area due to opposing political factions and cultural protocols. Within certain rural areas in KwaZulu Natal, politically polarised communities live side by side. Preference for telecommunications service to one political faction over the other has led to acrimony in the community and even destruction of telecommunications equipment and alienation of the network operator by certain communities.

The issues of cultural protocol have real bearing on telecommunications service. Figure 2.1 illustrates the tension due to one type of cultural protocol experienced by Telkom in KZN. Community A and a small part of Community B are within radio range of telecommunications services. For some valid reason such as financial or geographical this may be the only telecommunications service available to this area. It is customary that the Chief be provided with services before or at the same time as members of the community that he heads. Community B and its Chief are all within radio range and may therefore all enjoy services if required. However, the Chief for community A is out of the radio beam and therefore the small number of people in Community A that are within radio range may not enjoy telecommunications services until their Chief has been provided with services.

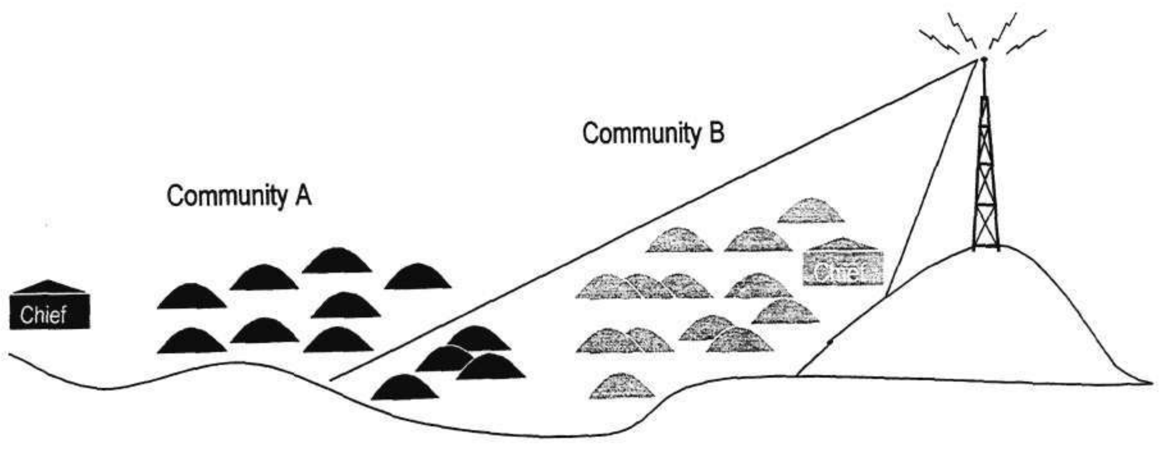

Figure 2.1. Cultural protocol regarding telecommunications services

Providing telecommunications infrastructure to areas, which have a high migration rate or the threat of complete collapse due to AIDS or wars, are real issues that must be faced from an economic sustainability point of view and the dire need for immediate services.

2.10 Implications Of Political And Regulatory Factors On Telecommunications

The telecommunications industry is a highly regulated industry in most countries. Apart from the fixed line service the frequency spectrum is regarded as a finite natural resource, and therefore subject to intense regulation. However, the regulation is not always friendly to the deployment of wireless telephony for example. Certain countries such as the USA have reserved more than ample spectrum for national use such as for the department of defence. This reservation tends to influence the regulation in developing countries allied to the USA. Frieden (1997) provides an interesting account on the business, legal, regulatory and spectrum challenges on the widespread deployment of wireless telephony.

The political stability or instability and the particular political philosophy of a country have an impact on financial factors, priority of service and deployment of parallel infrastructure. Often, the choice of technologies is a political decision rather than one based on the most effective solution. The policy environment which usually has the flavour of the political philosophy, and which determines the extent and type of coverage together with the speed of roll out of the infrastructure, will directly influence the technology and its associated architectures to be deployed.

As mentioned under section 2.8 "Impact of Physical Factors and parallel infrastructure on rural telecommunications", parallel infrastructure is necessary if telecommunications is going to stimulate rural development. Very often separate bodies that work independently from each other deploy or develop the different new infrastructures to a particular area. An integrated approach, supported by a regulatory nudge will ensure collaboration and consequently cost efficiency and effectiveness for rural development. Surely when a power company is rolling out its distribution lines it can simultaneously assist in the roll out of telephone lines. Many rural areas have access to satellite footprints for television reception but do not have telephone services. Yet telephone traffic could easily be transported on these same satellites but regulatory impediments forbid such practices as in the case of South Africa.

In South Africa the raison d'être for rapidly expanding the telecommunications infrastructure into the under-served areas is the commitment of the 'new' democratic government to its Reconstruction and Development Programme. The new Telecommunications Act (Act 103 of 1996) provides for the South African Regulatory Authority whose function, amongst others, is to draft necessary regulations pertaining to Universal Telecommunications Access. In simple terms, a telephone within at least 5km of the household and a Universal Service Fund has been set up to help finance this. While these efforts are commendable there still needs to be an integration of policies that ensures the optimal use of a communication link, be it satellite broadcasting or optic fibre backbone.

Another way to finance this is the part privatisation or liberalisation of the state's telecommunications operator. Progressive liberalisation of the telecommunications sector can advance the cause of Universal Access as in the case of India where 75% of the population live in remote areas. As Sinha (1996) states:

> "In May 1994 the government (of India) announced it would liberalise telecommunications as part of the overall economic restructuring that was underway. The new telecommunications policy reflected the government's view (a) that the rapid improvement and development of telecommunications was vital to the success of the wider economic reforms; and (b) that such development

> could not take place under the public monopoly model that had governed the sector since the country became independent in 1947."

Of course one has to ensure that there is no room for market skimming which will further the divisions between the information rich and the information poor. In South Africa the parastatal Telkom SA has been part privatised with a short-term privilege of certain monopolies but with conditions relating to specific rollout targets to the various areas.

Hudson (1999) cautions another myth that a carrier of last resort is the best means to ensure rural access. Some countries require the dominant operator to act as a 'carrier of last resort,' with a universal service obligation (USO) to provide rural service if no other carrier has done so, such as in the case of Telkom SA. Typically the carrier with the USO is entitled to a subsidy to provide the service based on its cost estimates. However, this policy can be flawed if there is no incentive for the carrier with the USO to use the most appropriate technology and to operate it efficiently. It can also serve as a justification for the dominant carrier to be protected from competition (as in the case of Telkom SA) because it has additional costs and obligations not required of new entrants. If subsidies are provided to serve high-cost areas, they should be made available to any operator willing to provide the service. A more recent push is to involve the local communities in the management of the infrastructure. It is suggested that small, medium, and micro enterprises be set up within the community as local service providers and peer-to-peer network operators. However, for this to take effect the regulatory and policy environment needs to adapt.

The above analysis is not meant to be an exhaustive treatment of all the challenges facing the planners of rural telecommunications infrastructure but is meant purely for the purposes of demonstrating that the issues relating to rural telecommunications are multi-dimensional and may indeed be contextual to a particular under-served area. Successful rural telecommunications service is a far more complex problem than just a function of optimal network design for example. This initial treatment of the challenges also leads one to believe that there may be multiple uncertainties regarding the planning of telecommunications infrastructure and the prioritisation of issues and that there needs to be a technology or methodology available for managing these uncertainties. In addition, there seems to be an interdependence thread running through these various challenges.

These tensions are illustrated in the ITU-D Study Group 2 report. In suggesting solutions for Universal Service the report makes mention of the tension between expanding the geographic extent of the network versus adding access lines (ITU Study Group 2, 1997: 16). It describes the 'direct' approach to Universal Service as one that assigns a high priority to rolling out the local loop plant of the PSTN (Public Switched Telephone Network) into rural areas and other low-income under-served areas. The 'indirect' approach assigns a high priority to expanding the geographic reach of the PSTN by extending the trunk networks. The ITU Study Group 2 suggests that the direct approach is characterised by low priced basic services, which leads to cross subsidies from business, and long-distance calls, which may eventually impede economic growth. The indirect approach, on the other hand, is characterised by an increase in long-distance services, which has a high market value and hence increases national per-capita incomes. The study group suggests that this approach will in the long-term lead to affordable non-subsidised residential basic services. Mention is made of India containing over 500 000 villages with populations under 1000. The 'direct approach' will result in locally linking a substantial portion of the households in a particular village at subsidised prices. However, this service might be of limited value as face to face communication may be a cultural imperative, if not the preferred choice or just convenient. The indirect approach though will provide a long-distance telephone service for the purposes of trade, health care and education.

It is evident therefore that the approach to universal service for the purposes of rural development is inextricably linked to economic, financial, technological and cultural issues at least, and further dictated to by the telecommunications policy environment. Following the writings of Rosenhead (1989) on the description of complex systems, one could also describe the issues surrounding rural telecommunications as being messy.

Barr (1998) mentions five principles that have been found to be of great importance in implementing rural telecommunications programmes:

- Provision of Universal Access.
- Carefully planned, organised and managed rural programme.
- Appropriate regulatory framework.
- Internal and investment financial resources.
- Commercial approach.

While the author does not disagree with these principles, what is lacking is a comprehensive planning framework that deals with the various challenges discussed in this chapter, with respect to the telecommunications infrastructure. It is envisaged that the next section will elucidate this problem even further leading the way towards the goal of this thesis.

2.11 Traditional Approaches To Rural Telecommunications Planning

2.11.1 International Engineering Recommendations On Rural Telecommunications

Rural telecommunications is now taken seriously by most developing countries around the world. The ITU has made a noble recommendation with respect to the "Planning and Implementation of National Telecommunication Development Plans for Rural and Remote Areas" (ITU-D7, 1998). However, while it alludes to the various issues that need to be considered in the planning of rural telecommunications service mentioned in this paper it still does not provide a methodological "planning and implementation" framework that is necessary for the development of the rural area. At best this one page document calls for some form of planning that goes beyond the traditional technology-only aspects.

The ITU, which is responsible for recommending world standards, amongst other things, for the telecommunications sector, recommends four models for rural areas based on settlement patterns and physical geographical layout of the area. Sets of appropriate technologies, including network configurations are then matched to these four models. These four systems are called optimum systems for rural areas (ITU, 1989).

The ITU Development Study Group 2 goes further by making mention of the various issues involved in rural telecommunications such as the economic, social and cultural issues, discussed in earlier chapters. However, the planning for the provision of rural telecommunications is once again focused purely on the network issues. There seems to be little or no correlation between the issues mentioned earlier in the handbook and the planning and design aspects discussed in the latter part of the book. The outcome is more or less a set of recommended prescriptions for network infrastructure configurations. (ITU-D Study Group 2, 1997)

A software planning tool, PLANITU, recommended by the ITU for the optimisation and dimensioning of telecommunications networks seem to comprise a more *'integrated and interactive'* approach to the planner for finding minimum cost solutions for the various building blocks of the network. Fig. 2.2 gives a concise but clear overview of the functional architecture of PLANITU.

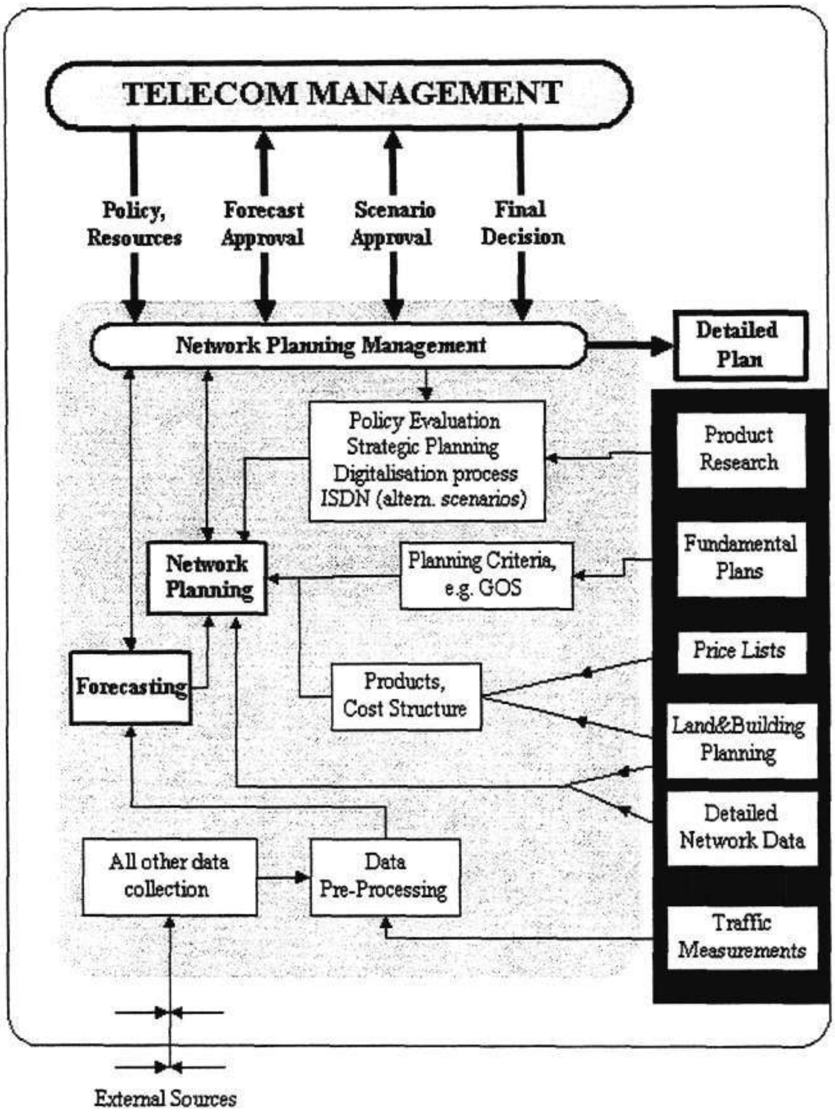

Figure 2.2. Network planning, functions and interfaces (Source, http,//www.itu.int/planitu/)

The processes reflected in the diagram are typical of the planning activities carried out by network providers or telecommunications operators around the world, including South Africa. The various categories of data as reflected on the diagram, are used to investigate various network scenarios against the criteria of *'minimum cost solutions'*. In general, the focus is on network planning which is not the same as planning and design of telecommunications infrastructure. In addition, it is assumed that the information or data required will be reliable if available in the first place. The complex issues pertaining to rural areas such as those discussed earlier in this chapter are not given sufficient attention. It can also be concluded that the planning process that is implied in PLANITU is linear and mechanistic, lacking an in-depth interrogation of the problem situation with respect to rural telecommunications planning for a particular rural area.

If one were to go beyond the objectives of PLANITU to a much higher level of planning of telecommunications infrastructure, then the Systems Engineering methodology aptly characterises current practice. Systems Engineering is discussed in detail in Appendix A of this thesis but for the purposes of this section it will suffice to mention the salient aspects.

Systems Engineering has three broad dimensions: -

- The knowledge and information dimension.
- The time dimension which entails program planning, project planning, system development, production, installation, retirement.
- The logic dimension Problem formulation, value system design, systems synthesis, systems analyses, optimisation of alternative, decision making, planning for action to implement.

In its application to rural telecommunications planning, Systems Engineering is dominated by the time dimension. The whole approach places an emphasis on defining a range of unambiguous objectives so that the performance of the system can be determined accurately. Indeed, Systems Engineering, which has been developed through practice at Bell Laboratories, has been successful as a methodology for telecommunications turnkey projects that dealt with the provision of services. However, it is the contention of the author that when it comes to rural telecommunications, especially in developing countries, the methodology of Systems Engineering is inadequate to cope with the softer but messy issues associated with rural telecommunications, such as those that aim to promote development.

Other practices that form part of rural telecommunications planning fall within the domain of operational research (also discussed in Appendix A). A number of papers have been published with regard to decision support systems for telecommunications planning and management (see for example Lee *et al*, 1994; Kim *et al*, 2000; Tam and Tummala, 2001). However, the approach once again focuses on just one aspect of the problem, usually technical in nature, albeit an important aspect. Lee *et al*, (1994) for example, uses the Analytic Hierarchy Process, a multicriteria decision making method, to develop a two-phased decision support system to aid the design of rural area telecommunication networks. The objective is to build the best-optimised rural area telecommunications network via hub cities considering the criteria of population, economy, health, education and transport. This approach, once again, is suitable for a relatively predictable set of conditions. It does not cater fully for a messy environment and the goals of development of rural communities, especially in developing countries.

One of the more recognised authors in rural telecommunications, Heather Hudson, has made a significant contribution to rural telecommunications development and in particular the planning aspects. Some of her publications have already been cited in this chapter. Her approach to rural telecommunications development is a developmental and integrated one. However, at best she raises several questions for consideration in the planning of rural telecommunications infrastructure. She provides no enabling planning methodology or framework for rural telecommunications planning (see for example Hudson and Parker, 1975; Hudson, 1984).

2.11.2 Rural Telecommunications Planning In KwaZulu Natal, South Africa

This section is informed by the discussions that were held with the Telkom SA, KwaZulu Natal (KZN) regional focus group that was arranged by the author to address the questions raised in Appendix G (Smith *et al*, 2000). KZN has the largest rural area and rural population in South Africa. Telkom SA, the sole provider of fixed networks, allocates capital funds to the KZN Plan and Build division for infrastructure growth. Amongst other things, the KZN Plan and Build division has to provide telecommunications access, services and new infrastructure to both urban and rural areas. The challenging task/s are to balance the allocated funds amongst the various projects, which must include the so-called non-profitable rural projects, which are regulatory imperatives.

In describing their idea of rural telecommunications the focus group used phrases such as low population density, sparse populations, scattered smallholdings and farms. A generic description was also submitted - any area that cannot be serviced by using a cable direct from the exchange due to size and distance. During the discussion a deeper understanding of the socio-political issues about rural areas emerged, such as the tensions between different political factions and the significance of the role of the traditional leader in a particular community. The major initial drivers for the planning of rural telecommunications for a specific area are the backlog of applications for telephone services from the population of the rural areas (at least three years) and of course the licensing imperatives. The focus group regards the provision of rural telecommunications as a social obligation and a means to provide public telephony (payphones) for all. Therefore it is expected to recoup their investments only after five to ten years. It is also expected that the community in the meantime will 'prosper'. The provisions of urban telecommunications however are regarded as revenue streams and are therefore planned accordingly.

In general terms the focus group described planning as the process that is used to determine what needs to be done, which areas to service, when it will be done, how it will be done, high level costing of technology deployment, and finally the design and deployment of the infrastructure technology. So the planning team could be conceptualised into two sectors namely the planning/interface team and the design/engineering team. The planning/interface team provides the design/engineering team with the shape file or project scope of a particular rural area. The planning/interface team, which consists of people from the fundamental planning office, marketing and sales, communication, and demand forecasting disciplines, will sub-categorise the area into perhaps five or six categories with the corresponding demand as well as the potential demand for telephone services, be it POTS which will include payphones, or POTS-plus. In essence this is no different from what is reflected in Figure 2.2. This data will always have an uncertain confidence factor. In fact the initial demand for an area that has never had any telecommunications whatsoever is normally relatively high on paper but much lower in actual practice - the sustainability factor is difficult to determine in all cases. The interface team will then hold meetings with the community to make them aware and create an interest in their area. The demand then tends to increase but eventually settles down, due to the churn factor, to a more meaningful forecast.

The interface team obtains the data relevant to demand either by a site survey of the rural area or by scanning existing office records. This data is then processed by the design team on a Geographical Information System (GIS). The design team will often verify this data through independent visits to the rural area and then finally match the technology, from a prescribed set of technologies, to the final demand forecast. A decision is then made by the planning team as to whether this is a viable proposition, not necessarily based on the profitability of the investment. Planning for contingencies such as the impact of AIDS and other disasters on the rural population is not done at the moment, as according to the focus group, this is not a problem as yet. The author disagrees that AIDS is not a problem as yet with respect to telecommunications planning.

One could not find any current rigorous planning framework or methodology/ies for the planning and design of rural telecommunication infrastructure that caters for not only the issues involved in the provision of rural telecommunications but also explores the dynamics and inter-relationships between these issues in a systemic way. What is clear from the investigations is that there is no holistic planning of the rural telecommunications system, in terms of rural development, that is meant to service a particular area. The planning process and techniques used are very much based on the assumptions of systems engineering and hard Operations Research, assuming that the goals of the problem are easily identifiable, the boundaries of its sub-problems can well be outlined and that the optimal solution to the problem can be found. Although the planners mentioned that certain rollout targets stipulated by the government had to be met, the key objective of the rural telecommunications planning seems to be the optimisation with respect to cost.

> "The method of developing and optimising design alternatives is an interactive process that involves judgement and a sound knowledge of the requirements, existing facilities, and available technical solutions. ... The objective of the optimisation process is to find the configuration with the lowest life cycle cost over the study period." (ITU-D Study Group 2, 1997: 26-27).

Further, the planning and design of the infrastructure are done by 'experts' who would normally have a technology background, and a worldview of the planning situation imposed on them, either by the dictates of the organisation or the industry, or by tradition. Even if there is some justification for the planning to be done by the 'experts' there is no methodology that supports holistic intervention in a rural area with respect to telecommunications infrastructure that is used. Usually the various decisions are made separately in time and space by the politicians, legislators, network operator's area managers, accountants, and engineers who all have their particular domain and who all try to optimise the so-called solution according to one's own domain. The entire planning process is about optimising and deploying the network according to the stipulated time and specifications. Although this may be good engineering practice, this approach is insufficient to deal with a societal problem such as that associated with the provision of rural telecommunications. Whether the network meets the objectives of 'maximum benefits to all stakeholders,' notwithstanding Goulet's goals for development, is an issue that becomes at best, secondary. It was also interesting to note that the availability of parallel physical infrastructure such as electricity and transportation which is also vital for rural development is not given due consideration. There was no process or programme in place to measure or monitor whether the telecommunications infrastructure is having any impact on rural development. The Telkom SA focus group uses the rough gauge of increased demand with time.

On a more fundamental issue, the current planning paradigm is such that off-the-shelf technologies usually developed for situations quite different to that of the current problems are provided as a solution. The approach then becomes one of providing a well-known and tested solution for a problem that is not deeply understood. The planning framework developed in this thesis focuses the attention on obtaining a deep and shared understanding of the problem and then in a consensual way finding ways of improving the current situation, such that the emergent properties of the system are realised.

2.12 Concluding Remarks On Current Practices In Rural Telecommunications Planning

There is nothing wrong, from a formal point of view, with the way in which rural telecommunications planning is currently conducted in South Africa. However, the preceding analysis shows that the current planning processes and methods address only a part of a socio-technical system. They ignore to a large extent the finer details about the role of the human element in this problem. This is due to the inherent limitations of the paradigm within which the current planning process takes place. This leads to the conclusion that what should be far more important is, at least, the systemic development of the particular rural telecommunications system as a whole. The author submits that the current planning process for telecommunications infrastructure cannot address this goal.

Mitroff and Linstone (1993: 95) write:

> "The fundamental notion of interconnectedness, or nonseparability, 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*."

This means that, in the context of this thesis, the framework for planning and design of rural telecommunications infrastructure must be conceived of and managed as a whole system. Chapter three postulates a conceptual systemic model of a typical rural telecommunications situation. An in-depth analysis of this model will show why rural telecommunications need to be managed as a whole system, and that this is possible in the planning environment.

CHAPTER 3

TOWARDS A SYSTEMS THINKING APPROACH TO RURAL TELECOMMUNICATIONS PLANNING

In analysing the challenges involved in rural telecommunications in chapter two, one is now able to establish a much clearer picture of the issues, and relationships amongst these issues, involved in rural telecommunications. Based on the research thus far, the author takes the view that what is commonly referred to as rural telecommunications is really a rural telecommunications system (RTS), where technology is just one part or a subsystem of this RTS. There are two themes that are implied in the title of this chapter: The RTS, and planning of this system. The first part of this chapter covers an in-depth discussion of the RTS – the evolving structure of this system, and its nature and characteristics. The second part of this chapter provides an in-depth conceptual treatment of planning and in particular planning that adheres to the tenets of systems thinking. Only those general systems aspects that are necessary for the development of this chapter are provided here. Appendix A engages in a comprehensive treatment of the various systems approaches.

3.1 A General Conception Of Systems

'System' is a term that is so commonly and widely used (or abused) by society that it has become a mere generalised label with ambiguous meanings, and is therefore necessary to provide an overview of the theoretical perspectives on systems that informs this thesis. The systems sciences have undergone steady development since the 1940s and so the interpretations of the systems approach are both broad and diverse. The progress within the systems movement include salient works on General System Theory, Organizations as Systems, Hard Systems Thinking, Cybernetics, System Dynamics, Soft Systems Thinking, Emancipatory Systems Thinking, and Critical Systems Thinking. For an annotated bibliography on these various developments one can refer to Lane and Jackson (1995). Appendix A of this thesis delves deeper into the system approach, however, in this section the scope of discussion shall be limited to those aspects that are deemed necessary for an initial understanding of the RTS and justification for its representation. Emphasis will be placed on describing the structure and the behaviour of systems, which shall include notions such as emergent properties, hierarchy, communication and feedback control (cybernetics), homeostasis, transformation, boundary, open/closed system and environment.

Ackoff (1981) defines a system in terms of its elements or subsystems as a set of two or more essential elements, which satisfies the following conditions: -

- The system as a whole has one or more functions.
- The behaviour of each element has an effect on the behaviour of the system as a whole.
- The behaviour of the elements and their effects on the whole are interdependent. In other words no element or subsystem has an independent effect on the system as a whole.
- However subgroups of the elements or subsystems are formed, each has an effect on the whole and none has an independent effect on it i.e. independent subgroups cannot be formed.

The properties of a system are produced by the interactions of its essential parts/elements and this implies that when an essential part of a system is isolated that part loses its ability to carry out its defining function. The performance of a system is dependent on the interactions of its elements and not on the individual performance of the parts. Figure 3.1 shows a typical system with its necessary components. The system is identified from its environment by the imaginary boundary that separates it from the environment and so will have inputs and outputs which may be physical or abstract depending on the type of system. The system transforms the inputs into outputs.

The status of a system as either an overall system or a subsystem is not absolute. The elements in the system may be regarded as subsystems themselves consisting of elements or further subsystems with interdependent relationships and with their own set of inputs and outputs. It is for this reason that systems are said to constitute hierarchies (see also Goguen and Varela, 1979).

The system depicted in Figure 3.1 is an open system in that it permits inputs from, and outputs to, its environment. The relationships in the systems are characterised by feedback loops where the behaviour of one element may feed back either directly or through another element/s to influence the element that initiated the behaviour. Whereas the concept of equilibrium is associated with closed systems, homeostasis is used to describe the dynamic steady state, which the system maintains through communication and control amongst its elements, within its environment.

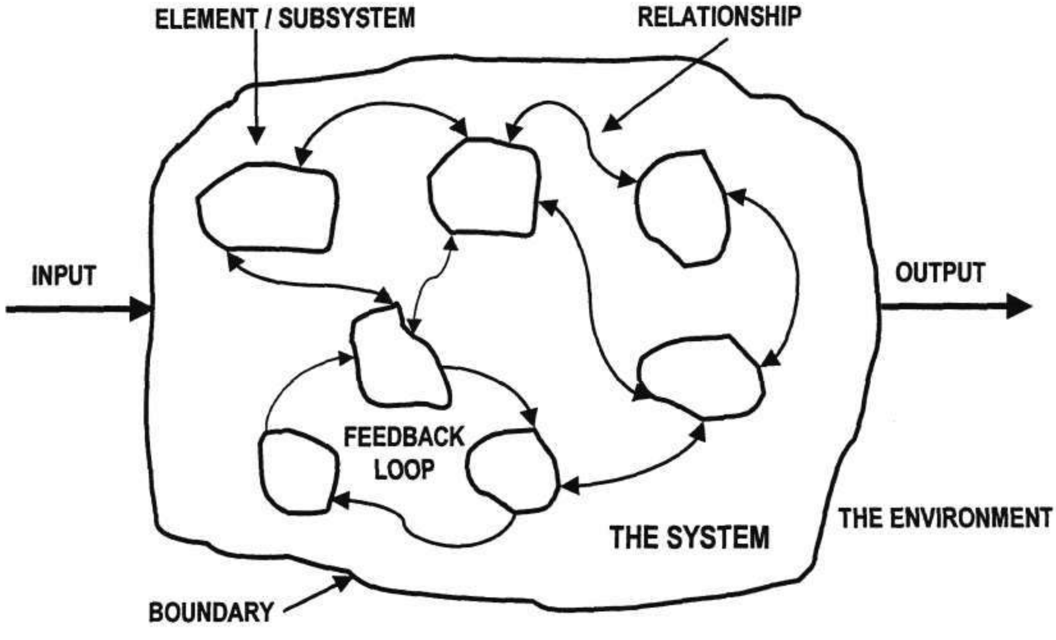

Figure 3.1. A general system model and its elements

Flood and Jackson (1991: 6) use the term 'synergy' to explain the emergent properties of a system where synergy is referred to as the increased value of parts working together as a whole. Emergent properties then arise when the interconnections of the elements exhibits synergy such that the 'whole is greater than the sum of the parts'. It is primarily because of this behaviour of a system that the reductionist approach or approaching complex systems through analytical means is said to be inappropriate in understanding systems. In the reductionist approach one tries to understand a system by building descriptions of the elements or subsystems without considering the relationships between them.

In the reductionist or analytical approach the system is decomposed into a family of subsystems somehow simpler than the original system from which they were extracted.

The properties of the original system are then inferred from the properties of the subsystems. The extraction of a subsystem corresponds to a process of abstraction (Rosen, 1977), in which the potential interactive capabilities (number of degrees of freedom) of the original system, are excluded and only a certain number are retained. It must be noted that for the process of abstraction to result in any significant conclusions, three basic requirements must be followed (see Rosen, 1997). First, the subsystems must be simpler than the original system from which they were abstracted. This is obviously crucial. Second, the subsystem must be obtained by legitimate or justifiable means. This is purely a subjective matter. Third, the properties of the subsystem so obtained must permit the determination of the properties of the original system. However, one must be aware that the abstracted subsystem may exhibit new interactive capacities of its own and therefore one must be able to distinguish between those properties that will be inherent in the original system and those which arise in the subsystem but are not related to the relationship between the subsystem and the original system.

The full properties of a system cannot be determined by a subset of subsystems, otherwise it means that those subsystems not in the subset are redundant. The author is not suggesting however that the systems (holistic) approach and the reductionist approach are opposed to each other. They could be complementary depending on the problem context. This view is strongly supported by Goguen and Varela (1979) who advocate that the reductionist view and the holistic view of systems are complementary. While reductionism implies attention to a lower level, holism implies attention to a higher level. In the systems approach to planning and design of rural telecommunications infrastructure, it will be extremely difficult, if not impossible to finalise action in terms of the deployment of the infrastructure without some form of a reductionist technique.

It is beyond the scope of this thesis to engage in an in-depth study of the ontological positions of systems, i.e. whether systems exist independent of the human mind or otherwise. However, in order to avoid confusion and misunderstanding regarding the nature of the RTS the ontological position that this thesis takes on the RTS shall now be clarified.

Constructivism, according to Klir (1991) is the position adopted by the mainstream of contemporary systems science. According to this view, systems do not exist in the real world independent of the human mind. In other words every system is a construction based upon some world of experiences, and these, in turn, are expressed in terms of purposeful distinctions made either in the real world by our perceptual capabilities or the world of ideas by our mental capabilities (Klir, 1991: 13; see also Gaines, 1979; Goguen and Varela, 1979). Constructivism does not necessarily deny the existence of the real world independent of the human mind; it is not an ontological view but an epistemological view (see Glasersfeld, 1987). This has important implications for the RTS, as will be seen in the next section.

Before investigating the structure and behaviour of the rural telecommunication system a general treatment of the various types of systems will add to a firm theoretical underpinning and elucidation of the RTS. Although the foundational concepts of systems are universally accepted by the systems community, the classification of systems depends very much on the particular applications. For example they may be classified by size, by discipline, and by function. Ackoff and Gharajedaghi (1996) in their examination of the consequences of mismatching systems of one type to models of another use purpose as the classifying criterion. This is an appropriate criterion for this study because of the underlying proposition that the RTS must have a definite purpose/s such as development of the rural community and that the planning and design of the telecommunications infrastructure must cater for this purpose.

Ackoff and Gharajedaghi (1996) distinguish between 'purposeful' and 'goal seeking entities'. A system is purposeful if it produces the same functionally defined outcomes in different ways in the same environment, and functionally different outcomes in the same and different environments. Choice is necessary for purposefulness. A system that can behave differently but produce only one outcome in any one of a set of different environments is regarded as goal seeking, for example plants whose goal is survival. Systems fall into three basic categories according to their purposes: Deterministic, Animated and Social systems.

Deterministic systems have no purposes of their own and neither do their parts, but normally serve the purposes of others. The parts serve the function of the whole and so are also deterministic systems. The ability to make choices is not a characteristic of deterministic systems and therefore they can only perform one function in any particular environment. Their behaviour and properties are determined by their internal structure, the causal laws and its environment. A telephone network is an example of a deterministic system.

Animated systems have purposes of their own. However, their parts have functions but no purposes of their own. For example, the parts of a human body have vital functions but not purposes of their own. Instead the functions are necessary for the pursuit of the purposes of the human being such as those found in Maslow's Hierarchy of Needs (Maslow, 1971: 44). Social systems on the other hand are systems in which both the system and its parts have purposes of their own such as a rural society or corporations. A rural society may consist of rural communities, which will consist of families, and ultimately persons, each hierarchy having purposes of its own.

Large complex systems often constitute a combination of deterministic, animated and social systems. As Ackoff and Gharajedaghi (1996: 14) mention, animated systems have deterministic systems as their parts and are also capable of creating and using deterministic systems. Social systems have animated systems as their subsystems and all three types of systems are contained in ecological systems as an example. Finally, in attempting to model systems Ackoff and Gharajedaghi make some remarks based on the modelling of systems over the years. They mention that when models of one type are applied to systems of a different type at least as much harm is done as good. In social systems for example mechanistic or deterministic models were used in the early days, which produced some good. However, as the systems matured a more appropriate model was required. The authors propose five characteristics that should be included in the design of social systems in order to function as effectively as possible: Democratic organisation, internal market economy, multidimensional organisational structure, interactive planning and a decision support system (Ackoff and Gharajedaghi, 1996: 22).

It can be argued that the planning, design and deployment of rural telecommunications infrastructure, is an intervention (bringing about purposeful change) in the particular rural society, through the creation of a RTS. If the deployed infrastructure is to achieve its purposes in terms of development then one needs to have a deep understanding of the RTS. The type of system that best describes the RTS, i.e. whether it is a social system or a technological system, and the behaviour of this system, will become more explicit as the next sections unfold. The first part of this chapter covers perhaps the foundational pillar of this thesis, a new and novel perspective on the typical RTS.

3.2 The Rural Telecommunications System

In contemplating the issues pertaining to rural telecommunications in chapter two, and based on the systems theory covered thus far, the author proposes that a typical rural telecommunications system (RTS) should be conceived as illustrated in Figure 3.2, where the RTS evolves as a result of the interdependent relationships between the subsystems. It must be noted that the figure does not reflect all possible subsystems. The dynamics such as the tensions between financial investment, socio-economic development, and return on investment, and, the impact of the physical environment on the infrastructure and vice versa, lead to such a conception of the RTS. Furthermore this conception shows clearly that the RTS is interdependent on a host of subsystems which are themselves interdependent on each other, and which may also be regarded as systems having subsystems of their own. The obvious significant implication of this idea of a RTS is the fact that the technology infrastructure is only a subsystem within the RTS, albeit a necessary part.

A common tendency amongst telecommunications practitioners is to regard the technological infrastructure subsystem as the RTS. Attention is focussed on this subsystem with the expectation that this is what will stimulate economic development for example, in a particular rural area. While there may be some evidence of this development, this does not mean that planning and design of this technological infrastructure in isolation or with some forced consideration of some external factors, is sufficient for the sustainability of a vibrant RTS. Chapter two discussed current trends and practices on the part of telecommunications infrastructure providers and it was concluded that the approach is very much reductionist. At best those subsystems shown in Figure 3.2, such as the physical environment, political and regulatory, sociological and cultural, parallel infrastructure, and economic subsystems, are regarded as factors that need to be considered in the planning and design of rural telecommunications infrastructure. This is certainly not the same thing as a holistic approach let alone a systems approach, especially when one now considers the extent of the RTS as shown in Figure 3.2. In fact, what this model indicates is that the emergent properties of the RTS are not only dependent on the rural telecommunications infrastructure subsystem, but arise out of the synergistic interactions among the various subsystems as already mentioned.

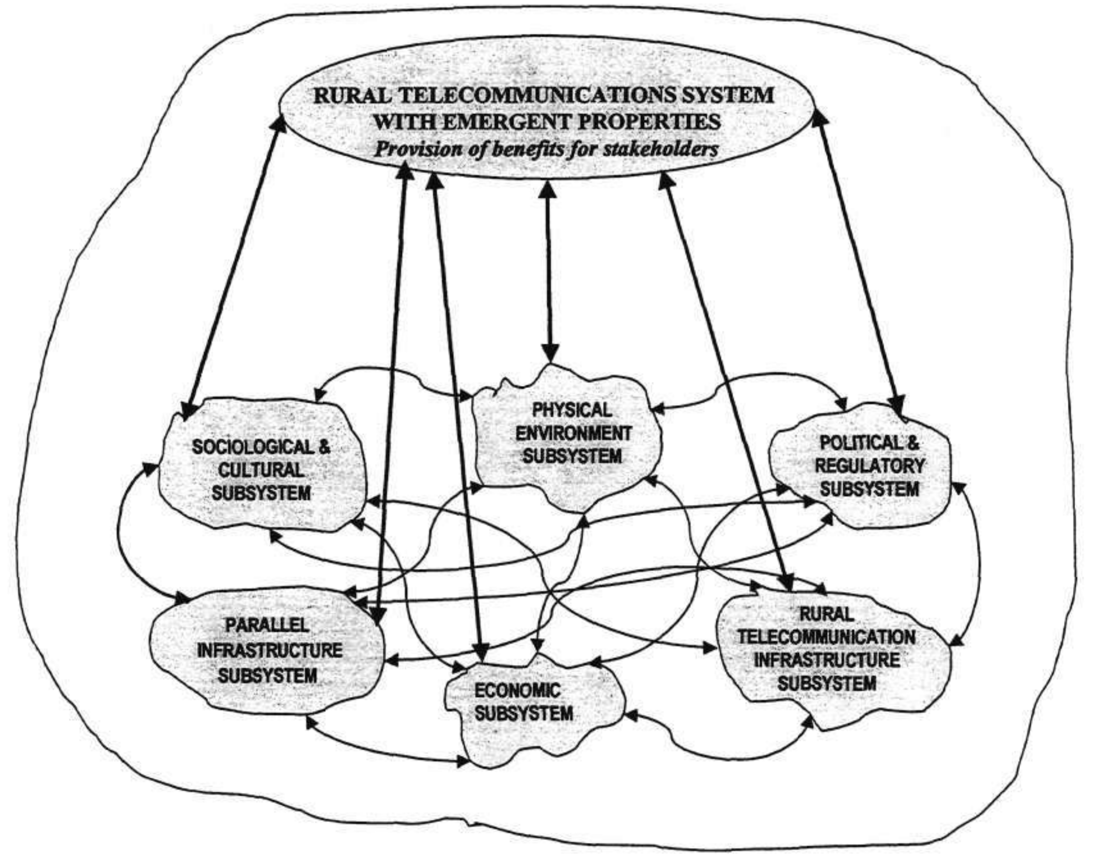

Figure 3.2. A Rural Telecommunications System showing the relationships between the subsystems and the emergent properties of the system

Figure 2.2 from chapter two fairly represents the general practice in telecommunications 'infrastructure' (network) planning. In contemplating the network planning, functions and interfaces illustrated in Figure 2.2, one sees a systematic functionalist approach, and at best only certain parts of the RTS as depicted in Figure 3.2 are considered. Even when one analyses the approach that the local telecommunications operator currently uses for planning rural telecommunications infrastructure (Smith *et al.*, 2000), the general trend seems to be to only consider those aspects that directly affect the network configuration. There is no imperative to think in terms of the network being an intervention into the rural society. An analysis of the systems approach and a deep contemplation of Figure 3.2

suggest that these current practices are not comprehensive enough or as can be, for a healthy RTS to develop.

It is argued here that the development of the rural communities, and any other spin-offs for that matter, that are ususally expected as a result of telecommunications services, results from the synergestic interactions among the subsystems of the RTS as a whole. In the RTS this is the same as the emergent properties of the RTS. In a nutshell the emergent properties are defined as 'benefits to all stakeholders' of the system. This means that it is possible in a RTS for the rural community, the telecommunications infrastructure providers, any other investors and government agencies to all have their expections met, as long as conducive interactions among the subsystems exist. Providers of telecommunications networks and services, in particular the planners of the infrastructure, must take due cognisance of this in their commitment to providing telecommunications access with the expectation of societal development.

The author is not suggesting that it is possible to develop a methodology that would guarantee the realisation of these ideal desires. Of course the ideal would be to manage the RTS as a whole system and so engage in comprehensive planning with all subsystems together. But this is not pragmatic, at least under the current circumstances in South Africa. It must be taken into consideration that an exact representation of the RTS or anywhere near such exactness is not possible for a complex, dynamic and heterogeneous system. Each RTS will be different simply because each rural community will be unique. Figure 3.2 indicates boundary lines around the entire system and around the subsystems. This is by design of the author and not absolute (see Klir, 1991: 10-13 for a concise discussion on the constructivist view of systems). This model however, can be used to reveal new insights as to what a RTS is all about and the impact of this on the planning framework for the telecommunications infrastructure. It can be claimed that it is important for managing the planning and design of rural telecommunications infrastructure that considers the RTS as a whole system to have a framework that facilitates planners to think systemically and as comprehensively as possible in their approach.

In the context of the goal of this research, i.e. the development of a planning framework for rural telecommunications infrastructure, there is an important part of the RTS that is not reflected in Figure 3.2 and that is the planning situation. This omission is deliberate on the part of the author to avoid confusion and attaching less significance to the planning sub-system of RTS. Planning is more than merely a subsystem. Also the main purpose of Figure 3.2 is to reflect the author's perception of a RTS as compared with treating narrowly the RTS just as the infrastructure subsystem. Mitroff and Linstone (1993: 99) write, "The systems designer, analyst, or manager is a fundamental part of the problem being analysed; the individual's psychology as well as social context are inseparable from how he or she represents a system or a problem".

The word 'system' descends from the Greek verb 'sunistánai', which originally meant 'to cause to stand together'. This origin suggests that the structure of a system includes the quality of perception with which the observer causes it to stand together (Senge *et al*, 1994: 90). Considering the comments by these authors and the essence of constructivism (Glasersfeld, 1990; Klir, 1991), one must conclude that the planning and design activity for rural telecommunications is part of the management subsystem of the RTS. This idea has serious implications for the development of the framework.

In attempting to fully conceptualise a 'Systemic Approach' to the problem of concern, i.e. the planning and design of a RTS such that all stakeholders benefit, it is necessary to delve deeper into behaviour and characteristics of the RTS in order to understand the degree and nature of the complexity of this system.

Is the behaviour of this system deterministic, animated or social? There is no simple answer to this question. Although one can safely postulate that the RTS as a whole is an animated system, the RTS cannot be boxed into any one particular type of behaviour. The author argues that this is a matter open to interpretation. For instance the model shows the economic subsystem as within the RTS because of the need for initial financial investment in the infrastructure, but an equally valid argument is that the RTS triggers economic development and so is a subsystem with the economic system. However, from the perspective of the planning and design of rural telecommunications (i.e., how can one leverage the planning and design of infrastructure to realize the emergent properties of the RTS) the suggested perspectives represented in Figure 3.2 are appropriate and supported by constructivism. Defining the RTS as shown in Figure 3.2 is valid if this is regarded as an epistemological view rather than an ontological view.

The RTS then has deterministic, animated and social parts associated with it. The rural telecommunications network (deterministic), the sociological and cultural subsystem (animated and social) and the others shown in Figure 3.2 are all necessary parts of the RTS. Therefore the model as depicted in Figure 3.2 is an approximation of the real system meant only for the purposes of gaining a deeper understanding of the problem and also to justify the systemic approach. Although Figure 3.2 is a conceptual model, the two tangible necessary components of the RTS are the people and the communication technology. By contemplating the possible synergy between these two elements within the RTS one begins to learn more about the characteristics of the RTS.

3.3 The Rural Telecommunications System As A Socio-Technical System

Warfield (1976; 1994; 1999) has made a significant contribution to dealing with complex societal problems over the last thirty years. In particular his contribution to the discussion of the structure of and the complexity inherent in socio-technical systems elucidates the RTS. Warfield proposes that the technological system may be partitioned into three classes (Warfield, 1994: xxiv): -

- Class (A) consisting of members that operate on principles established in the physical sciences such as the basic radio, telephone, the internal combustion engine and telephone lines – either wire or wireless.
- Class (B) consisting of members that are referred to as "intellectual technology" such as telecommunications software, literature about the software and routing algorithms.
- Class (C) comprising of a mix of elements from the above two classes. The satisfactory outputs of this system will depend on the appropriate integration of these elements into synergistic units. Examples of such systems are telecommunications network management systems, decision support systems and a telephone exchange.

It is the contention of the author that the ultimate purpose of any technological system is to add value to the human being and ultimately to society, although sometimes the value added to one human being may be at the expense of another. Technological systems therefore, do not exist for their own purposes but ultimately for the purposes of society.

Warfield also discusses 'socio-technical systems', which are a mix of the classes of the technological system and people (Warfield, 1994: xxv). As one may easily deduce, in general the satisfactory outputs of such a socio-technical system must largely depend on the synergistic interaction between the technological aspects and the social aspects. In a pure technological system the operating principles of the elements are usually predictable and the design specifications of the system can be unambiguously defined. However, interfacing the technological system to a range of social aspects, results in a system that is not implicitly comprehensible anymore. Such are the consequences when rural telecommunications technology and a rural society is brought together, forming a RTS. The author proposes then that an apt description for a RTS is a socio-technical system, and by studying the current salient writings on socio-technical systems one would obtain a deeper insight into the RTS.

In order to obtain this deeper understanding of the rural telecommunication socio-technical system, the earlier developments of socio-technical systems (STS) theory shall be investigated. Thereafter some current thinking and contributions to the original STS will be discussed which would assist in providing a clearer description of the rural telecommunications socio-technical system.

Socio-technical Systems Thinking, historically associated with Eric Trist of the Tavistock Institute of Human Relations in the UK, was initially developed from an organisational behaviour and operations research point of view (see Trist *et al*, 1963; Emery and Trist, 1965; Emery and Thorsrud, 1969,1976). Figure 3.3 shows the traditional socio-technical systems (STS) model. It comprises three key entities, the organisation, the people engaged in the organisation and the technology needed for the people to be effective in relation to the organisation. The interaction of these three entities gives rise to a social subsystem and a technical subsystem. Socio-technical Systems Thinking subscribes to the idea that organizations which are treated as open systems (interacting with its environment) will operate at optimum only if their subsystems such as the technological and social are jointly optimised (sic). Commenting on joint optimisation and the balance of the social and technical subsystems, Trist mentions:

> "The technical and social systems are independent of each other in the sense that the former follows the laws of the natural sciences while the latter follows the laws of the human sciences and is a purposeful system...Their relationship represents a coupling of dissimilars which can only be jointly optimised. Attempts to optimise for either the technical or social system alone will result in the sub-optimisation of the socio-technical whole" (Trist, 1981: 24).

Socio-technical Systems Thinking also promotes the idea of semi-autonomous work groups that take collective responsibility for the way the tasks are accomplished.

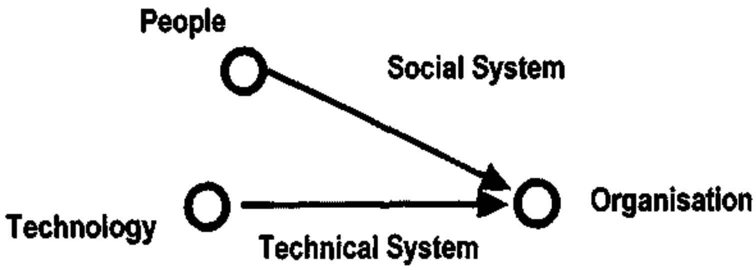

Figure 3.3. The traditional model of socio-technical systems (Following Pentland, 1996)

The traditional socio-technical systems approach in analysing and designing organizations is not without serious limitations. Although the STS approach conceptualises the nature of the organisation as a system, it sees this system transforming various inputs such as raw materials or knowledge into desired outputs such as finished products or services. In other words the task is to get from input to output with as few errors as possible (Pava, 1983: 14). Fox conceded that most of the successful experiences with STS had been with well-defined, linear systems rather than the systems that have no implicit cause-effect structure that characterises organizations today (Fox, 1995: 100). Moreover the optimisation principle practised in STS has to be reliant on predictable events and if one views the STS as an open system then uncertainty rather than predictability is a more likely characteristic of STS.

Pava (1986), suggested an additional type of analysis within STS i.e. determination of the quality of interpersonal and group deliberations about problems facing the organisation, for complex, non-linear situations. He suggests that the interactions of people, with their individual behaviours and styles, can have a tremendous impact on the technology as well as the organisation. Taylor and Felten called for an evolution of the theory and practices of the conventional STS:

> "The principles of STS will survive and live on, demanding new approaches and applications. Those who truly understand and are willing to go the extra mile, challenging the mechanistic and machine age paradigms, will discover new horizons - learning new ways to manage and integrate the opposites" (Taylor and Felten, 1993: 222).

Whereas traditional STS theory defines work within the framework of two systems dimensions namely the social and technical system, Pentland (1996) adopts a more "richer and dynamic" STS framework in an attempt to find the direct relationships between people and technology within an organisation. She views the STS as having three discrete, dynamic subsystems: people, organisation, and technology, each interacting one with another and all embedded in a larger system, the complex external environment, as shown in Figure 3.4. According to Pentland (1996) a "The Third System" now emerges from the direct interaction between the technology and the people.

The STS depicted in Figure 3.4, which is adopted by Pentland, and the RTS proposed by the author in Figure 3.2 are fundamentally similar in concept in that both systems adhere to the tenets of an open socio-technical system. It must be mentioned though, that Pentland's model was used for the purposes of her thesis on "The missing link in Socio-technical Systems Analysis: Relating people and technology" and not for any organisational design, systems analysis or synthesis. While the 'organisation' is not inherent in the RTS it is nevertheless a complex web of interrelated subsystems together with a dispossessed rural community and technology. For all intents and purposes then, one could regard the RTS as being a socio-technical system.

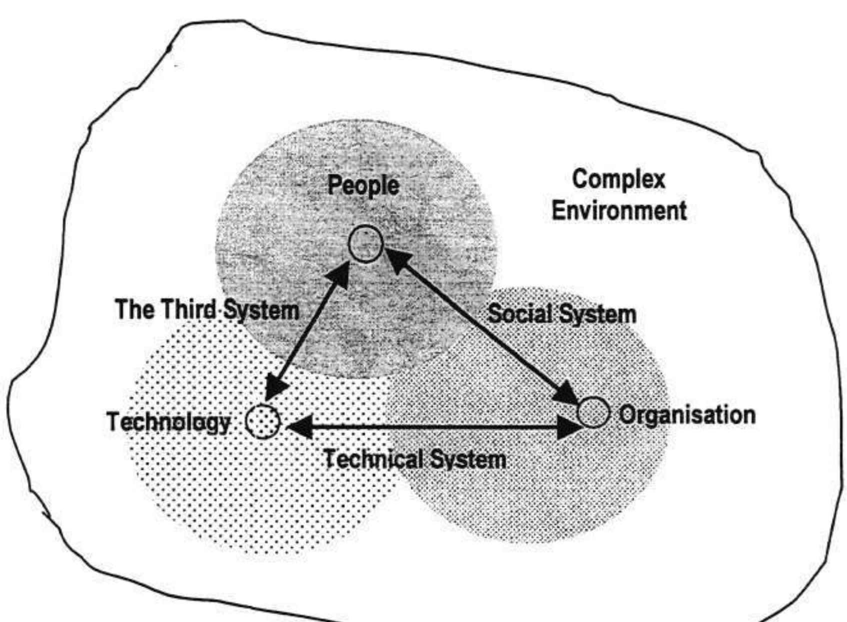

Figure 3.4. The enhanced socio-technical systems model according to Pentland (1996: 33)

The discussion thus far in this chapter has clearly shown that rural telecommunications is really about a RTS that adheres to the tenets of a socio-technical system and therefore planning for rural telecommunications is really planning for a socio-technical system. What remains to be investigated is a holistic synthesis of the RTS with a view to developing an appropriate systemic framework for the planning and design of rural telecommunications infrastructure such that the emergent properties of the RTS will be realized. In other words, how does one plan and design the rural telecommunications infrastructure subsystem such that the maximum possible contribution may be made to the realisation of the emerging properties of the RTS.

While the RTS is really a socio-technical system both in terms of Warfield's (1994) definition (i.e., the rural community plus the communication technology infrastructure) and of the Tavistock Institute and its variation by Pentland (1996), the author could not find an appropriate Socio-technical Systems methodology that caters for the task of this thesis. Warfield has developed a method called 'Interpretive Structural Modelling' which is insufficient as a whole methodology to be adopted for this work. Chapter four and Appendix A expands on this further.

It is interesting to note that Fred Emery, a co-author with Eric Trist on socio-technical systems, has promoted another approach as a replacement for the conventional STS approach (Emery, 1995). The participative design approach for the process of redesigning organizations is intended to overcome some of the problems associated with the traditional STS approach, such as the long complicated process, driven by experts that generated resistance to change.

Although the idea of optimisation was used in the development of socio-technical systems theory this terminology shall be avoided for reasons already mentioned. Rather the contemporary systems thinking idea of emerging properties is more appropriate. Emergent properties of a system are attributable to the system as a whole and therefore cannot be reducible and attributed to the optimisation of any particular subsystem. In an RTS the emerging properties are the benefits accrued to all the stakeholders of the system such as rural development, general economic development and increased revenues for the Telco. It is the contention of this thesis that these cannot be attributed to the optimisation of a single subsystem such as the telecommunications network but are a property of the system as a whole. It is proposed therefore that in order to better realise the emerging properties, one needs to have a planning framework that will not only address the traditional hard engineering issues but also the softer issues, in a systemic way. Of course this approach now exacerbates whatever complexity there was in the traditional planning approaches of rural telecommunications infrastructure. The next section clarifies the complex nature of the RTS and the planning and design activity.

3.4 The Complex Nature Of The Rural Telecommunications System

The challenges facing Rural Telecommunications Planners discussed in chapter two (albeit not an exhaustive treatment), the dynamics of socio-technical systems and more especially the structure and relationships involved in the RTS suggests that the solution/s required to resolve the tensions between the various challenges will certainly not be trivial. There are many terms that are used in the telecommunications industry to capture the breadth and depth of all the challenges associated with a particular RTS. However, whatever descriptions are used, the intention and conclusion is always the same, that is, the issues involved in rural telecommunications are messy and therefore complex in nature.

One of the deciding factors for using the systems thinking approach is that it is predominantly concerned with understanding complexity in a system. A significant step towards achieving the goal of this research is a deep analysis and understanding of the particular problem contexts with respect to *the complex nature of the RTS.* That goal being a legitimate and plausible framework for rural telecommunications planning and design that will ensure optimal benefits to all stakeholders of the telecommunications infrastructure.

In dealing with large-scale societal problems Warfield (1976: 194) has this to say about the consequences of the complexity that these problems entail:

> " ...Complexity implies that one individual can, at best, do no more that contribute to a solution. Second, complexity implies that the number of elements involved in a problem is large, and there are many linkages among the elements stemming from a multiplicity of important contextual relations. Third, complexity feeds on itself. As the complexity of the problem induces many minds to be applied to it a new complexity – that of interrelating and distilling group efforts

> into a format where they assume significant utility. Finally, there is the requirement that widespread knowledge of proposed change be understood and supported by a constituency with the power to effect change."

Any planning and design framework for rural telecommunications infrastructure has to tackle the complex issues in a RTS and therefore must be founded on a clear understanding of complexity.

3.4.1 Multiple Perspectives On Complexity

There have been various attempts at defining and measuring complexity, but as yet there is no agreed-upon explicit definition of the concept (Cambel, 1993). There are several operational descriptions, most of these being based on the systems approach. Perhaps the *simplest* definition is that of Simon (1969) when he says, "Complexity is that which is not simple." Typically the study of complex systems is concerned with the structure and the dynamics of systems and their interaction with their environment (see Prigogine, 1985). The Webster's dictionary also uses the systems concept of complexity: "A complex object is an arrangement of parts, so intricate as to be hard to understand or to deal with".

In his paper "Architecture of Complexity" Simon (1962) roughly defines a complex system as one that comprises a "large number of parts that interact in a nonsimple way". Although the whole is greater than the sum of these parts, it is difficult to deduce the properties of this whole because of the non-trivial interactions between these parts. Simon further states that hierarchy is a typical characteristic of complex systems where hierarchy is defined as a system that is composed of "interrelated sub-systems", each in turn hierarchic in structure until some lowest level of elementary subsystem is reached. There will be interactions among the subsystems and among the components within the subsystems and according to Simon the hierarchical complex systems can be "decomposed or nearly decomposed into subsystems" in order to analyse their behaviour. Evolution from simple systems to a complex one will occur at a more rapid rate if there are stable intermediate forms as can be seen in biological systems. In the human problem solving process, a similar situation occurs in that it involves nothing more that a mixture of selective trial and error until a solution is found. The cues signalling progress in the problem solving process play the same role as the stable intermediate states in the biological evolutionary processes.

Simon's 1962 architecture of complexity is based on the system itself and certainly has relevance to the RTS. However, an objectivistic characterisation of complexity in terms of structure and behaviour does not fully cater for the problem situation that this thesis is attempting to ameliorate. It does not consider the complexities due to human interpretations of the system, for instance. In the case of the planning and design of rural telecommunications infrastructure the different worldviews, inter alia, of the stakeholders, especially the planners or the planning team would also add to the complexity of the problem. Classifying complexity in terms of the number of elements of the system and the statistical relationship among them is also inappropriate for the problem at hand. Scherf (2000) states, " Complexity is not a feature which rests on the nature of a special object" (p 5), and goes on to state "... complexity depends on the prior knowledge and expectations about the system and the difficulty to get information, to find an adequate description, and to derive an appropriate internal model of the system behaviour." (p 6) Scherf concludes that because prior knowledge, information channels and the mental resources depend on the individual observer, complexity is a subjective phenomenon.

Warfield states that complexity should be perceived as a system attribute that may have components of situational complexity and cognitive complexity (Warfield, 1994: 132-155). Situational complexity refers to those aspects of the situation under study that are open to being intercepted by the human mind while cognitive complexity refers to those aspects that make interpretation difficult. Cognitive complexity therefore, is induced by situational complexity. Murthy expresses a similar view when he explains the inherent complexity of a system: "...there can be two aspects to it: (i) the complexity determined by the system purpose; and (ii) the complexity determined by the observer's purpose, which can be carried out as part of the total system" (Murthy, 2000: 75). These purposes in the case of the RTS are one and the same i.e. the provision of benefits for all stakeholders of the RTS.

Ryan's three level description of complexity offers a crisp summary on the discussion thus far (Ryan, 1998), and it certainly caters for the complex nature of the RTS in that all three types make up its complex nature: -

1. Static complexity which is a measure of the number of parts and the range of behaviours that make up the system.
2. Dynamic Complexity, which is the measure of the level of the dynamic interaction

between the parts.

3. Psychological complexity, which is a measure of the number of interpretations and interests, exhibited by those observing the behaviour.

3.4.2 Recognising Complexity In A System

Thus far the RTS was intuitively labelled as a complex system without any particular complexity perspective. Having done a brief analysis on the different perspectives on complexity the question that now needs to be answered is how does one initially recognise a complex system even before engaging a deep analysis of the system? One could use the Law of Requisite Variety (Ashby, 1958) or the Law of Requisite Parsimony (Warfield, 1988). The Law of Requisite Variety indicates the need for a match between the variety in the system under study and the variety within or among the observer/s of the system. One could then say that a mismatch with a greater variety in the system identifies it as a complex system. The Law of Requisite Parsimony indicates the need for the number of issues to be processed by the human mind to be within the bounded rationality of the human mind i.e. not exceeding (unless under exceptional circumstances) seven items. One could then say that if the bounded rationality of the human mind is violated then the system under observation is complex.

Warfield and Staley (1996) however, provide us with a more pragmatic set of necessary conditions for the recognition of complexity, which will inform the planning and design framework developed in this study. They state that a complex situation must contain a certain irreducible set of components, which are referred to as the necessary conditions for complexity. These seven necessary conditions being:

> "(a) a human presence; (b) a generic purpose associated with the human presence: (c) exercise of system inquiry by the human presence; (d) human purpose related infrastructure to make possible the system inquiry; (e) system related environment; (f) sensing apparatus for space-time sampling of the situation by the human presence and (g) cognition on the part of the human presence" (Warfield and Staley, 1996: 50-51).

When the Rural Telecommunications issues are viewed in the light of the foregoing description of complexity the following are observed: -

- There are two distinct but interrelated situations within rural telecommunications that displays complexity that one has to deal with in order for it to provide the maximum benefits to all its stake holders
- The relationship between the elements of a RTS exhibits properties similar to that described in Simon's "Architecture of Complexity". For within the RTS there exists subsystems such as the social and technological system, which are interrelated, and within these subsystems there exist interactions among its components. In Ryan's terminology the RTS exhibits both static and dynamic complexity.
- The planning team of the telecommunications infrastructure, irrespective of the number of members, contributes the psychological complexity mentioned by Ryan or the cognitive complexity mentioned by Warfield. This is a function of the planning and design situation and Warfield's and Staley's necessary conditions for complexity are implicitly present in this situation.
- The two interrelated complex situations in rural telecommunications then are the RTS and the planning and design situation. As this thesis unfolds it will become clear that the planning of rural telecommunication infrastructure has at least two dimensions of systemicity. The RTS per se and the planning process which entails the inquiry system. The outcomes of the planning and design process will both influence and be influenced by the dynamic interrelationships in the system.
- There are many ways of describing a complex system. Simon proposes a state description and a process description and for adaptive organisms there is a correlation between the two. Given the "desired state of affairs and an existing state of affairs" the adaptive organism has to find the difference between these two states and then to develop a process that will reduce this difference (Simon, 1962: 472). This principle modus operandi of adaptive systems when managing complexity can be applied to the RTS. One way of dealing with the challenges of rural telecommunications is to define the ultimate desired state of the RTS and then assess the current reality. Complexity can then be simplified by designing and managing a sequence of processes that will take the current reality to the desired state of affairs. This is a key component in Ackoff's Interactive Planning to be discussed later in this thesis (Ackoff, 1981). Although this might seem obvious and some may argue is common sense, the process of determining the desired state and the current realities is not a trivial issue.

One thread that has been running through the foregoing discussion is that part of the solution to a complex problem is in the management of that complexity and as a necessary primer to this management there must be an appropriate inquiry system. This is certainly axiomatic for the complex planning and design situation of rural telecommunications. One must bear in mind that because of the uncertainties and heterogeneity of rural telecommunications and the uniqueness of rural communities, it is not possible to find all the necessary and sufficient conditions for managing all planning and design situations for all rural areas. However, the following statement by Warfield (1995) is encouraging and alluded to the significance of inquiry systems:

> "To misplace the origin of complexity in the object of inquiry, instead of in the mind of the observer, is to commit an error that is unlikely to be undone...If, however it is correctly realised that complexity is in the mind of the beholder, the possibility of reducing complexity through learning processes comes to the fore."

On the need for an appropriate inquiry system, the author shall not delve deep into the study of 'Design of Inquiry Systems' for that requires separate research. However, Murthy (2000), based on the work of salient authors on modern inquiry systems makes the following summary, which at this stage provides sufficient elucidation:

> "The design of inquiry system is essential before one tries to understand the world around us. An acceptable design has many aspects to it. Basically it must have the ability to reveal the truth of a system. It must be capable of adoption by people who can pursue the method steadfastly until contradictions are revealed. It can be of many types based on logic and/or personalised quest, but it must have the contours and character of a dialogue with nature, revealing, if not in one shot, gradually in steps the nature of reality: For complex systems this method or way proves to be most effective." (Murthy, 2000: 82)

Regarding the management of complexity Warfield proposes four approaches that may be used in the planning and design situation (Warfield, 1994: 139-142). Although this is not a full set it will however lead to 'stable states' in the quest for a holistic solution.

- These approaches are: -
- **"The control of situational escalation"** which is a function of the diverse views of the planning team and dynamic nature of some of the issues involved in the planning of rural telecommunications infrastructure, amongst others.
- **"The elimination of the situational detractors"** that may have an adverse effect on the planning process. These factors are characteristic of the individual planning team members and may be intrinsic to the situation, cultural or extrinsic, i.e. independent of culture or the situation such as believing that technology will solve all the problems of

the world.

- **"The reduction of personal cognitive burden"** which is a function of the level of desired expertise required for the holistic planning and design of the rural telecommunications infrastructure.
- **"The provision of personal enhancers"** to enhance the capacity of the individual team members to become more effective in the complex planning situation. Examples of potential enhancements are effective group process, computer assistance to the team and capacity to structure information effectively.

The leading question that guides this thesis henceforth is: Given the systemic nature of rural telecommunications as depicted in the heuristic model of the RTS (Figure 3.2), and the complex nature of this RTS in terms of both the situational complexity and the cognitive complexity, how does one plan and design the technology infrastructure subsystem such that the emergent properties of a RTS are realised? To the best knowledge of the author this is a novel approach and the contention is that this novel approach will ultimately lead to a telecommunications technology infrastructure subsystem that will play a more effective role in the RTS in realising its emergent properties of 'benefits to all stakeholders'.

The next core issue that needs further discussion and reflection is the concept of planning . The fact that there are numerous publications on this topic not only emphasises the significance of 'planning' in all spheres of human life, but also indicates the vast scope and interpretations of planning issues. Therefore an attempt shall be made to limit the discussion on planning in the next section to a philosophical and conceptual overview of planning, sufficient enough to inform the development of an appropriate framework for planning of rural telecommunications infrastructure.

3.5 A Conceptual Overview Of Planning

3.5.1 General Definitions And Concepts Of Planning

Our understanding of the terms 'planning' or 'design' is usually based on our intuitive connotations about these terms depending on the particular context of application, rather than on concise and unambiguous definitions. The topic of this thesis will ultimately lend a rural telecommunications flavour to the fundamentals that will inform the planning activity. One advantage of having a contextual approach to the discussion on planning is that interpretations become simpler and the role players are easily identified. The danger is that planning becomes a rigid sequence of steps meant for a particular context, and then unconsciously generalised to other situations. The following statement by Warfield (1976: 121) elucidates this point:

> "The suggestion that the planning can provide the focus for a general discussion of planning would meet appropriate resistance if the process was treated as a rigid sequence of steps to be followed in all planning situations. Instead, what seems to be needed is a framework of a planning process that is sufficiently flexible to permit discretionary deletions and amendments without destroying its essential character. But like all frameworks, to be useful it should contain algorithmic ingredients showing ways in which the various recommended activities can be carried out efficiently, while still satisfying the requirements for participation, understanding, and adequacy to attain quality and develop acceptance of a plan".

Planning is investigated in various disciplines like management, economics, accounting, artificial intelligence but this thesis investigates planning from the point of view of systems thinking as that is of relevance to the research topic. The need for a systemic approach was derived from the analysis of the current theory and practice of planning of rural telecommunications in the previous chapter. A comparison of the value of various planning approaches as advocated by different disciplines is a huge task that requires a separate investigation and falls outside the scope of the research. Despite the many connotations of planning, the essential ingredients of a plan are: A goal is set, a group of alternatives is created, each alternative is scanned as to whether it will or will not effectively lead to the goal, one of the alternatives is selected, the plan is implemented, and the decision maker monitors the implemented plan, (Churchman, 1968). In order to ensure that the most suitable planning methodologies are used, it will be prudent to first approach the issues in planning and design with as little bias or context as possible. A deep understanding of the fundamental concepts and nature of planning is vital for a plausible planning framework for rural telecommunications.

The differences between 'planning' and 'design', if any, or whether planning is a pre-activity to design or vice versa also depends on the context of application. For example Archer (1965) states that "design is a goal-directed problem-solving activity" while Rittel (1971) states, "design is an activity aiming at the production of a plan *(e.g. designing a* *planning process)*, which if carried out, will result in a situation with desired characteristics and without undesired or unforeseen side and after effects" (quoted in Olsen, 1982: 5). Olsen further explains: "design is meant to refer to processes of problem solving, policy making, and planning found in such disciplines as architecture…education, engineering, industrial design… and social work." On page six of Olsen (1982) a concise definition by Archer on planning is provided: "Planning is the activity of anticipating and specifying how an objective can be achieved" or put another way: "Planning is the design of a desired future and of effective ways of bringing it about" (Ackoff, 1999: 99).

While there may be an apparent contradiction with respect to the chronological order of planning versus design, what is at least clear is that planning and design are inextricably linked. The human activity of planning in the context of the traditional engineering fraternity is more conducive to infrastructure type technologies such as telecommunications and electrical power distribution. The human activity of design in these contexts is usually a post activity to planning being informed by the planning. Once infrastructure is planned for a particular area then the technology solutions, for example, need to be designed. This will be taken as the typical situation for the case of rural telecommunications.

3.5.2 Some General Categories Of Planning

Branch (1962) discusses various generic types of planning, such as functional planning, project planning and comprehensive planning. In functional planning one can perform an intricate series of actions, which lead to a predetermined result. Well-defined actions are limited in that they are defined by the planners' capacity to predict results. When mathematical means fail reliable forecasting, the planners rely on their experience and reasoning. Project planning incorporates a greater range of diverse elements than functional planning. It may involve a range of disciplines and some elements can be predetermined with quantitative precision while others are designed on the basis of accumulated experience, experimental tests and logical reasoning. Some aspects are indeterminate.

Warfield mentions two purposes of planning, the 'Deterministic Activity Programming' and the 'Milestone Programming', which fits in well with the functional and project planning and also the classification of systems mentioned in section 3.1.1. In deterministic activity programming a distinctive set of activities is developed, resources for carrying out these activities are then identified, schedules are developed, assignments are made and work proceeds strictly according to plan. Although decisions were made as part of the planning process there is no need for any interim decisions. Milestone programming on the other hand is similar to the deterministic activity programming but there is at least one (usually several) milestone point in the plan at which key decisions are to be made. In other words, there is an element of future uncertainty, which can only be resolved after a part of the plan has been carried out (Warfield, 1976: 122-123).

Comprehensive planning refers to the human endeavour to perform a major achievement such as to shape the environment, shape a society or affect the future, and will normally include functional and project planning which are themselves subject to comprehensive planning. Social planning, corporate planning and (as this thesis will show) rural telecommunications infrastructure planning fall into the category of comprehensive planning and so the focus of the discussion on planning in general will be on comprehensive planning. However, this section will not be complete without mention of strategic and tactical planning.

Ackoff mentions that the distinction between strategic and tactical planning is more relative than absolute (Ackoff, 1999: 102). The difference is in terms of range, scope and orientation. Strategic planning is long range planning whereas tactical planning is of shorter range. Both are necessary and complement each other. Because the terms long and short are relative Ackoff describes strategic and tactical planning as being concerned with the longest period worth considering and the shortest period worth considering, respectively. Strategic planning is broad in scope while tactical planning is narrower. However, a strategic plan for a department in an organization may be viewed as a tactical plan by the management. In terms of their orientation strategic planning is concerned primarily with the formulation of goals and selection of the means for attaining those goals i.e. ends oriented, whereas tactical planning is means oriented being primarily concerned with the means to pursue those goals. Here again means and ends are relative and if the planning is to be realized then both strategic and tactical planning are required.

3.5.3 The Nature Of Planning

In dealing with social planning Ulrich (1996) provides a dimension to planning that has important implications for the RTS. Ulrich mentions that social planning is usually practised as a form of scientifically informed means that accomplishes a given end. This planning is usually characterised by a technocratic paradigm in which the expert-driven planning is regarded as the preferred approach. Therefore Ulrich comments that planning is often the problem rather than the solution as it imposes solutions upon people that are not their solutions, as they had no voice in their making. Ackoff has very similar criticisms. He mentions that most conventional planning is carried out by professional planners for others (Ackoff, 1981). It is the experience of the author that in the South African context this position is beginning to change, both at governmental levels and at corporate levels. However, one must take heed of Ackoff's caution that often participation means taking into account the desires, hopes and expectations of others as the experts see them instead of direct involvement in the planning process by the relevant stakeholders.

A different notion of planning is provided by Ulrich in that planning should be regarded as the art of promoting improvement or alternatively the art of making decisions that affect other people. This notion of planning then immediately begs the crucial question as to what constitutes an improvement? In order to assist this particular approach, Ulrich proposes democracy in planning but with a critical approach, and thus provides a framework called 'Critical Heuristics' to achieve this. Critical Heuristics has two main thrusts: -

- To develop a sense of critical consciousness amongst the planners, experts and decision makers so that they may be more self-reflective and democratically minded when trying to bring about improvement and secondly,
- To empower the ordinary people who will be the direct customers of the improvement with a critical amount of competence which will enable them to become effective participants in the planning process, and thereby become less dependent on the goodwill and expertise of the planners, experts and decision makers

Although Ulrich's theory pertains to social planning it raises some important issues for rural telecommunications planning, for planning and design of rural telecommunications infrastructure is really about planning for a socio-technical system. The question 'what constitutes improvement?' is a critical question for the planning of the RTS, for if the planning team does not understand what 'improvement' means then planning of the RTS with development in mind becomes a futile exercise. The thrust of the Critical Heuristics framework therefore has some implications for the rural telecommunications planning framework in that due consideration has to be given to democracy or representivity and to the undue influence of power within the planning team.

Ackoff (1981, 1994) perceives the corporation as a social system, and in his discussion on the nature of planning with respect to corporations, alludes to the fact that planning is still far from being an exact science or a fine art. At best the only elucidation on planning is at a general level. In attempting to get a deep understanding of the nature of planning one may strive for an appreciation of what planning can do, a philosophy with which it can be approached, a concept of how it can be organised or systematised, and an awareness of the best methods, techniques and tools that can facilitate the planning and also be incorporated in the plan (Ackoff, 1999: 100). What is certain is that decisions are part and parcel of planning. While planning is clearly a decision making process according to Ackoff, this decision making has some very special characteristics: -

- Planning is anticipatory decision making in that the decisions taken in the process are well before the required actions. Otherwise planning would not be necessary.
- The decisions that are required in planning are interrelated or interdependent. While some decisions may be simple, planning is characterised by complex decisions, which is a function of the interrelatedness of the decisions rather than the decisions themselves. In keeping with the systems idea, Ackoff describes planning as a 'system of decisions' and because they are too large to handle all at once, planning itself must be planned. In other words the planning must be divided into phases or stages. However, one must be careful not to violate the systemicity by subdividing the planning problem into independent subplanning problems. What this means is that decisions made early in the planning process must be taken into account when making decisions later on in the process, and earlier decisions must be viewed in the light of the decisions made subsequent to them. Conventional planners consider a plan to be an aggregation of solutions to problems that are dealt with independently and yet it is the relationships between the various sub problems/subsystems that contribute to the

properties of the system as a whole.

- Planning is a deliberate attempt to produce one or more desired future states that are unlikely to occur without intervention. Therefore the decision making must ensure that inappropriate actions are avoided and opportunities are exploited.

That planning consists of a system of decisions and therefore needs to be planned has some important implications for the nature of planning. Planning is not just an act or a single human activity, it is a process in which development takes place and has no natural conclusion or termination (Ackoff, 1999). It is a process that asymptotically converges towards an 'ideal solution'. The reasons for this are two-fold: Reviewing of the plan or the previous decisions is limitless, and secondly, one normally deals with an open system which implies that the system being planned for and its environment changes during the planning process. The fact that nevertheless implementation has to take place at some stage means that improvements rather than absolute solutions should be the goal of planning. This is in keeping with Ulrich's view. Senge *et al* (1994: 33) also emphasise the value gained from the planning process itself. They see the role of planning as an infrastructure to enhance learning throughout an organization. It is during the planning process that new worldviews about the issues at stake surface, as an example, and if the term 'planning as learning' is to become a reality then at least equal attention must be given to the process of planning as the plan itself. Ackoff makes the most appropriate summary:

> "...Planning is a process that involves making and evaluating each of a set of interrelated decisions before action is required, in a situation in which it is believed that unless action is taken a desired future state is not likely to occur, and that, if appropriate action is taken, the likelihood of a favourable outcome can be increased." (Ackoff, 1999: 102).

3.5.4 Orientations To Planning

One final dimension to planning in general based on the dominant orientation of the planners shall be covered in this section. Ackoff (1981) mentions four basic orientations to planning, which are elaborated below: -

- **Reactivism:** The dominant orientation in reactivism is the past. Reactivists are satisfied neither with the present situation nor with where they are going but prefer the way things once were. They move into the future facing the past and hence have a better view of where they have come from rather than where they are going. Reactive planners see technology as their prime enemy because they see technology as the principal trigger for change. They believe that all the current problems have a cause and if this could be identified and suppressed or removed then the problem will disappear. Being hostile to technology they look for answers in history and experience rather than in scientific experiments and so they are more comfortable with qualitative rather than quantitative thinking. Reactivists tend to rely on traditional authoritarian and paternalistic hierarchical organisational structures. As a result the organisation is ruled from the top down and planned from bottom up where the organisation is reduced to convenient elements. Each manager then optimises his/her particular section and the plan is sent up to the next hierarchy. Planning is the prerogative of management and is ritualistic. However, there are some noteworthy advantages. There is a respect for history from which things could be learnt and it embodies a feeling of continuity. The preservation of tradition tends to make people feel secure although this might be short-lived.

- **Inactivism:** Inactivists are satisfied with their current situation Their objectives are survival and stability and they therefore try to prevent change although they do not like the way things are going. Inactivists delay as much as possible any action and will only act once their stability is threatened and therefore crisis management is a typical practice. Contrary to what the term 'inactivism' may suggest, inactivists are kept very busy with bureaucracy and the various large committees that are engaged in endless exercises. They are pre-occupied with customs, protocols, rules and conformity instead of efficiency and creativity. Typically this type of organisation survives independent of its performance. However, some problems do solve themselves if left alone and sometimes doing nothing is better than doing the wrong thing. So inactivists can survive if the environment is conducive, albeit for a short while.

- **Preactivism:** Preactivists are neither willing to return to a previous state nor comfortable with the way things are but insist on embracing the future. Planning is concerned primarily with predicting the future rather than preparation and strategizing for it. Preparation for a predictable future is of little value. They seek to accelerate change, which is largely triggered by technology, and exploit the opportunities that come with it, always striving to be at the leading edge of competition. Preactivists rely more on experiment than on experience and are therefore not afraid of taking calculated risks. Optimal performance, efficiency and fast growth are the prime values. Planning proceeds from the top down and is driven by 'professional' planning staff and management.

- **Interactivism:** Implicit in reactivism, inactivism and preactivism is an assumption that the future is largely out of their control and all that can be done is to accept this future and plan accordingly. Interactivists however are not willing to return to the past, settle for things as they are or accept the future as it appears to them. They believe that the future is largely subject to creation and therefore planning is seen as the design of a desirable future and the intervention of ways to bring it about. The question of the amount of art and science in planning is addressed in interactivism. Science and the humanities are seen as two sides of the same coin. When faced with a problematic situation previous experience and other situations are examined for common elements and the available relevant knowledge is identified. Science enables one to do this. Then the unique features of the problem situation indicate the required knowledge not yet available. The humanities enable one to do this. In other words humanities and experience reveal the questions to be answered and the values to be obtained and science provides the answers to these questions and efficient ways of pursuing these values. Because interactivists focus on improving performance over time towards an idealized future, learning and adaptation are the key requirements. This also helps to cope with social change and the continual need for new solutions. Ackoff states that "humans are more than ends-seeking animals; we are ideal seeking" and therefore the interactivists believe that the failure in addressing the right problems is due to a lack of awareness of what the ideals are when planning.

Ackoff (1981) uses an apt metaphor of a person riding a moving tide to illustrate the different orientations, which provides a good summary. The inactivist tries to hold a fixed position in a moving tide; they are satisfied with doing well enough. The reactivist tries to swim against the tide while the preactivist tries to ride with the tide along its leading edge, wanting to do as well as possible to optimise. The interactivist tries to control the tide wanting to do better in the future than the best one is capable of doing now. It must be pointed out that the four planning orientations seldom occur in their pure forms but rather occur as a mixture dominated by any one of the orientations. Interactivism arose out of an effort by Ackoff to develop a methodology of management and planning called Interactive Planning (IP) that is grounded on systems principles.

In searching for an appropriate planning and design framework for a mess such as the RTS it is clear that the current 'predict and prepare' philosophy is unsuitable. Rather, the ideas implicit in the interactive orientation of planning mentioned above, have been adopted for the development of the framework. It is also now clear that planning means comprehensive planning which will include functional and project planning, the deterministic activity programming and the milestone programming, amongst others. The challenge is developing a framework that will be conducive to systemic activities that will provide a rural telecommunications infrastructure that will provide benefits to all stakeholders.

3.6 A Synthesis Of The Arguments Thus Far: Further Considerations On The Nature Of The RTS

Having defined the boundaries of the problem of rural telecommunications, the complex issues involved in its planning need to be understood, appreciated and managed properly. A systemic framework assisting in the planning of rural telecommunications infrastructure needs to address these issues. The treatment on the RTS, the complex nature of this system and the overview on planning when synthesised, have some important implications for the planning and design framework for rural telecommunications infrastructure. What the following synthesised summary will show is that planning and design for rural telecommunications infrastructure is really planning for a complex dynamic socio-technical system, and the challenge is leveraging this planning and design of rural telecommunications infrastructure to facilitate the emergent properties of the system

- If rural telecommunications is to be effective in achieving its intended purpose that defined purpose being benefits to all stakeholders, then due consideration must be given to the RTS as a whole. For the emergent properties are a function of the synergistic interactions within the system and not just the telecommunications technology.

- It has been argued that the RTS is an open, complex, and dynamic socio-technical system and is therefore prone to lack of information, uncertainty and unpredictability. A reductionist approach for an 'absolute solution' within a technocratic and optimisation paradigm is definitely inappropriate. Implicit in these paradigms is the required availability of reasonable certainty and predictability. Rather, the idea suggested by Ulrich that planning is the art of promoting improvement is appropriate for a socio-technical system such as the RTS. This also means that the positive features present in current practices must be complemented or harnessed.
- The composition of the RTS implies that the knowledge required for planning and design of rural telecommunications infrastructure within a RTS extends far beyond the traditional engineering domain. The softer issues such as cultural diversity, ownership of the system or inclusivity, dealing with multiple stakeholders and a firm grasp of the socio-economic issues are just as important as the hard technological issues. The composition of the planning team therefore has to cater for this wide knowledge base and at the same time be representative of all stakeholders and so democratic principles need to be entrenched in whatever methodologies will be used for the planning.
- In terms of Ackoff and Gharajedaghi's (1996) classification of systems, the RTS has subsystems that are deterministic, animated and social in behaviour. The planning and design methodologies must cater for this diversity in the system behaviour while the framework needs to be as generic as possible, as suggested by Warfield.
- It has been argued in the discussion on complexity that the planning of rural telecommunications infrastructure has at least two dimensions of complexity associated with it: Situational complexity inherent in the RTS and the cognitive complexity associated with the planning team in interpreting the situational complexity. This is tantamount to saying that the planning framework must cater for the systemicity in the RTS and the systemicity required in the activities of the planning.
- The RTS is continuously evolving as long as the animated system is part of it, and so in planning for a moving target there have to be mechanisms for constant review. In other words planning and design is a continuous process. In addition, this continuous process must harness the learning that takes place during this process for the purposes of development.

Having now completed an analysis of the RTS and its complex nature the research will now move on to the next phase of finding appropriate systems approaches and corresponding methodologies. It will be prudent at this stage to clarify the terms 'methodology', and 'technique' as the next part of the thesis focuses on these issues. Methodology in the context of this thesis is a structured set of guidelines for activities to deal with the messes people face. Methodologies are underpinned implicitly or explicitly by certain philosophical assumptions. A technique is a specific activity that has a clear and well-defined purpose within a methodology (Mingers and Brocklesby, 1996; Bowen, 1998).

A set of criteria for methodology for complex systems proposed by Murthy (2000: 99) is considered as an initial orientation to the search for an appropriate approach to the development of a planning and design framework for rural telecommunications infrastructure. Any inquiry system and technique required to solve complex societal problems must consider the following: -

- Multidimensionality is inherent in complexity and therefore the methodology must be capable of identifying and dealing with as many dimensions as possible. Group participation and the facility for continuous learning must be important features of the methodology since a single individual will have limited knowledge on all the issues pertaining to the complex situation.
- Interdependent relationships and mutual influences between the elements (and sub-elements) of the system are basic hallmarks of complex systems. These must be identified by a cybernetic relational diagram. In addition the communication between elements must be traceable. Since the nature of a system is to act as a whole the methodology must be capable of assisting the analysts in understanding what in the system makes it act as a whole.
- A reasonable identification of the system must be made.
- There must be a means of establishing the viability (and sustainability if necessary) of the system.
- Evolution is characteristic of complex systems and therefore the methodology must be capable of identifying those parameters that trigger evolution.
- The methodology should cater for complimentary use of other system methodologies and continuous improvement to the solution.

- The methodology must embrace emancipatory approaches.

The issues discussed in this chapter thus far lead to the need to explore existing research in rural development and relevant systems thinking approaches. A recent discussion of rural development and systems thinking is presented in Brown (1997). It concludes that the fields of rural development and systems thinking have each developed diverse multiple methodologies for aiding development, managing change and problem solving (see also section 2.4 of this thesis). It finds certain similarity in rural development research (e.g. see Scoones and Thompson, 1993) and Total Systems Intervention (TSI) version one (see Flood and Jackson, 1991) in terms of their focus on the philosophical base of a particular research approach. It argues that the second version of TSI (Flood, 1995) leans more towards assessing the appropriateness of methodologies, tempered by considering their philosophical underpinnings (Brown, 1997: 153). There are two issues that arise from it.

The first one is the choice between a developmental research approach and a systems approach. The systems approach was chosen due to several but related reasons. Due to the fact that rural telecommunications as a system is less dependent on the human element than a traditionally defined rural farming system it seems that developmental approaches will be less appropriate than a systems approach. Secondly, the analysis in the preceding sections demonstrated that a substantial drawback of the existing methods for planning of rural telecommunications in South Africa is the lack of systemicity. But there is a deeper compelling reason. A fundamental thread that runs through this thesis is that the provision of telecommunications infrastructure to a particular rural area is not just a technology issue. It is a necessary subsystem of the RTS and a significant intervention into the rural society. Midgley (2000: 113) defines intervention as "purposeful action by a human agent to create change". The main goal of this research is to develop a framework for the planning and design of rural telecommunications infrastructure such that these activities are the purposeful action that ultimately results in improvements in the rural society. The systemicity in the RTS has now been established and this immediately justifies the need for a systems thinking approach to the development of the planning framework for the telecommunications infrastructure.

The second issue is about the suitability of a particular systems approach. A detailed presentation of the major ideas related to possible systems approaches that have potential relevance to the problem of this research is presented in Appendix A. A detailed justification for the choice of particular methodologies to be included in the planning framework will be presented later in the next chapter. The following section provides some conclusions regarding the relevant systems approaches with their underlying philosophy and salient methodology/ies, which are worth considering for the development of the planning framework.

3.7 Some Conclusions Regarding The Possible Appropriate Systems Approaches Suitable For The Purposes Of This Research

Chapter two and three of this thesis discussed the major features of the RTS, which indicates that it is a complex, dynamic socio-technical system with many diverse stakeholders. The need for a systems thinking approach to the planning of rural telecommunications infrastructure has already been established in this chapter. Appendix A provides an informative account on the developments in the systems thinking field with respect to the various systems approaches and their relevant systems methodologies. This Appendix should help one to appreciate how the systems movement has evolved and expanded from General Systems Theory, to what is generally classified as Hard Systems Thinking, and Soft Systems Thinking through to Critical Systems Thinking.

One of the key intentions of General Systems Thinking was to provide a meta-level language and theory in which the problems of different disciplines could be expressed and solved. It was envisaged that this would promote the unity of science. According to Checkland (1999) there is very little evidence of this anticipated outcome, although General Systems Theory made a pioneering contribution to the systems field. Midgley (2000: 46-48) has criticised General Systems Theory for its silence on the subject/object dualism, i.e. the observer (subject) of the system is somehow independent or does not influence the observed (object).

Hard Systems Thinking or "the functionalist systems approach" (Jackson, 2000) seeks to model the real world system of concern with a view to optimising its performance according to predefined ends and objectives (Lane and Jackson, 1995). Therefore, implicit in hard systems thinking is the demand for quantification and optimisation. However, large complex systems such as the RTS are dynamic and therefore characterised by uncertainty and issues such as conflicting values and objectives that cannot be quantified. Jackson (1991) mentions that within the hard systems approach it is quite possible for the most powerful stakeholder to promote vested interests and so hide conflict. Having manipulated the situation hard systems approaches seek to be 'scientific, objective, and apolitical'. Some of the well-known methodologies within the hard systems thinking include Systems Engineering, Systems Analysis, and Operational Research (see Appendix A for details)

In soft systems thinking the world is taken to be complex, confusing and messy with diverse perspectives, and in coping with it a process of inquiry into it can be organised as a learning system. Thus the concept of system no longer applies to the outside world but instead to the process of learning about the world. It is this shift in systemicity from the world to the process of inquiry into the world that forms the fundamental intellectual distinction between hard systems thinking and soft systems thinking (Checkland, 1983, 1999). Jackson (2000) categorises soft systems thinking as an interpretive systems approach. The primary area of concern in this approach is perceptions, values, beliefs and interests. It accepts that multiple perceptions of reality exist, and one needs to find a way of accommodating this. Methodologies in soft systems thinking seek to understand these perceptions, values, beliefs, and interests so that one could predict and control outcomes. Culture and politics play an important role in the interpretive systems approach. Some of the well-known methodologies within soft systems thinking include Interactive Planning (Ackoff, 1981), Soft Systems Methodology (Checkland and Scholes, 1990), Strategic Assumption Surfacing and Testing (Mason and Mitroff, 1981), and Unbounded Systems Thinking (Mitroff and Linstone, 1993).

According to Jackson (1994), however, the limitations in the different strands of system thinking began to surface in the 1980s and there was a failure to think through the relation between the various approaches. Critical Systems Thinking (CST), which draws its philosophical justification from Critical Social Theory, was developed as a strand of systems thinking to address this failure. An overview of CST if provided in Appendix A, and is also discussed further in the next chapter.

What remain to be decided are the most appropriate systems approach and the corresponding methodology. However, the problem is not as simple as this, because the RTS does not just fit into a single systems thinking paradigm. Furthermore, it is evident that a single methodology is not going to be sufficient to deal with such a diverse problem. The various methodologies discussed in Appendix A have their strengths and weaknesses and a justified way of harnessing the strengths of different methodologies needs to be found.

There are two issues that now need to be resolved for the development of the planning framework and these are also discussed in detail in the next chapter. The first issue is the appropriate systems approach to be included in the framework, i.e. the choice among hard systems thinking, soft systems thinking and critical systems thinking approaches. Following the detailed presentation in Appendix A of possible relevant systems approaches to the problem on hand, Soft Systems Methodology (SSM) (Checkland and Scholes, 1990), Interactive Planning (IP) (Ackoff, 1981) and Interpretive Structural Modelling/Interactive Management (ISM/IM) (Warfield, 1994 and Warfield and Cárdenas, 1994) are considered. There are no known comparisons of SSM, IP, and ISM/IM, but one can rely on the deep analysis by Sinn (1998) of Interactive Planning and SSM and draw some conclusions pertaining to SSM and IP.

Although both methodologies belong to the interpretivist paradigm, Ackoff and Checkland make different ontological assumptions. Checkland's ontology is "almost completely subjective" whereas Ackoff's falls between subjective and objective (Sinn, 1998: 445). For Checkland, the systemicity is in the mind and not in the real world, as reflected in SSM. Ackoff makes suggestions about the real world (see for example the concept of the circular organisation in Ackoff, 1981). In addition, Ackoff includes significant elements of functionalism and structuralism into theory, for example some of the techniques that are used in IP such as reference scenarios. No elements of functionalism are incorporated into SSM. Warfield's ISM/IM is agnostic to ontological assumptions. It is interesting to note that Jackson (2000) classes IM as an interpretivist methodology. However, Warfield's contribution on ISM/IM stems from his recognition of complexity in dealing with societal problems. ISM, which is the critical kernel within the overall methodology of IM, is a participatory learning process in an attempt to deal with complexity - both cognitive and situational (see section 3.4 of this thesis). The organisation of complexity is the key to finding resolution to that complexity. Relational mathematics and computer assistance is crucial to the method of ISM. IM was conceived as a more embracing system of managing complexity. It is based on a method of science called the *Science of Generic Design* (Warfield, 1994). Warfield does not offer any particular position with respect to his ontology. However, one can glean from his writings that he recognises that subjectivity must be considered and managed when intervening in objective real world systems. One can conclude then that his ontology is more objective than Checkland's, and perhaps more objective, if not, similar to Ackoff's ontology. It must be noted that ISM/IM is more concerned with managing complexity than planning for uncertain futures (as in IP) and that ISM/IM has been applied to engineering design problems (managing the complexity of the design) as well (see for example Warfield and Staley, 1996). Another similarity between IP and ISM/IM is that although IM incorporates soft techniques such as brain storming and the nominal group technique (Delbecq *et al*, 1975), there are a range of functionalist techniques that are also included, such as trade off analysis and decision trees.

There are other comparative issues that have relevance to the development of the planning framework. SSM and IP have different approaches to conflict among participants or stakeholders in an intervention. Ackoff views conflict as an illusion, which can be dissolved through the processes in IP (Sinn, 1998: 447). In fact, IP requires a diverse group of participants to reach a consensus on an idealised design before they act. Flood and Jackson (1991) have criticised this view on consensus as being unrealistic. There are bound to be situations were interests truly diverge and produce real conflict. Checkland recognises this and therefore SSM encourages participants to learn about their assumptions and problem situation such that an accommodation can be reached to facilitate action. So SSM enables action in spite of conflict. Warfield is silent on the issue of conflict, but from his theory on complexity (Warfield, 1999) one can assume that recognition of complexity implies recognition of diverse interests. The problem, however, is that ISM/IM does not sufficiently cater for deep conflictual situations. The techniques that deal with multiple views and interests such as brainstorming and the nominal group technique finally resolves issues by voting. Even the ISM process itself inherently assumes common objectives and goals, that being the resolution of complexity. The following statement supports this view:

> "The development of IM is based on the recognition that for coping with complex situations there is a need for a group of people, knowledgeable of the situation, to tackle together the main aspects of concern, to develop a deep understanding of

> the situation under analysis and to elaborate the basis for effective action; all these founded in a spirit of collaboration, commitment and within the framework of serious and organised effort." (Warfield and Cárdenas, 1994: 1).

While these processes will require some discussion before a final decision is made it is not enough to deal with conflict. Warfield emphasis the importance of his methodology being based on a "method of science", implying that this foundation justifies the techniques in his methodology.

Related to the conflict/consensus/ issue is the issue of stakeholder participation in the intervention. Ackoff suggests the concept of the circular organisation to improve participation in the intervention (Ackoff, 1981). Checkland does not recommend a structure for broad participation. In IM the actors are strategically chosen. They consist of the IM team external to the organisation requiring the intervention, active participants (designers, implementers) and observers (these are people that may have a bearing on the problem situation but may be deemed not important enough to participate) (Warfield and Cárdenas, 1994: 44). One problem with this is that the participants are chosen by the 'powerful' without any enabling method or technique. However, this may be acceptable in a non-coercive situation. A challenging issue for the planning framework for rural telecommunications is how to take into consideration the emancipatory interests of the rural community, which has a direct bearing on development. This will be addressed in the next chapter.

SSM is more flexible than IP, which requires considerable consensus to move forward. SSM is more a learning methodology than a fully-fledged organisational intervention and therefore is more conducive to quick implementation. IP, on the other hand, is more comprehensive in its approach, facilitating action after inquiry through the logistical phases of means, resource, and implementation and control planning. The strength of ISM/IM is in its structuring of the complexity that is inherent in a problem situation in such ways that one can move to decisive action in the real world, with respect to implementation of a plan.

There are other methods and techniques that were considered for the planning framework, such as Unbounded Systems Thinking, Critical Systems Heuristics, Systems Engineering, and Stakeholder analysis, but these will be covered in the next chapter in the formulation of the framework. What is becoming evident thus far is that IP, SSM or ISM/IM may not be sufficient as a whole methodology for the planning framework. The various strengths of the different methodologies will have to be harnessed in an appropriate and legitimate way for the formulation of the most suitable framework for rural telecommunications planning. This is the second issue mentioned and is discussed below.

The second issue is about the how to make a decision regarding the justification of the potential mix of techniques suitable for the problem on hand. The first version of TSI (Flood and Jackson, 1991) assumes that one whole methodology is to be chosen for a particular intervention, which often does not meet the needs of a complex practical problem like the one regarding the planning of the infrastructure for rural telecommunications. Both this version of TSI as well as its second form, formulated in Flood (1995) suffer from the shortcoming that they treat problem solving at a meta-methodology level, "from above" and thus seem to create a new paradigm themselves according to one of the original authors of TSI version one (see Jackson, 1997). TSI (version two) has been criticised for its lack of sufficient philosophical justification and complexity (Jackson, 1997). For those reasons we assume that the ideas on Multimethodology (Mingers, 1997, discussed in chapter four) are suitable for the problem on hand. Multimethodology draws its philosophical justification on Critical Social Theory and hence corresponds to the idea that rural telecommunications planning has to address the needs of the poor and dispossessed. This will be a starting point in the development of a new systemic framework for rural telecommunications planning.

Midgley (2000) defines 'systemic intervention' as purposeful action by an agent to create change in relation to reflection on boundaries. This in essence reflects the activities of the planning and design framework that ultimately intervenes in the RTS. These issues will be further investigated in the following chapter.

CHAPTER 4

TOWARDS METHODOLOGICAL PLURALISM FOR THE DEVELOPMENT OF THE SYSTEMIC FRAMEWORK FOR RURAL TELECOMMUNICATIONS INFRASTRUCTURE PLANNING

This chapter summarises the findings thus far, emphasising the nature of the RTS, and then mentions the salient features that the planning framework for rural telecommunications infrastructure (RTI) should comprise of. The need for a pluralistic systems approach to the problem is justified and thereafter an appropriate systems methodology is sought for the development of the framework. The final outcome of this chapter is a systemic framework for the planning of RTI that will facilitate the realisation of the emergent properties of the RTS.

4.1 The Salient Principles Of The Planning Framework

In chapter 2 of this thesis, an analysis of the various issues involved in rural telecommunications was done. This lead to the conclusion that a systems approach to the planning of RTI would be more appropriate than the existing practices. In chapter three a systemic model of the RTS was proposed. This model supports the view that what is commonly referred to as rural telecommunications is really a system of several interrelated parts contributing towards rural development. The technological infrastructure is just one part or a subsystem of the system. In terms of the behaviour of the system it was argued that the RTS could not be boxed into any one particular type of system behaviour. Instead it was shown that the RTS is a sociotechnical system that has deterministic, animated and social parts associated with it. In section 3.4 it was shown that the RTS is complex in nature and that it exhibits both situational complexity and cognitive complexity and that one way of dealing with complexity is to manage that complexity.

It was mentioned that while an emergent property of this system is the provision of benefits to all stakeholders of the system, a key purpose of the system is the development of the particular rural community that it serves. Therefore the provision of infrastructure must cater for this purpose. It was also mentioned that if the emergent properties are to be realised then the relationships between the various subsystems (such as the economic, sociological and cultural, and physical environment subsystem) of the RTS must be taken into account in the planning of the technological infrastructure. Also covered in chapter two was an investigation into the current planning processes and procedures recommended by the ITU and those operationalised by the fixed network provider, Telkom SA, in KZN, South Africa. There are techniques and tools that are currently being used that the author finds desirable to cater for in the new framework proposed in this research, but as a whole the existing approaches do not address the problem of rural telecommunications planning holistically. Therefore certain *continuity* in the RTS planning practices needs to be reflected in the principles of the proposed framework. The above leads to another conclusion for the features of the new approach – the need for *systemicity*. The methodologies that are catering for the latter however, and especially soft systems methodology is perceived as too general, lacking specific direction (Mihova-Petkova, 1999). The practical needs of the planning process are for a *rigorous approach* as in any other engineering field.

The analysis of the existing systems approaches conducted partly in chapter three and partly in Appendix A demonstrated the appeal of critical systems thinking as a suitable overall methodology. This appeal stems from the practical need for the new approach proposed here to address the interests of the disadvantaged, a reality due to the past of this country. Improvement in their plight as a result of the development of RTS is necessary. Another practical need is to create the preconditions for improvement of the realisation of the potential of those involved in the planning of RTS as the available resources are scarce in a developing country and require more careful selection and allocation procedures within the planning process. These practical needs correspond to some of the features of critical systems thinking (see Flood and Jackson, 1991; Jackson, 1991; Jackson, 2000; and Midgley, 2000). Hence the principles of critical awareness at the level of systems thinking as a whole and at the level of particular methodologies (see Jackson, 1991: 204)) lead to the need to consider the possibility for a *pluralist approach to problem solving combining* the positive features of different systems approaches. The social awareness in Critical systems thinking (see Jackson, 1991: 204) leads to the need for a framework that is *emancipatory in nature and improves the situation of the rural community* as already mentioned above. Other desirable features of the framework are the need to support multiple perspectives (See Mitroff and Linstone, 1993) and hence *all aspects and perspectives* of various nature need to be considered. Following the work in problem structuring techniques (see Rosenhead, 1989) there is a need for a framework that promotes understanding and learning in a bottom up way, within the context of a particular problem situation.

Based on the analysis thus far the principles guiding the framework for the planning of RTI were derived (see Table 4.1).

Table 4.1. Principles that underpin the planning framework for rural telecommunications infrastructure.

FP1.	**The framework must be systemic in nature in order for the emerging properties of the RTS to be realised.**
FP2.	**The framework must provide sufficiently rigorously guidelines for planning, taking into account however the complexities of the problem.**
FP3.	**The framework must combine the strengths of various relevant approaches for complex problem solving.**
FP4.	**The framework must take care of the disadvantaged rural communities in terms of providing an avenue for redress and transformation. As an initial step they should be represented in the planning process.**
FP5.	**The framework must be flexible and adaptable, promoting learning about the problem within the context of a particular rural areas, taking into account the needs of a developing country such as South Africa.**
FP6.	**All aspects, whether technological or not that contribute to the success of the deployed rural telecommunications infrastructure, must be considered in this framework.**
FP7.	**The framework must provide for the inclusion of the positive features present in the current planning processes.**

In summary, the above principles were derived from the analysis of the drawbacks of existing planning approaches to rural telecommunications, the need to address the complexity of the problem, and the need to provide a holistic approach that improves the provision of telecommunications infrastructure to the previously disadvantaged.

In moving towards the development of the systemic framework for planning of RTI another issue has to be addressed at this stage. Given the nature of the RTS as discussed in chapter three, one now needs to decide on a suitable systems thinking approach or a mix of approaches, taking into consideration suitable methodologies/methods/techniques, for the framework. It has to satisfy the above principles and to be in line with the latest achievements in the theory of systems thinking.

Part of chapter three and Appendix 1 of this thesis provided an overview of the various systems approaches and their salient methodologies. The systems approaches were categorised into the traditional paradigms of hard systems, soft systems, and critical systems thinking. The problems that one encounters in the process of the planning of RTI do not fall exclusively within the hard systems strand, or the soft systems strand for that matter. Therefore one can intuitively see that a single methodology belonging to a single strand of systems thinking will be insufficient to cater for the task at hand. Rather a combination of methodologies or parts of methodologies, methods/techniques may be necessary. In searching for the most appropriate systems approach for a problem such as the planning of RTI, it was decided that critical systems thinking would be most suitable. One of the fundamental commitments made by critical systems thinking, methodological pluralism, proves most conducive for the problem at hand. It will be instrumental in realising critical awareness and emancipation in the planning framework.

Upon investigating the possibility and suitability of combining various systems methodologies, methods, and techniques, one is faced with a 'paradigm crisis' that has challenged the systems movement for a number of years. The feasibility of mixing methodologies and techniques developed in different paradigms for a particular intervention is an issue of many debates. In essence the paradigm crises arises out of claims that philosophical paradigms are irrevocably incommensurable (for more details see Kuhn, 1970; Burrell and Morgan, 1979; Jackson and Carter, 1991). Nevertheless, Midgley (1997: 256), amongst others, holds a different view and summarises elegantly the paradigm problem facing proponents of methodological pluralism: "All system methodologies make different philosophical and theoretical assumptions – i.e. they are born in different paradigms – so if we wish to mix them, or bring them together in a framework, we have to justify this at the level of philosophy". The above justifies the need for the following sections to explore issues related to the nature of paradigms, their perceived incommensurability and the possibility to apply a pluralist approach in the proposed framework for RTI planning..

4.2 On The Nature Of Key Paradigms Relevant To Systems Practice In Dealing With Societal Systems

The discourse in paradigm thinking was initiated by Thomas Kuhn in his book "The Structure of Scientific Revolutions" (Kuhn, 1962). In its second edition he defines paradigms as 'universally recognised scientific achievements that for a time provide model problems and solutions to a community of practitioners' (Kuhn, 1970: VIII). He sees science not as a linear progression of falsified hypothesis, but, rather a revolutionary change from the old to the new, throughout history. The divide between the old and the new is so great that there can be no reconciliation between the two, in other words the paradigms are incommensurable (see Burrell, 1996). However, as a result of his work being exposed to scrutiny, his treatment of paradigm incommensurability changed over the years, from total incompatibility between the paradigms, to a less radical current position of the presence of 'translation failure' between paradigms (see Sankey, 1993: 760).

Masterman (1970) shows, however, that Kuhn (1962) uses the term 'paradigm' in at least 20 different ways in the "Structure of Scientific Revolutions" and so, for want of an appropriate definition for the purposes of this thesis, the explanation by Burrell (1996: 647) shall be adopted. He states:

> "a paradigm marks out, in an agreed and deep seated sense, a way of seeing the world and how it should be studied, and that this view is shared by a group of scientists who live in a community marked by a common conceptual language, who seek to build upon a shared conceptual edifice and who are possessed of a very defensive political posture to outsiders"

(see also Mingers and Brocklesby, 1996).

In the process of planning RTI, such that all stakeholders of the RTS benefit as much as possible, the planning teams, as part of the process, conduct inquiry to obtain knowledge needed for design and will intervene into the rural society when implementation of the infrastructure takes place. The entire planning process then, through to the implementation will be based on assumptions about the nature of human knowledge and inquiry, and the nature of society.

According to Burrell and Morgan (1979), the assumptions about human knowledge and inquiry (or social science), can be analysed in terms of ontology (beliefs about the nature of the world around us), epistemology (beliefs about how knowledge is generated and communicated), human nature (whether human beings are conditioned by their external circumstances i.e. deterministic, or whether human beings are voluntaristic i.e. of free will), and methodological nature. The assumptions related to ontology, epistemology, and human nature has a direct influence on the methodological nature. Some methodologies may treat the social world like the natural world, as hard, external to the observer, and as objective reality – the objectivist approach. On the other hand some methodologies may treat the social world as being much softer, and therefore stress the importance of the subjective experience of individuals in the creation of the social world – a subjectivist approach.

The assumptions about the nature of society can be analysed in terms of the notions of a 'sociology of regulation' and a 'sociology of radical change' (Burrell and Morgan, 1979). The former is concerned with the need for regulation in human affairs. The contribution by Durkheim (1893/1985) on the nature of social cohesion and solidarity, for example, elucidates the sociology of regulation. On the opposite end of regulation, the sociology of radical change is concerned with a person's emancipation from the structures, which limit and stunt his/her potential for development. "Its basic concern is to find explanations for the radical change, deep-seated structural conflict, modes of domination and structural contradiction which its theorists see as characterising modern society" (Burrell and Morgan, 1979: 17). Marx (1867/1976) contribution to sociological and economic thinking elucidates the sociology of radical change.

The nature of human knowledge and inquiry in terms of a subjectivists – objectivist dimension, and the nature of society in terms of sociology of regulation – radical change dimension are mapped, by Burrell and Morgan, into a coherent framework, which depicts four different paradigms as shown in Figure 4.1.

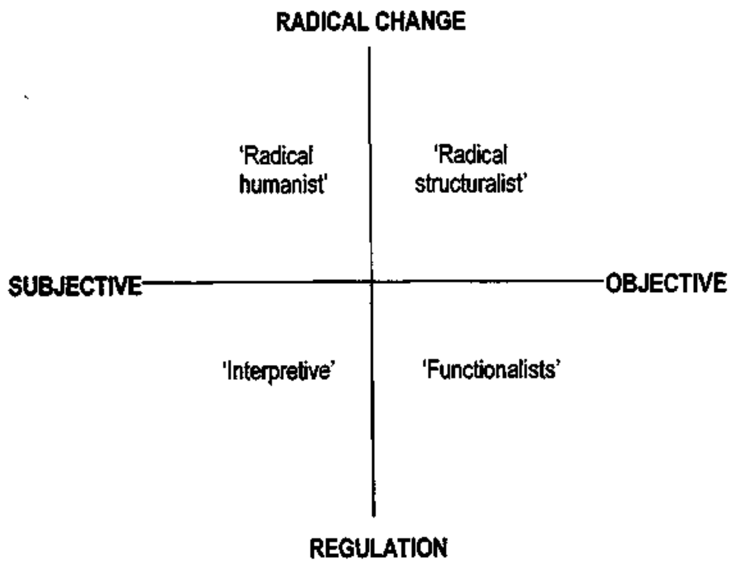

Figure 4.1. Four paradigms for the analysis of the nature of knowledge and inquiry, and the nature of society (after Burrell and Morgan, 1979)

Each of the four paradigms - functionalists, interpretive, radical humanist, and radical structuralist – share a common set of features with its adjunct neighbours on the axis separating them, in terms of one of the two dimensions. However, each define fundamentally different perspectives for the analysis of social phenomena, and will require different methodologies, methods, and techniques. It must be noted that working within the same paradigm does not necessarily imply complete unity of thought within this paradigm, amongst the agents. As Burrell and Morgan state: "Given the overall meta-theoretical assumptions which distinguish one paradigm from the other, there is room for much variation within them…. certain theorists adopt more extreme positions in terms of one or both of the two dimensions than others" (Burrell and Morgan, 1979: 24).

The functionalist paradigm represents a perspective, which is firmly rooted in the sociology of regulation and approaches its subject matter from an objectivist point of view. It seeks to provide rational explanations for social phenomena and is a perspective, which is highly pragmatic in orientation. The interpretive paradigm follows the tenets of a sociology of regulation and views the social world from a subjectivists point of view. It seeks to understand the real world within the frame of reference of the participant as opposed to the observer of the phenomenon.

The radical humanist paradigm and the radical structuralist paradigm are both committed to radical change but from a subjectivist and objectivist standpoint, respectively. The radical humanist perspective places crucial importance upon human consciences and believes that the limitations of existing social patterns could be transcended and so human beings could realise their full potential and be emancipated. The radical structuralist paradigm on the other hand concentrates upon structural relationships within a realist social world. Radical change is built within the very nature and structure of society, and explanations are sought for the intrinsic interrelationships within this structure. The radical humanist paradigm has much in common with the interpretive paradigm in that they both make similar assumptions about the nature of social science, as shown in Figure 4.2. The radical structuralist approach to social science is similar to that of the functionalist paradigm.

ASSUMPTIONS CONCERNING:	PARADIGMS			
	FUNCTIONALIST	INTERPRETIVE	RADICAL HUMANIST	RADICAL STRUCTURALIST
ONTOLOGY	Realist	Nominalist	Nominalist	Realist
EPISTEMOLOGY	Positivist	Anti-positivist	Anti-positivist	Positivist
HUMAN NATURE	Deterministic	Voluntarist	Voluntarist	Deterministic
METHODOOGY	Nomothetic	Ideographic	Ideographic	Nomothetic

Figure 4.2. A scheme showing the four paradigms as proposed by Burrell and Morgan (1979) in relation to the assumptions in their approaches to social science.

The contributions on the paradigm debate by Burrell and Morgan (1979) have not gone without criticism. Clegg (1982), for example, mentions that the simplification of the paradigm analysis into a two dimensional grid is typical of a functionalist's approach. This whole approach to the paradigm analysis is in conflict with Burrell and Morgan's intention of identifying and encouraging alternatives to functionalism. Another major criticism of

Burrell and Morgan's work is their strong leaning toward the mutual exclusivity of the paradigms, or paradigm incommensurability, as it is better known. However, Burrell and Morgan's (1979) book does draw attention to the fact that whatever methodologies are used for intervention in the real world, they will always be based on assumptions, hidden or explicit, about reality in the context of the four key paradigm. Moreover, the contribution highlights the fact that the popular functionalist approach which is associated with the method of science, is not the only means of organisational inquiry and analysis.

Jackson (1991) points out that Burrell and Morgan (1979) only deal with 'radical structuralism', and that the paradigm grid prevents one from identifying the nature and appreciating the significance, of the distinct structuralist approach in social theory. From Figure 4.1 and 4.2 it is clear that Burrell and Morgan perceive objectivists as following a positivist's epistemology. However, Keat and Urry (1975), quoted in Jackson (1991: 22), make a distinction between objectivists who subscribe to a positivist's epistemology and those that subscribe to a 'realist' epistemology.

Whereas a positivist epistemology seeks to discover patterns and regularities that determine a certain phenomena, a realist epistemology is concerned with the explanation and understanding of the deep underlying structures and mechanisms at work which causally generate the observable phenomena. And so according to Jackson (1991: 23),

> "Structuralism, in the realist form, is concerned with uncovering and understanding the underlying structures or systems of relationships that generate the surface phenomena perceived in the world.... Structuralists attempt to provide models of the causal processes at work at the deep structural level that produce observable phenomena and the relationships between surface elements".

4.3 The Various Paradigms That The Planning Framework Needs To Embrace And The Issue Of Paradigm Incommensurability

The framework that is developed in this research concerns itself with the RTS and the principles for it derived in section 4.1 imply that it cannot be restricted to a single paradigm. The development of the RTS is interdependent, inter alia, on the hard technological infrastructure, the hard parallel infrastructure, the soft socio-cultural subsystem, and the socio-economic subsystem. With respect to appropriate systems approaches for the planning of telecommunications infrastructure such that the emerging properties are realised, both hard and soft approaches are necessary. Framework principles five and six (Table 4.1) in particular, necessitate interpretivist methodologies. Framework principle six also together with framework principle seven calls for functionalist methodologies akin to Systems Engineering, to deal with the technological issues. In addition, framework principle four emphasises the need for emancipatory approaches in order to address the empowerment and transformation issues of the rural community. It is clear therefore that the framework cuts across various paradigms and one needs to find a way of accommodating this.

Some of the criticisms of paradigm incommensurability were mentioned in the last section. In searching for a theory or philosophy that will justify the complementarity of different paradigms, the author considered first the work of Flood (1990) and Jackson (1991). These authors use the theory of knowledge-constitutive interests by Habermas (1972) to justify complementarity among paradigms. According to them the various paradigms are aligned with the three human interests, the technical, practical, and emancipatory. The technical interests refers to the way in which one controls and manipulates one's environment or the need for instrumental action, the practical interest refers to human social action and the need for understanding of meaning rather than causality and, the emancipatory interests refers to the need to free ourselves, through critical self-awareness, from restrictive power relations. Therefore, instead of viewing paradigms as incommensurable, it is possible to regard them as complementary on the grounds of the three essential human interests identified by Habermas (1972).

Midgley (1992; 1997) raises two issues with the justification that Flood (1990) and Jackson (1991) apply for paradigm complementarity. He sees the use of knowledge-constitutive interests as a justification for paradigm complementarity as standing above and beyond the paradigm debate. This leads to the danger of having a dogmatic position which is contrary to the quest for diversity. Secondly, he questions the legitimacy of the theory of knowledge-constitutive interests, especially the technical interests. Human beings should be seen as having an interest in preserving its non human environment rather than seeing the natural world for human control and consumption. Midgley (1997) uses Habermas's (1984) later work, the theory of communicative action, in dealing with the paradigm issue. He thus proposes an alternate perspective in dealing with the paradigm incommensurability issue based on Habermas as discussed below.

According to Habermas (1984), inherent in any act of communication are four validity claims. The first is the precondition for effective communication i.e. that which is being said is intelligible. The other three claims relate to the three worlds: The claim that the content of the statement being communicated is true relates to the 'external world', the claim that the person making that statement is justified relates to our 'social world', and the assumption that the person speaks sincerely relates to one's 'internal world'. These three worlds exist seamlessly, but come to be viewed as separate due to the nature of language. Although a statement may appear to belong to one world, a position on the other two is always inherent in the statement. Therefore according to this theory one cannot stand above the paradigms, but the communicative action theory of Habermas (1976) justifies the complementary use of methodologies from the different paradigms for a particular intervention.

Gregory (1992) has also made an important contribution to the paradigm debate. She suggests that it is impossible to transcend the paradigm debate without forming another paradigm. Instead of trying to justify the complementarity between different methodologies Gregory (1992) advocates that the differences should be harnessed, and that one should learn from these differences. She uses the metaphor of constellation to explain her pluralistic practice (see also Gregory's 1996 discussion on discordant pluralism). A constellation of stars in the sky is dynamic and could be observed from many different vantage points. Similarly, one should develop one's own constellation of methods, appreciating both the similarities and differences among them.

In her examination of the nature of communication between people based on different paradigms, Gregory (1992) concludes that one interprets what the other is saying through one's own terms of reference, and therefore one needs to be aware that full understanding is not necessarily achieved. Appreciating the other's viewpoint allows one to see paradigms in relation to the perspectives of others and this in turns transforms one's own paradigm.

The problems associated with paradigm incommensurability within the planning framework then, may be resolved following on the treatment of Midgley (1992,1997) and Gregory (1992) on accommodating different paradigms, as discussed in the last section. What this means for the framework is that special care has to be taken when choosing the different methodologies or techniques that will address the framework principles, such that the various paradigms are accommodated. As a result this should lead to the realisation of the emerging properties of the RTS. The next section deals further with the question of mixing methods in more detail.

4.4 Pluralism In Systems Practice

Jackson (1997) interprets pluralism as the combined use of different methodologies, methods and/or techniques in systems practice. Midgley (1998), in a similar vein to Jackson, says that pluralism views all methods as complementary, addressing different kinds of questions. It involves the production of theories of knowledge and reality to explain the variety of methods that is embraced. In contrast, isolationism refers to the different strands of systems thinking developing independently of each other, and implies that there is only one systems methodology that would solve all problems. Imperialism refers to the case of a dominant methodology which is committed to a particular epistemology, but will incorporate other strands in systems practice e.g. Checkland (1983) regarded hard systems thinking as a special case of soft systems thinking (see Jackson 1991: 257-261). Pluralism requires the development of a coherent philosophical perspective that will allow the systems practitioner to overcome isolationism while retaining the variety inherent in competing methodological paradigms.

In promoting the practice of methodological pluralism, Midgley (2000: 174) explains in an interesting way the value of a plurality of methods. He sites three interrelated problems that arise with the lack of sufficient plurality of methods. The first is a possible conflict amongst the stakeholders in their understanding of a problem situation where the method being used does not cater for the different interests. The result is a marginalisation of one or more of the interested parties. The second problem with a lack of plurality of methods is to do with the ability to cope with new insights as the intervention unfolds. Very often when a method that was assumed appropriate in the first place cannot resolve the unexpected unfolding circumstances, the circumstances are somehow manipulated to fit that method. The third problem associated with a narrow choice of methods, is that the intervener may unconsciously develop a restricted world view, associated with a particular methodology, on the problem situation. The intervener therefore may be unaware that he/she is unresponsive to different perspectives and changing agendas during an intervention.

It will be prudent at this stage to deal and dispense with the concerns surrounding atheoretical pragmatism. When dealing with simple technological systems it is acceptable amongst engineering practitioners 'to do what ever it takes so long as it work, complying with predetermined specifications'. In a complex environment such as that of the full RTS this practice is unacceptable. Building on Flood (1989) and Jackson (1987) there are at least four problems associated with atheoretical pragmatism. When dealing with societal systems the trial and error approach means costly experimentation. Laboratory experiments and simulation techniques are not pragmatic or accurate enough. It is important to understand why certain methodologies work and sometimes do not so that one is better informed and so mistakes could be avoided. Secondly, the promotion of knowledge about methodologies to other practitioners and other disciplines is difficult without a formal theoretical language. Perhaps more important for the planning situation is the sustainability of success.

Atheoretical pragmatism may enjoy short term success but could lead to long term consequences. A methodology that is backed up by strong theory or philosophy is less likely to have long term consequences if used according to the dictates of its theory. Finally, and perhaps as important as the latter reason for the planning situation, because atheoretical pragmatists are not concerned with the theoretical underpinnings that justify the success of a methodology and the boundaries under which they work, their activities could lead to authoritarian practices. Often, especially in technocratic societal planning, the methods and techniques are more suitable to the planners themselves, or the organisation they represent rather than the situation planned for.

Jackson and Keys (1984) were amongst the pioneering critical system thinkers to consider the issue of methodological pluralism. They produced the "system of systems methodologies" (SOSM) that triggered the subsequent developments in methodological pluralism. They held the view that different systems methodologies have different strengths and weaknesses and therefore are suitable for application in different circumstances. Although Burrell and Morgan's grid of sociological paradigms provided some reference for the theoretical underpinning of systems methodologies, it was insufficient. Apart from a lack of clear distinction between the functionalist and the structuralist approach, the grid was not conducive, in terms of its language, to the kind of action-oriented interventions that system methodologies seek. In response to these shortcomings, Jackson and Keys (1984) provided a different grid or framework, SOSM, which is more conducive to the practice of system methodologies. Their the primary purpose was to find a way of overcoming the mutual exclusivity inherent in Burrell and Morgan's grid. It will now be discussed in the context of the rural telecommunication situation to illustrate the significance of methodological pluralism. Thereafter more recent trends in pluralistic practice will be analysed with a view of finding the most appropriate application for the planning framework.

Jackson (1991) defines a problem context as a situation that includes the would-be problem solvers and participants i.e. those who can make decisions that affect the behaviour of the system/s, and the system/s within which the problem lie. So comparing this definition to the rural telecommunication situation one is faced with Jackson's problem context. The participants in Jackson's definition however, will be those representing the stakeholders of the RTS. Based on his definition Jackson suggests that there are two aspects of problem contexts that might have a particular important effect on the nature of the problems found within them. These are the nature of the system/s in which the problems are located and the nature of the relationships between the participants. Table 4.2, which shows the ideal-type grid of problem contexts, has its roots in Jackson and Keys (1984) "system of system methodologies", elucidates the search for appropriate methodologies for the rural telecommunications planning.

It has been established that the RTS as a sociotechnical system is complex (chapter 3), even though certain parts of the technological subsystem may be governed by predictable behaviour and so may be regarded as simple. Initial investigations show that, in general, the views of the stakeholders will range from unitary (genuine agreement on some issues), to pluralist where genuine accommodation of differing interests is possible. However a coercive situation (fundamental conflict amongst participants and consensus is achieved only through power or domination) is possible, especially in the South African situation, considering its history. In this situation one may argue that the RTI will lack legitimacy and it is best, perhaps, not to provide any service. Alternatively emancipatory methodologies may be successful in ensuring a legitimate infrastructure. One thing is certain though, that the simple-unitary context, which is traditionally applied to telecommunications planning, is no longer appropriate for rural telecommunications planning, especially for developing countries. The issues that need to be considered in the framework for planning of RTI lead to problem situations that run across at least more than one category in the Jackson and Keys (1984) grid.

Table 4.2. Problem contexts according to their complexity and the stakeholder views, after Jackson & Keys (1984), Flood & Jackson (1991)

Complexity of systems	Problem Situation	Divergent views of the stakeholders		
		Unitary	**Pluralist**	**Coercive**
	Simple	Simple unitary	Simple pluralist	Simple coercive
	Complex	Complex unitary	Complex pluralist	Complex coercive

The System of System Methodologies however, has had its fair share of criticism albeit serving as a stimulus for wider and deeper research into methodological pluralism. The proposed principles that must guide the planning framework indicated the need to consider more than one methodology, methods or techniques from more than one paradigm. The operationalisation of SOSM, Total Systems Intervention version one (Flood and Jackson, 1991), dictates the use of a whole methodology in a particular situation and therefore is not the most appropriate pluralistic approach for rural telecommunications planning. Jackson (1997: 350) admits in his analysis of SOSM:

> "In retrospect one weakness is that the pluralism is, implicitly, seen to relate to different interventions. The use of different methodologies in the same intervention is not considered. Another is the lack of distinction is maintained between methodology (...), methods or techniques."

In addition, by placing methodologies into discrete categories, one limits the interpretation and applicability of the methodology (Gregory, 1992). It has been shown in later years that it is possible to use methodologies/methods in different situations to that for which they were originally developed (Flood and Romm, 1995). Another criticism, also by Gregory (1992), is that the nature of the SOSM framework is such that it does not allow for the on-going developments in the methodology. Systems Dynamics, for example, was originally regarded as a 'hard systems' methodology but if emphasis is placed on the process then one may regard it as a 'soft systems' methodology as well. A criticism of the SOSM put forward by Midgley (1997) is on the issue that boundary judgements (stemming from Critical Systems Heuristics by Ulrich) are not being given sufficient attention. Although the SOSM accommodates coercive situations, the boundary judgements need to be made even in identifying coercive situations. In the light of all the above criticisms the SOSM was not preferred as a suitable methodology for the planning framework.

White and Taket (1997) provide another perspective on pluralism, based on postmodernist philosophy, in particular Nietzsche 's (1973) writings. Although this perspective pertains to OR practice it will nevertheless elucidate the discussion here. The authors embrace a 'will to methodologies' rather than a 'will to methodology'. They are critical of the 'will to methodology' in that although it is driven by the 'will to act' and as a consequence leads to pluralistic practice, this pluralism still involves a "will to a singular truth, a will to a singular metamethodology, so as to tame, control or master pluralism rather than embrace it". Relativism rather than the will to act is embraced by the authors who offer as an alternative a will to methodologies with no preconceived idea as to where this will will lead the practitioner. The emphasis is on creativity and reflexivity and White and Taket (1997) call this 'will to methodologies' pragmatic pluralism.

White and Taket (1997) insist that their methodological choice is not "anything goes" but rather "doing what feels good". It is not whether one method provides better truth than another that matters so much, for all methods provide truths one way or another, according to the authors, but whether or not the method is capable of giving those entertaining it feelings of freedom and empowerment. The notion of praxis (theorising as a means of critical reflection on practice) is preferred to the traditional theory/practice dichotomy, for stimulating action. The features included in White and Taket's (1997) approach include the use of triangulation, combining parts of different methods, being flexible and adaptive, and being critically reflective. The work of White and Taket has however been criticised by Jackson (1997) and in Mingers and Gill (1997) among others, and was perceived as not suitable for justifying the framework in this research.

So what are the principle characteristics that pluralistic practice should adhere to? In analysing the development of pluralism in the systems field and other applied disciplines, Jackson (1997) mentions the salient features that must be considered in the practice of pluralism. He states:

> "pluralism must be an approach to managing complex problems which employs a metamethodology to take maximum advantage of the benefits to be gained from using methodologies premised upon alternative paradigms together, and also encourages the combined use of diverse methods, models, tools and techniques, in a theoretically informed way, to ensure maximum flexibility in an intervention".

Others, like Midgley (2000), seem to prefer discussing pluralism not as a metamethodology but rather as mixing methods from different paradigms. In contemplating the various options in this respect, for the purposes of this thesis, Total Systems Intervention (TSI) (Flood and Jackson, 1991; Flood, 1995) and, the work by Mingers and Brocklesby (1996, 1997) and Mingers and Gill (1997) on multimethodology were considered. As mentioned previously, TSI version one promotes the use of a single methodology after the choice of it is made, hence it does not provide for combining the strengths of different approaches in the same intervention. On the other hand TSI version two (Flood, 1995) has been criticised for its complexity and therefore it seems not to be a promising path to deal with the problem on hand. In view of this, multimethodology was considered more appropriate for the development of the framework. The next section investigates the essential features of multimethodology and its relevance to the framework for RTI planning.

4.5 On The Relevance Of A Multimethodology Approach To Complex Problem Solving As Planning For RTI

Multimethodology is concerned with combining together more than one methodology, in whole or in part, or techniques from different methodologies within a particular intervention. Mingers (1997a: 2) states that "Multimethodology can be seen as a particular form of methodological pluralism" and although Mingers asserts that multimethodology is dissimilar with another particular form of critical systems thinking (TSI) it does however fulfil the need for methodological pluralism as advocated by critical systems thinking. Mingers and Brocklesby (1996) show that there are a number of ways of combining methodologies or techniques within an intervention. These depend on whether the methodologies are mixed in the same intervention or across different interventions for the same problem situation; whether the methodologies or techniques come from different paradigms; or whether parts of methodologies are combined (Midgley, 1997 refers to this as partitioning).

Table 4.3 provides a typology for the different ways in which methodologies or techniques can be combined with respect to the relevant paradigms. These combinations have already been practised and one can refer to Mingers and Brocklesby (1996) and Mingers (2000) for further references of case studies. In situations where the methodological combination or the combination of parts thereof come from the same paradigm there is little philosophical difficulty in justifying the combination. The task is a simple one of finding the most effective combination. However, in a multi-paradigm version of methodology enhancement the main problem is the legitimacy of transferring a technique from one paradigm to another. Paradigm incommensurability was discussed in section 4.3. The most complex situation according to Mingers (1997) is where parts of different methodologies from different paradigms are brought together to construct an ad hoc 'multimethodology' most suited for the particular intervention. The same author (page 9) refers to this as "strong pluralism" and argues that most, if not all, interventions would be dealt with most effectively with a mix of methodologies from different paradigms.

Mingers (1997) gives two main arguments as a rationale for multi-paradigm multimethodology. Real-world problem situations do not tend to fall into a single paradigm but are complex and multidimensional. Different paradigms expose different aspects of the problem situation and therefore multimethodology is recommended as a way of dealing with the richness of the real world. Habermas (1984) developed a framework that shows the real world as interdependent relations among the three worlds - the material world, the social world, and the personal world. The material world is external to the human being. Knowledge about the real world is gained through external observation rather than participation, as in the social world, or experience, as in the personal world.

Table 4.3. Different possibilities for combining methodologies (Adapted from Mingers and Brocklesby, 1996)

TYPOLOGY	METHODOLOGY/TECHNIQUE COMBINATION	SINGLE OR MULTIPARADIGM
Methodological isolationism	Using only one methodology or technique from only one paradigm, e.g. SSM only	Single
Paradigmatic Isolationism	Using more than one whole methodologies from the same paradigm for different interventions within a problem situation, e.g. SSM and IP	Single
Methodology Combination	Using more than one whole methodology from the same paradigm for the same intervention within a problem situation, e.g. systems engineering and simulation.	Single
Methodology enhancement	Using parts from one or more methodologies from one or more paradigms within a dominant methodology for the same intervention, e.g. cognitive mapping in SSM or SD in IP.	Single or Multiple
Methodology Selection	Using more than one whole methodology from different paradigms for different interventions within a problem situation, e.g. VSM and SSM	multiple
Whole Methodology Management	Using more than one whole methodology from different paradigms for the same intervention within a problem situation, e.g. VSM and IP	multiple
Multi-paradigm Multimethodology	Mixing parts from one or more methodologies from different paradigms for the same intervention within a problem situation, e.g. systems engineering and ISM.	multiple

The personal world is the world of the human being's individual thoughts, emotions, feelings, experiences, and beliefs. This world is subjective in that it is a function of the individual, generated and experienced by the individual. Finally there is the social world that the individuals share and participate in. Knowledge about the social world is one of intersubjectivity since it is a function of human construction but at the same time pre-exists any particular individual. It comprises of a dynamic mix of language, meaning, social practices, and rules that enable and constrain society's action. The most challenging dimension with respect to societal interventions is that of power.

It is interesting to note that Mitroff and Linstone (1993) have similar views and therefore suggested the technical, organisational or societal, and personal perspectives to a problem situation, within their unbounded systems thinking approach, technical being similar to the material world. Their work is based on previous pioneering insights on multiple perspectives by Linstone, one of the two authors of *The Unbounded Mind.*

According to Habermas (1984) and Mingers (1997) then, intervention into any real-world situation will have to cater for a complex interaction of elements that emanate from the hard material world, the social world with all its cultural and social practices and power structures, and the personal world where individual beliefs, values, fears, and emotions must be expressed and understood.

Secondly, an intervention is usually a process that consists of different activities with variations in the problem context and so methodologies tend to be more useful when contexualised. An intervention usually consists of different phases: Appreciation of the problem situation, analysis of the underlying structure, assessment of ways to bring about improvement, and action to bring about changes (Mingers 1997: 12). It is unlikely that a methodology or technique will perform equally well in all phases.

In relating the above discussion to the rural telecommunication problem and in particular the planning situation, one is confronted with Habermas' three worlds picture. The complex elements that the planners face will come from all three worlds. This is explicit in the discussion of the RTS discussed in chapter three. In addition, it is also clear that the planning activities of the telecommunications infrastructure will not only consist of different phases but will also be an ongoing process and it is the contention of this author that a single methodology or technique will be insufficient for the activities involved and a mix of approaches would be more suitable. Therefore multimethodology is the appropriate type of pluralism that needs to be reflected in the planning framework for RTI.

4.6 A Multimethodological Framework For The Planning Of Rural Telecommunications Infrastructure

Although the planning framework (also referred to as 'the framework') will be generic in nature, the practical validation will be done within the South African context. Therefore some clarity on the current situation in terms of what or who is the major driving force (authoritative power), and who is responsible for the planning and its implementation of the RTI in South Africa, is necessary. Due to past imbalances with respect to telecommunications access (see chapter two), the current South African Government has made a committment to rural telecommunications through its Universal Access Policy. Explicit in this commitment is the expectation that Universal Access will play a major role in the reconstruction and development of the dispossessed communities. Therefore while there may be many other drivers for the provision of telecommunications services, the development of RTI is an imperative of the South African Government which is overseen by the appropriate portfolio departments and regulatory authority.

The ownership of the public network is a monopoly in South Africa, at least at the time of writing this thesis. Telkom SA, which was previously state-owned, has been mandated by the Government through an incentive scheme to deliver on its Universal Access imperatives. There are two other mobile or cellular network providers since 1994, and a third one that will begin operations at the end of 2001, but the planning and deployment of telecommunications infrastructure, in accordance with Government imperatives is the responsibility of Telkom SA. The services on the mobile networks are bandwidth limited, and the costs far exceed that of the fixed network. So for the purposes of the framework RTI refers mainly to that which is provided by a network operator such as Telkom SA. What this means is that Telkom SA provides and controls the financial resources and therefore are the legal owners of the network, notwithstanding any other innovative ways of doing things (Refer to chapter two of this thesis). The RTS planning framework promoted through this research does not depend in any way on the issue of who owns the network. According to the proposed framework, irrespective of the telecommunications governanace structures, if the planning of RTI is carried out systemically following the suggestions in this thesis, then there will be greater success in achieving the reconstruction and development intentions and benefits for all the other stakeholders.

Entrenched in the seven framework principles (see Table 4.1) are issues pertaining to systemicity, complexity, flexibility and the empowerment and transformation of the rural society. The review of systems thinking in Appendix A indicated that the different approaches had their strengths and weaknesses. Systems engineering for example is strong on a turnkey design and implementation of a hard system that is not characterised by too much uncertainty. IP on the other hand is strong in planning for uncertain futures. It is interpretivist, systemic, and comprehensive in its approach but it does not provide a rigorous and efficient way of dealing with complexity. The systems approach that pays special attention to empowerment of the human being is Critical systems thinking. ISM/IM is a methodology specifically developed for the purpose of managing complexity, irrespective of whether the problem situation belonged to the interpretivist or functionalist paradigm. Thus in trying to meet the principles of the framework, complexity is addressed through IP and ISM/IM. The imperative to address the needs of the disadvantaged rural people is satisfied through basing the overall planning framework on the foundations of critical systems thinking in broader terms (as discussed previously) and more particularly, on multimethodology, analysed in this section. The following sections will discuss some of the methodologies that form the elements of the framework and its overall structure.

4.6.1 The Appropriateness Of Interactive Planning As A Dominating Systemic Methodology Within The Planning Framework

Sections 3.5 of this thesis covered an overview and the important aspects of IP, relevant to this research (see also Appendix A). In a nutshell IP is comprised of five phases, 'formulation of the mess, ends planning, means planning, resource planning, design of implementation and control' (see Appendix A, Figure A.5). Ackoff views organisations as "purposeful systems", containing "other purposeful systems", and being part of "wider purposeful systems". Section 3.2 of this thesis showed that the RTS could also be regarded as a purposeful system. Therefore IP is, in principle, an appropriate dominating planning methodology applicable to the RTS just as SSM is often seen as a dominating methodology in other multimethodology interventions (some discussion regarding this role of SSM can be found in Jackson, 1997). Section 3.5.4 of this thesis discussed 'orientations to planning' and it is the 'interactivism' which underpins IP that has drawn special attention to IP for the purposes of this framework. Another reason is the better focus towards the final goal of the process which makes it more preferable than SSM.

A more appropriate way of looking at the process supported in IP, in the context of developing the planning framework, is reflected in Figure 4.3.

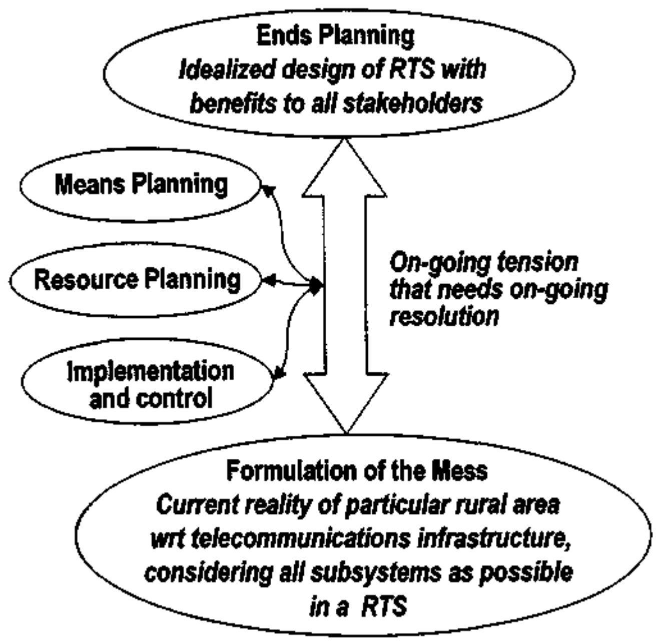

Figure 4.3. The various components of Interactive Planning working in a systemic fashion, with respect to the planning of rural telecommunications infrastructure.

IP is intended to be a holistic, democratic, and continuous adapting process that move towards an idealized design, in this case a RTS whose emerging properties are benefits to all stakeholders. Importance is shifted away from the plan itself to the planning process. In practice there will always be a tension between the current reality of a particular rural area and its idealized design, with respect to the RTS. The processes of means planning, resource planning and implementation and control, of the telecommunications infrastructure must contribute to the resolution of the tension. Figure 4.4 illustrates further the adaptation of IP in terms of three major planning activities, as a guiding orientation for the planning framework. The means planning, resource planning, and implementation and control phases could be clustered as the leverage phase that would determine how to move the RTS in a particular rural area from the current reality towards the idealised design.

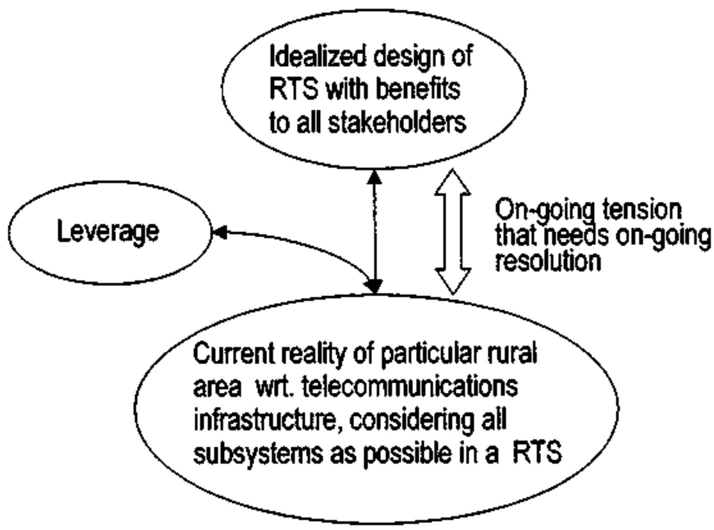

Figure 4.4. An adaptation of Interactive Planning as a guide to the planning framework for rural telecommunication infrastructure

There is an interesting and important similarity between IP and Critical Systems Heuristics). The main purpose of critically heuristic boundary questions in the 'ought' and 'is' modes is to critically evaluate the boundary judgements made in the planning for 'improvement'. In essence the emancipatory process of moving from the 'is' mode to the 'ought' mode in Critical Systems Heuristics is no different from moving from current reality towards idealized design in IP. This author argues that this process has emancipatory connotations or has the potential for such. It must be emphasised that IP is a *system* of activities and therefore is more than the sum of its parts; it is a product of their interactions. Moreover the different phases loose their essential properties when separated from that system (Ackoff, 1981: 240).

The RTS is a complex dynamic system and therefore it is most unlikely that one is able to plan and design the ideal RTI at the first attempt. It must be noted that although the holistic principle advocates that the different phases are executed simultaneously and interdependently, it is not always prudent to apply this to the rural telecommunications situation, for some parts have to be done first, such as 'means planning' before 'resource planning'.

The three operating principles then on which IP is based, the participative, continuity, and holistic principles satisfy the requirement of framework principle 1 of the framework, at least. As the framework unfolds it will be demonstrated that IP as an overarching guide, facilitates the inclusion of the requirements of the rest of the principles of the framework. The whole of IP, including its constituent parts, falls wholly within an interpretivist or soft systems paradigm, whereas the RTS is a sociotechnical system with parts belonging to at least more than one different paradigm. The individual methodology/methods and techniques that are recommended in IP, such as 'reference scenarios', are intended for corporate organisations. In fact IP lacks detailed methodological support for systems other than corporate organisations (see also Omerod, 1997). Therefore IP shall be used dominantly as a providing the main operational orientation of the framework but will be enhanced with more appropriate methodology/methods/techniques that would satisfy the requirements of the framework. Henceforth the subsequent discussion on the choice of methodologies/methods/techniques to be included in the framework will be guided by the phases in IP. The first stage in the planning framework is associated with uncovering the current realities within a particular project for introducing RTI, which is sometimes expressed through the metaphor of a "mess" introduced by Ackoff himself. .

4.6.2 Methods And Techniques For The Formulation Of The Mess Phase

Having decided on the overarching systemic guide to the framework, the next task is to deal with the 'formulation of the mess'- who should undertake this formulation and how should this be carried out and finally represented. In this stage one needs to focus on the different assumptions, beliefs, and worldviews involved in the provision of telecommunications services and the purposes or intentions of the RTI, from the point of view of the stakeholders, bearing in mind the context of the RTS. Issues involved in the complex task of planning the infrastructure may also surface during this stage. However, it is not the intention to deal with the efficient design of the infrastructure subsystem at this stage. Thereafter the mess needs to be formulated using an appropriate method or technique.

The mess has two dimensions to it: The complexity inherent in the system of problems in the RTS with respect to the real world, i.e. the particular rural area, in terms of what is lacking as far as the RTI is concerned that will stimulate development, and, the complexity involved in the planning of the RTI in the context of the former. If the planning of RTI is to be leveraged to assist in realising the emerging properties of the RTS, then it is the contention of framework principle five that a wider representation of stakeholders, than just the planning team belonging to the telecommunications network operator/provider, is necessary, at least in certain key parts of the process. As a last resort there must be some way of finding out the concerns of the stakeholders and considering these, if for some reason stakeholders cannot partake in the planning process. In addition the telecommunications infrastructure is also interdependent on various other subsystems as reflected in the RTS, Figure 3.2 and so the success of the infrastructure planning is then also dependent on inclusion of stakeholders from these subsystems. One can reasonably assume that the different subsystems will have their own expectations regarding telecommunications services, which may differ from each other. As a first task in the 'Formulation of the Mess' stage, the question whom or which stakeholders should be involved in the process and how should this be managed, need to be answered.

4.6.2.1 Stakeholder Analysis, Critical Systems Heuristics, And Rich Pictures – Towards Formulation Of The Mess

The term 'Stakeholders' generally refers to those persons who have a vested interest in some common problem situation. The 'stakeholder concept' has been receiving much attention and perhaps popularised, over the last decade in South Africa. Prior to 1994, under the Apartheid Regime, it was uncommon to consider stakeholders in decision making, and also in activities such as planning and policy formulation. The culture on the part of government institutions, including parastatals such as telecommunications and transport providers and operators, and public utilities such as power generators and distributors, was non-consultative and technocratic. Hardware or installations belonging to these institutions were often seen as symbols of race discrimination and of a repressive government. Even after 1994, when the new government started to emphasise and insist on consultation with stakeholders where relevant, telecommunications infrastructure providers kept the consultation with stakeholders to a bare necessity, usually to solicit information pertaining to customer demands. Moreover this was done within the traditional planning structures and methods.

One significant way to obtain buy-in from users of the telecommunications infrastructure is to ensure that this constituency, amongst others, is included or accommodated in the planning process. However, one must take cognisance of the fact that the final decisions pertaining to the kind of infrastructure that must be deployed, will be made by the telecommunications infrastructure providers and operators. It is proposed that a concise but deep treatment on the identification and choice of pertinent stakeholders, which is to serve as an initial step in the formulation of the mess, must be included in the framework. This will be a significant step towards realising the emerging properties of the RTS. In addition the concept of stakeholders has systemic connotations and further enhances the systems approach enunciated in this thesis.

Banville *et al* (1998) provide a deep analysis and elucidation of the two aspects contained in the generally accepted definition of stakeholders: 'vested interest' and 'problem situation'. The vested interests of stakeholders and thus the stakeholders themselves, and the nature of the problem situation, are interdependent. The authors provide some "general non–mutually exclusive categories" of stakeholders that are pertinent to rural telecommunications planning.

"Standard stakeholders" refers to those persons who affect and are affected by the problem situation and who participate in its formulation and resolution. This is normally regarded as the ideal democratic decision making process. "Fiduciary stakeholders" refer to those persons who act on behalf of clients, representing them. They participate in the process of formulation and resolution of the problem, but are not directly affected by the solution. "Silent stakeholders" refer to those persons who neither participates in the process nor have any control over the resources or uncertainties that are relevant for resolution of the problem, but are affected by the problem. Silent stakeholders need not necessarily exist at the time of the problem or its resolution. The deployment of telecommunications infrastructure, for example, will certainly have an impact on future generations. Silent stakeholders also include those who do not have the means to make their voices heard (Banville *et al*, 1998: 18).

Vroom (1974) looks at another way of dealing with the inclusion of stakeholders, based on the type of the decision process itself, which has important bearing for the framework. Type A, which is an autocratic process, pays insignificant attention to the stakeholders. In the consultative process, type C, the stakeholders are consulted but those that are in charge of the problem make the final decisions. In type G a group decision is made by a set of stakeholders, assembled around a particular problem. However, for the rural telecommunications planning situation it is not a simple issue of whether the process is type A, C or G. The processes involved range from simple-unitary to complex-pluralists, perhaps even complex-coercive. Therefore the decision-making processes will consist of a mix of types A, C and G. This issue will be further clarified later on in this section.

The second aspect in the concept of stakeholder implies that the problem is constructed around and by the stakeholders. Landry (1995) mentions that a problem by its nature is not without vested interest. It does not exist as an isolated form of reality waiting to be discovered. A problem is a construct resulting from interactions between elements and one or more subjects and the reality upon which the subjects wish to manipulate for a desired outcome. Therefore proper consideration of a problem situation, especially in a sociotechnical context, cannot be achieved without thorough stakeholder identification.

Banville *et al* (1998) argue that the stakeholder identification process significantly assists in formulating a problem, and that it can also be used to target those who may not be really regarded as owners of the problem situation, but could affect or be affected (for example in terms of resources) by the way the problem is solved. In the planning situation, such as that of the RTI, very often the direction to move towards for effective planning is uncertain. However, the iterative process of starting with even a fuzzy direction, determining an initial set of stakeholders, and reformulating the problem, leads to positive feedback that will lead to an ultimate configuration of the problem. Therefore it is important to note that the inclusion or accommodation of stakeholders may not only be necessary for just one phase of the planning, but may also be necessary in various stages of the planning process.

One crucial question needs attention before any further progress could be made with the framework. Who initiates the stakeholder management? In other words who determines the need and initiates the provision of RTI? It could be argued (see chapter two of this thesis) that the need for RTI in a populated rural area is always there. However, while 'customer demands' or application by the community for telecommunications services provides some initial trigger for the planning of RTI, there are other stronger drivers, at least in the South African situation. The South African Government, through the Ministry for Posts, Telecommunications, and Broadcasting, has made Universal Access a key priority and has accordingly placed certain access imperatives with respect to rural areas, on the sole public network provider and operator, Telkom SA. It could be concluded then that in general the initiative for planning of RTI will come from the Telco and therefore relevant agents from the Telco would start the iterative process of identifying and classifying the stakeholders.

One further crucial point regarding the management of stakeholders needs to be clarified. For an exercise such as the implementation of the framework there is bound to be a mismatch between which stakeholders are ideally desired and what is pragmatically possible. The stakeholder management process proposed in this framework ensures that all relevant voices are heard or represented, as possible.

The first step then in stakeholder management is for the Telco agents to categorise the possible stakeholders that would take part in the planning process or at least in the formulation of the mess, according to the following constituencies, adopted from Banville *et al* (1998). It must be emphasised that the categories are non-mutually exclusive, but this will assist in moving towards as exhaustive a list of stakeholders as possible.

- **Standard Stakeholders**
  - All those that **would be affected by** the planning activities and the

infrastructure to be deployed.

  - All those **that could possibly affect** the planning activities and the deployment of the infrastructure.

- **Fiduciary Stakeholders**
  - All those persons that can and may act on behalf of clients, who are deemed important and necessary for the formulation of the mess but may not be personally affected by the infrastructure.
- **Silent Stakeholders**
  - All those persons that could be affected by the planning and deployment of the infrastructure, but do not exist or are unable to voice their concerns, during the planning exercise.

Once this exercise is completed the results are now subjected to deeper analysis. With regards to framework principle seven (see Table 4.1), that is the need for empowerment of the rural community, an adaptation of Critical Systems Heuristics, supporting the above stakeholder identification, is offered as a means of ensuring a significant degree of empowerment. Critical Systems Heuristics regards social planning as 'improvement' and this is no different from what the planning framework seeks to do. In dealing with social planning as improvement Ulrich (1996: 9) cautions that planning can never serve all those in need equally; it implies choice, and hence, responsibility. Therefore a very good plan should make boundary judgements explicit.

Since the other elements like IP and ISM within the proposed RTI planning framework are better in satisfying goals that are similar to those covered in the remaining boundary judgment questions of Critical Systems Heuristics, only those four questions associated with the issue of who should be involved in the planning of RTS are considered. These questions are reflected in Table 4.4. They form part of Ulrich's (1983, 1996) original twelve 'critically–heuristic boundary questions'. They are used here to support the stakeholder management in ensuring a justifiable and responsible choice of stakeholders. It is more illuminating to use both the "ought" mode and the "is" mode, although not necessarily in this order. The process of reflection and debate on the questions and comparing these to the standard, fiduciary, and silent stakeholders initially selected will lead to a far more appropriate set of stakeholders, satisfying framework principle four of Table 4.1.

Table 4.4. Relevant critically-heuristic boundary questions to support stakeholder management. Adopted from Ulrich (1983, 1996)

"Ought" mode

- Who ought to be the plan's client? That is, whose interests ought to be served?
- Who ought to be the decision-maker/s? That is, who ought to be in a position to change the plan's measure of improvement?
- Who ought to be involved as planner/s? That is, who ought to be considered competent to participate in the design of the plan?
- Who ought to be witness to the interests of those affected but not involved? That is, who should argue the case of those who cannot speak for themselves but maybe concerned.

"Is Mode"

- Who is the plan's client? That is, whose interests does it actually serve?
- Who is the decision-maker/s? That is, who is in a position to change the plan's measure of improvement?
- Who is involved as planner? That is, who is considered competent to participate in the design of the plan?
- Who is witness to the interests of those affected but not involved? That is, who argues the case of those who cannot speak for themselves but may be concerned.

The final issue under formulation of the mess that now remains to be resolved is how will the formulation of the mess be carried out by the chosen stakeholders. A combination of The Multiple Perspective concept adopted from *Unbounded Systems Thinking* (Mitroff and Linstone, 1993), and Rich Pictures adopted from the interpretivist SSM (Checkland and Scholes, 1990), is offered as a suitable method for the formulation.

In seeking to obtain multiple perspectives on a problem situation, Mitroff and Linstone (1993) cater for the various inquiry systems that result in the different "ways of knowing". They prescribe a combined Technical Perspective (T), Organisational or Societal Perspective (O), and the Personal or Individual Perspective (P) on the problem situation. In formulating the mess then perspectives from the technologists or engineers, Telkom SA, and the community should be solicited on the dynamics inherent in the rural telecommunications system pertaining to the particular rural area under consideration. Issues such as, what are the development issues?, what are the government imperatives?, what does the community want or lack?, what is required to realise the emerging properties of the RTS?, how can Telkom SA meet these demands, etc should be included.

The resulting analyses should then be expressed as rich pictures. Given the diverse range of stakeholders, rich pictures is an appropriate way of expressing the multiple perspectives, interconnections and relationships, hierarchy, resources available, processes and structure, or the lack of all of these, with respect to telecommunications, of the particular rural area under consideration.

4.6.3 Ends Planning

Idealised design is the core activity of ends planning. It is a way that the stakeholders chosen in the "formulation of the mess" phase can prepare a vision of the ideal RTS, which will provide benefits for all stakeholders with respect to the services that are possible through the RTI, that they would like to experience, at the present time. For example, a primary health care system that is connected to developed areas or a library that can be connected to other well-developed information centres. Included in the idealized design will be the appropriate telecommunications infrastructure systems that will facilitate achieving the vision. For example, POTS (plain old telephone service) or/and broadband services. One must attempt these activities as optimistically as possible but ensuring technological feasibility, operational viability and the ability to adapt to rapid learning and change. A fundamental feature of idealized design is that the design *process* itself is one of the most important products especially for the purposes of development and this is in line with the purposes of the RTS. Ackoff (1981: 246) states "The idealised-design process facilitates and encourages widespread participation in planning, tends to generate consensus among its participants, extracts commitment from them, stimulates their creativity, and significantly enlarges their concept of what is feasible."

In adapting Ackoff's idealized design to the framework, two scenarios must be considered. First a constrained design, which assumes that the external (the other subsystems in the RTS) and internal (to the Telco) remains the same i.e. there is no possibility for change and so there is no need to forecast the environment. The second scenario is an unconstrained design that makes explicit assumptions about the external environment and so the planners/designers are permitted to make changes in those systems that would affect the performance of the RTS under design. Ackoff posits two advantages for this approach. Even in the constrained design the RTS can be redesigned if improvement is to be made to the system. Secondly, according to Ackoff the unconstrained design is seldom very different from the constrained design, and what this means is that most of the obstructions between the current systems and its idealised design lie within the designers and the system, and not with the external environment. This remains to be verified in the implementation of the framework. According to Ackoff (1981: 115), if there are considerable differences between the constrained and the unconstrained design then changes in the containing system, such as policy reform, change in organisational culture of the Telco, should be a major preoccupation of the remainder of the planning process.

In searching for an appropriate method/technique that will enable the process of idealised design, the assistance of some of the techniques used in SSM is once again contemplated. In particular the stream of logic based enquiry in which relevant systems are chosen, named, modelled and compared with perceptions of the real world situation, is proposed as a means of eliciting from the stakeholders what the idealised design/ends plan should comprise of. It must be noted that Checkland (1995: 51) mentions that while models in SSM, in general, are not designs for what ought to exist in the real world, there are the occasional special case where this is so. The planning framework provides for such an opportunity. The framework is intended to cater for a variety of situations; from an area that has no infrastructure at all to a rural area that has adequate infrastructure but may require improvement. The transformation processes therefore may vary considerably with respect to telecommunications infrastructure, depending on the circumstances.

It must be noted that while the use of root definitions and conceptual models in this planning framework is generic enough to cater for all ends planning situations with respect to telecommunications planning, these are intended for situations where the planners and stakeholders are struggling to initiate a design and reach consensus. In a more accommodating environment one could have a trivial approach to the ends planning, such as the use of trigger questions and brain storming. The case study reported in chapter five of this thesis used such an approach within the constrained/unconstrained design, which was then refined using ISM.

The formulation of the mess and ends planning are key epistemological devices within the framework. There activities deal with 'what needs to be done', while the rest of the activities in the framework concentrate on 'how to do those things that need to be done' as a result of the formulation of the mess and the ends planning.

4.6.4 The Leverage Phase: Means Planning, Resource Planning, Implementation And Control

The comparison between the current reality and the idealised design is a process that takes place throughout the framework, either subconsciously or deliberately. Once an initial plausible idealised design is completed the comparison will be deliberate with the intention of moving onto the next set of phases, i.e. ways of bringing about the idealised design, 'means planning', 'resource planning' and 'implementation and control'. The cluster of these three phases shall also be referred to as the 'leverage phase' in that it is these three phase that will determine how and when the current reality will be transformed towards the idealised design.

These three phases traditionally formed the bulk of the activities of planning, and are usually perceived to be dealing with certainties decided by some other department, such as marketing. Within the framework this part is also characterised by less uncertain information obtained from the comparison between the formulation of the mess and the idealised design. It is also this part of the framework that is most conducive to the inclusion of the usual traditional techniques of systems engineering, project planning, and other optimisation methods/techniques such as Opnet® or Planitu. The inclusion of some of the current techniques used by the telecommunications operator not only minimises the cost of possible failure, but also helps to overcome much of the resistance to new things. The framework uses the IM/ISM methodology to manage the activities of 'means planning', 'resource planning' and 'implementation and control'. This will be discussed in further detail later.

Means Planning

A means (in means planning) is behaviour that either produces a desired outcome or brings one closer to its attainment. For the rural telecommunications situation means will include systems of simultaneous and/or sequential courses of action directed at desired outcomes, such as Tele-medicine infrastructure, and systems of projects directed at desired outcomes, such as the rollout of infrastructure to provide POTS. One of the advantages of the systemic approach of the framework, and the idealised design in particular, is that a comprehensive overall picture of what needs to be done to achieve the idealised design becomes available. However, there will be those systems or parts of systems in the idealised design that may be unattainable in the current planning period due to the lack of resources for example. These will form part of the objectives that will be considered as part of the continuous planning principle. Those parts that can be achieved in the current planning range are referred to as goals (Ackoff, 1981: 168). It must be noted that the products of the activities carried out in the framework thus far are not restricted to the technological issues per se, but may lead to the need to develop new policies in order to assist the realisation of the emerging properties of the RTS.

There are two other distinct activities in means planning: formulating alternatives and evaluating alternatives. Ackoff (1981) suggests that perhaps the best way to evaluate a means is by a well designed experiment, However, this is not always possible especially in the situation of planning of RTI. A second way of evaluating alternatives is by the use of models. This allows for the use of some of the current simulation techniques used in the industry. ISM provides an elegant way of dealing with alternatives as will be seen in the case study in chapter five.

Resource Planning

Resource planning includes planning for resources such as materials, supplies, services, and of course telecommunication equipment, finances and personnel. Resource planning involves determining the amount and kind of each type of resource required by the means plan, how much of each will be available, what gaps are between requirements and availability and how they are to be filled. Ackoff (1981) mentions that in all phases of corporate planning resource planning is probably the most highly developed, and most of this centres around financial planning. This is no different twenty years later at least in the provision of infrastructure. The most important and less negotiable factor in planning is financial resources. However, within this framework resource planning is as significant an aspect as the other phases and financial planning is as significant as the other resources. This author notes that without financial resources no telecommunications infrastructure can be provided to the rural communities, however, it is the contention of the author that more investment in terms of rural development could be obtained within the same budget if this framework is followed. Besides, if the idealised design is plausible in that it clearly shows the potential for rural development, then any short fall in financial resources is more likely to be met by the executive decision makers.

Implementation And Control

The 'implementation and control' phase is concerned with the implementation of the decisions made in the previous phases and monitoring their performance. It is in this phase that continuous feedback is obtained to make possible whatever improvements are necessary to the telecommunications infrastructure. Decisions should be made as to who does what and when. These decisions should be made jointly by those responsible for carrying them out, those whom they report to, and those who report to them. The discussion so far in this section was about the nature of the leverage phase, while the following subsection will address the question of the appropriate systems methodology that is suitable for this phase of the RTI planning framework.

4.6.5 Interpretive Structural Modelling/Interactive Management As An Appropriate Methodology For The Leverage Phase

It is envisaged that inherent in both the formulation of the mess and the ends planning (idealised design) will be a range of issues, structures, and processes that contribute to the complexity of the RTS which would need to be considered and unpacked, while maintaining a certain level of systemicity. Ackoff (1981: 193) mentions under means planning that "what is required is a mapping of the complex interactions of the critical variables that define the mess". The nature of the activities in these phases is characterised by sequencing of events/issues/decisions, feedback for continuous improvement of its output, within a group effort. It is also envisaged that this group effort will come from the telecommunications operator. ISM/IM is contemplated as an appropriate methodology for the leverage phase.

As discussed in Appendix A of this thesis, ISM is the kernel of IM that emphasises the importance of structural thinking as the primary intellectual mode required in dealing with large complex systems. It is a process that will clarify and transform the ill-structured mental models and issues that emerge as a result of the comparison between the current reality of a particular rural area and the idealised design. The intrinsic character of the ISM process involves the sequencing of events/activities and a learning approach to decision-making through group interaction, which are also characteristic of the leverage phase of the framework

The ISM process will form part of the IM workshop which is assisted by the IM software. The use of intent structures, DELTA charts, preference structures, and decision trees makes IM an appropriate methodology for the leverage phase. In addition, as discussed in Appendix A, the process and products of IM such as 'definition development', 'alternative designs', 'choice of design', 'options field' and trade-off analysis all within a holistic methodology is a further justification for the use of IM.

This phase would also be open to current operational research/systems engineering techniques that have been tried and tested over the years, such as those in-house techniques and processes that are used for the configuration and commissioning of a telecommunications network. The final phase of the framework, 'implementation and control' could also be governed by ISM or the in-house processes. The evaluation of the deployed infrastructure however, is beyond the scope of this thesis as it requires a separate deep investigation on its own.

4.7 The Complete Framework For Planning Of RTI And Its Justification From A Validation And Legitimatisation Point Of View

The framework, which is illustrated in Figure 4.5, demonstrates how a pluralistic critical systems approach, in particular multimethodology, was applied for the purposes of harnessing the strengths of different methodologies in combining their appropriate methods and techniques. It was used to produce a framework that provides for a systems approach to rural telecommunications planning. Although it is promoting overall critical systems approach towards the problem, the various techniques and methodologies included in the framework shown in Figure 4.5, operate at various stages of the planning intervention within the realms of their own paradigms. The incommensurability issue was analysed in section 4.3 and the ideas of Midgley (1992,1997) and Gregory (1992) were accepted as possible basis for its resolution.

The dominating leading operational systems methodology in terms of the planning orientation is IP, which is interpretivist in nature on its own. However, here it is applied within the overall critical systems orientation of multimethodology, chosen as a basis for the mixing of the relevant systems methods in the planning of RTS. IP provides the mechanism for the intervention process. Within the proposed multimethodology planning framework for RTS are used specific interpretivist methods and techniques such as stakeholder analysis, rich pictures, and conceptual models. It involves also a few elements of a separate critical systems approach such as Critical Systems Heuristics. Another methodology that covers features of both interpretivism and functionalism such as ISM; and functionalist methods and techniques belonging to Systems Engineering are also included in the framework. The methods in the framework are diverse but their coherence is ensured through their inclusion in different stages of the dominating operational systems methodology, IP, and through the overall philosophical base of multimethodology, the critical systems thinking approach used to justify the mixing of the techniques from different paradigms.

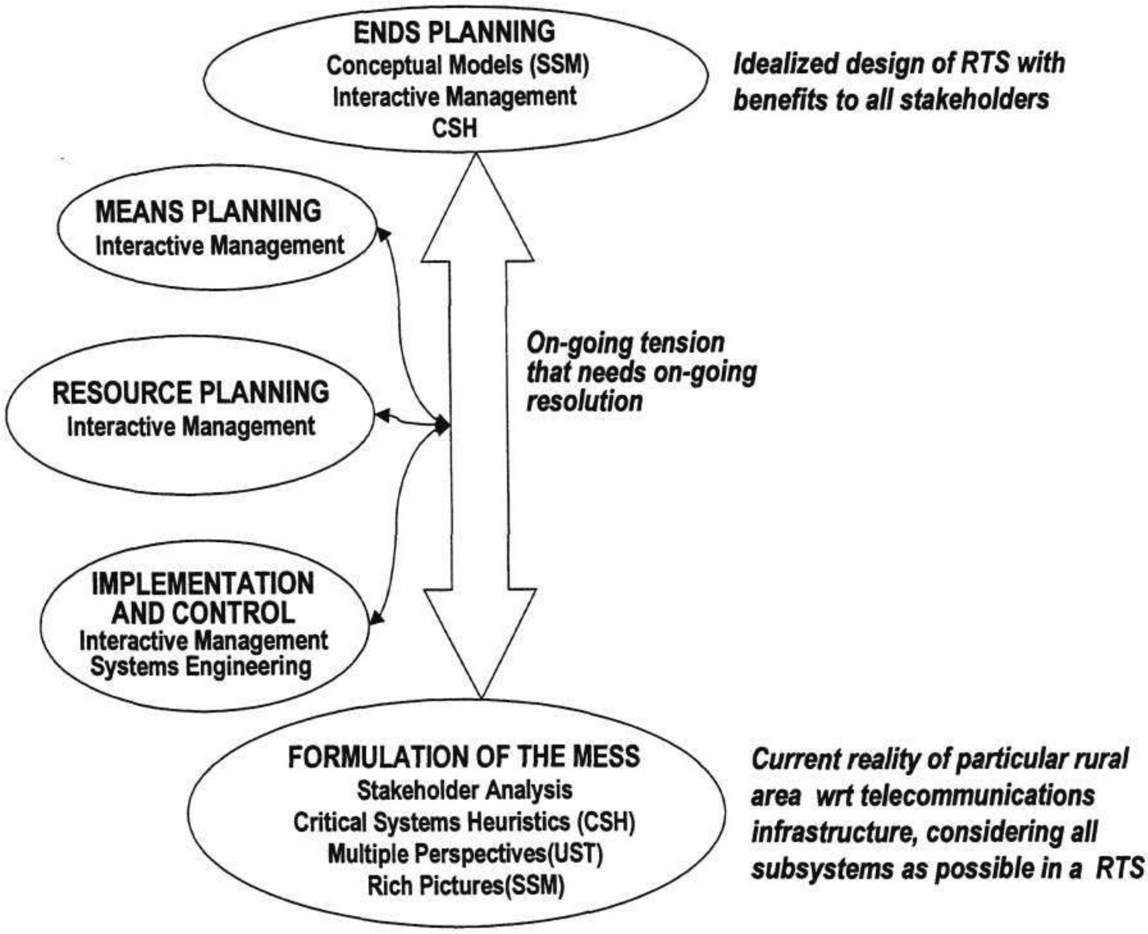

Figure 4.5. A Systemic Framework for the planning of rural telecommunications infrastructure, showing the various phases in planning and the associated methodologies/techniques

It is clear that none of the methodologies considered in the framework would have sufficiently addressed the problem situation on its own. IP, SSM and ISM/IM lack the emancipatory focus of the multimethodology based on critical systems thinking, used here as a guiding approach for the mixing of the various systems methods. IP and SSM lack appropriate rigorous techniques for dealing with complexity and in particular the leverage phase of the framework The framework combines techniques and methodologies from different paradigms to produce a holistic solution to the problem of rural telecommunications planning within a critical systems thinking perspective. It is all these characteristics of the planning framework that contribute to its compliance with the seven principles derived at the beginning of this chapter.

So far the justification of the framework is based on the nature of rural telecommunications planning and the existing body of knowledge in systems thinking. Another aspect of the justification is from the point of view of *validation and legitimisation*. It will be discussed below.

The justification of a framework such as the one developed in this thesis is not a straightforward exercise as when one deals with models for example. In traditional science and engineering, operations research, and social science research, one usually justifies the research product, based on the canons of science. The product of this research is a planning framework for RTI, which cuts across different paradigms, both interpretivist and functionalist. Using the canons of science for its validation is therefore more than a challenging task.

The framework is about changing or intervening in the real world situation (particular rural area) in order to give effect to the RTS with its emerging properties. The ultimate and ideal validation of the framework would require successful deployment of infrastructure in a particular rural area. That is to say, once the telecommunication infrastructure is deployed in a particular rural area, a rural telecommunication system starts to emerge. One needs to then ascertain the extent of the emerging properties of this system, that bring benefits to all stakeholders of the system vis á vis the development of the rural community. To carry out this exercise within the scope and duration of this project is unrealistic from the point of view of the long time it takes to implement the outcomes of the proposed planning framework. However, the nature of the framework justifies other alternate means of validating the framework which will be discussed below, but first, some important points need to be clarified.

In the journey to the development of the framework, the author proposed a model of a typical RTS based on a detailed analysis of the various issues in the provision of telecommunication services to rural areas. Models are usually associated with representations of the real world and therefore conducive to rigorous real world or simulation type validation. However, the model of a typical RTS was proposed as a heuristic mental construct for the purposes of understanding the mess that one has to deal with in developing a more appropriate planning framework for RTI. Although not a tangible system in traditional engineering terms, it nevertheless does provide a fair general representation of the reality associated with RTS planning.

Checkland (1995) discussed the validation of SSM models. According to him such models are valid if they are relevant and competently built. Checkland (1995: 54) mentions that:

> "In the 'hard' approach models must be shown adequately to represent a part of the real world; in a soft approach models have only to be internally valid, that is to say internally defensible against a set of principles which define a particular kind of intellectual construct, a particular kind of epistemological device".

The framework contains a number of soft elements and an element of learning in the process, and while the RTS model may not be conducive to the traditional operational research or systems engineering rigors of validation, it is nevertheless justified in that it is based on extensive analysis in chapter two and, it served as a competent and elucidating epistemological device for the purposes of developing the framework.

The RTS model satisfies the two aspects to the validation of epistemological devices: The experimental validation of the proposed framework discussed in the next chapter showed that according to the stakeholders involved the model is competently built and the model is relevant. This same argument is applicable to the framework itself, but due to its far reaching implications the validation of the framework will be considered in more detail.

The next issue or question that needs clarification is who are the owners of the framework? This will have an impact on the legitimisation and validation discussed in the next sections. The answer to this question is also not straightforward, especially when one considers the various actors in the RTS. This framework could be owned by Government agencies, telecommunications planners, or the community. However, the primary intention of developing the framework was to provide those responsible for the planning of RTI for a particular area, a systemic framework that will improve the current practice, in terms of benefits to the stakeholders of the RTS. Therefore, in the discussion on validation and legitimisation of the framework that follows, the OR specialist will be synonymous to the responsible planners such as Telkom SA, and the stakeholders would be the other actors in the system.

Many of the concepts and methods concerning validation have been developed in the context of making observations on the real world according to an experimental design. In general, validity could be defined as the quality of the fit between an observation and the basis on which it is made (Kirk and Miller, 1986). Legitimisation is usually associated with the acceptance of the model. Landry *et al* (1996) suggest that model validation and model legitimisation are two overlapping but nevertheless distinct activities and for an OR model (also pertinent to the framework) to be acceptable it has to be *valid and legitimate.*

Similar views are expressed by Midgley (2000:106) when he states:

> "The term 'validity' is generally used by proponents of observational science: If a method is valid, it yields knowledge that reflects reality without known distortions or intervention by the observer. However, those who believe that truly independent observation is impossible, tend to avoid the word 'validity' and talk about *legitimacy*".

The framework has to be legitimate in the eyes of those who will use it and those for whom it is intended. The less legitimate the framework is, the less likely it will be successfully implemented. A valid model is not necessarily a legitimate one and this holds true for the framework as well. The emerging properties of the RTS for which the telecommunications infrastructure is being planned, i.e. benefits accrued to all stakeholders will always be an indication of the validity and legitimisation of the framework.

4.7.1 On the Validation of the Framework

In searching for an appropriate validation scheme for the planning framework, the work of Landry *et al* (1983) is considered. Their paper focuses on "Model validation in operations research" and therefore the principles of validation in it concern the contemporary OR practice, i.e. situations that are characterised by uncertainty and the human element, where the representativeness of these situations is meaningless. This is therefore also applicable to the framework developed in this thesis. In situations such as these, Landry *et al* (1983) stress the usefulness and usability of a model (in relation to its representativeness), and the point that building a model involves being simultaneously engaged in its validation.

A simplified version of the modelling-validating process, according to Landry *et al* (1983), is depicted in Figure 4.6, and the ideas that emanate in this process shall now be applied to the planning framework. The modelling-validating activities are grouped into four interrelated and iterative stages; the problem situation, the conceptual model, the formal model and the solutions. In the context of the planning framework, the 'problem situation' that led to the development of the framework was explained in chapter one and chapter two of this thesis. The formal model to be validated represents the actual planning framework as shown in Figure 4.5.

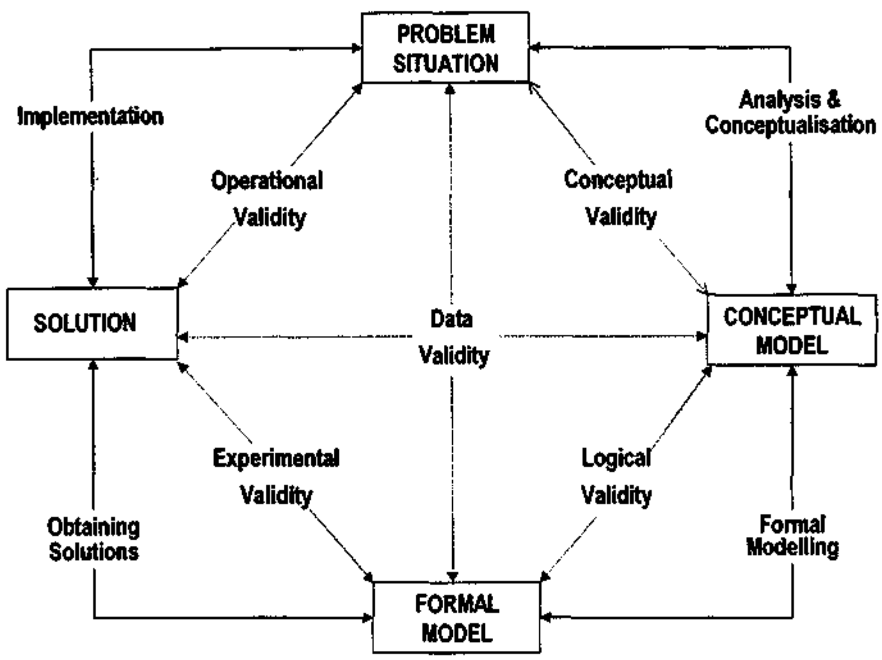

Figure 4.6. The modelling–validating process (Landry *et al*, 1983)

Referring to Figure 4.6, conceptual validation and logical validation shall be treated together. Conceptual validation is concerned with the appropriateness of the perspectives, assumptions and theories that underpin the planning framework. Logical validation usually deals with the analytical verification of the relationships within a model, but for the planning framework that cuts across different paradigms this is difficult. The preceding chapters of this thesis covered in detail issues such as the justification for a systems approach to the problem, the need for a multimethodological approach to the framework, and the rationale for the choice of the philosophical orientation of the framework, the methods and techniques used in it. They represent the conceptual justification of the proposed framework.

For the planning framework proposed here, experimental validation, operational validation, and data validation, if applicable, are all related to the implementation of the framework in field conditions within a chosen rural area. Therefore the intentions behind these types of validations will be considered in the case study in chapter five of this thesis.

Operational validity is concerned with whether the planning framework is of value to the planners in tackling the problem for which the framework was developed. In other words will the use of the framework justify resources such as time, effort and cost? This must be looked at in relation to the emerging properties of the RTS, and therefore a more accurate operational validity can only be determined once the framework has been used in real situations. One way to ensure the operational validity of the framework was the chosen strategy of continuous consultation with the RTI planners in Kwa Zulu Natal. Further additional measure of operational validity was determined in the case study on the experimental application of the framework discussed in chapter five.

The above considerations on validation of OR models are in general more applicable to hard systems thinking approaches. The fact that the proposed framework aims to facilitate learning about the problem of rural telecommunications infrastructure planning is a reason to classify its systemic nature as "soft" according to Checkland (1995). The same author suggests that the criteria for validation of hard systems models cannot be applied in such a case and instead a new criterion for validation of soft systemic intervention approaches is suggested by him. According to Checkland (1995) the validity of a soft systems model can be judged on the basis of whether it is relevant and competently built. Though the theoretical justification of the proposed framework contributes partly to such judgement, these issues can only be fully clarified through experimental implementation of such a model and will be dealt in the discussion of the lessons learned from the implementation of the framework.

As indicated earlier, the nature of a soft systemic intervention requires attention to its acceptance by the stakeholders and that is discussed in the following subsection.

4.7.2 On the Legitimisation of the Framework

There are a broad range of issues that are associated with the concept of legitimacy (see Banville, 1990), however, the fundamental issues all boil down to conditions for survival (such as for the community and the telecommunications operator), maintenance and sustainability, adaptation, or change within a system (Landry *et al*, 1996: 445). Legitimacy is a highly desirably attribute of human activities and a necessary condition for efficient sustainability of change in a system. Although it was mentioned that validation and legitimisation are two distinct activities in OR modelling, for the planning framework the two concepts (validation and legitimisation) are inextricably linked. In other words it cannot be valid if it is not legitimate in the eyes of its stakeholders.

The process of legitimisation of the framework based on Landry *et al* (1996) should encompass two complementary activities: comparison of the framework with a code that comprise values, norms, etc that are socially constructed (contemporary view), and judgement as to the conformity of the framework to the code. The complementary view on both validation and legitimisation is of importance to this research. The traditional methods of planning RTI in South Africa used up to the recent past enjoyed a sense of 'elitist legitimisation' in that the code was designed by a non-democratic government and the single network provider, led to either inappropriate (or the lack of) telecommunications infrastructure in rural areas. However, one must take into consideration that while a systemic approach will lead to a more democratic view of legitimisation it may be less comfortable for the network provider, at least initially.

How does one ensures the legitimacy of the framework during its development? Landry *et al* (1996) provide a set of seven heuristics that provide guidelines for the OR specialist when developing models. The context is the relations between the stakeholders of the model and the model itself. While all seven heuristics may not be directly applicable to the planning framework they nevertheless point to some ideas that are worth considering. The heuristics address the following issues: -

- The legitimacy of the framework in the eyes of all stakeholders

- The potential of the framework to generate knowledge, promote thinking and understanding, and help to formulate decisions and actions.
- The conformity of the framework to the cognitive capacity and value system of the stakeholders.
- The flexibility within the framework to accommodate different stakeholders and unforeseen circumstances.
- The preconceived ideas and concepts of the stakeholders regarding problem definition and likely solutions.

When one considers the planning framework principles in Table 4.1, and the nature of the methods and techniques recommended in the RTS planning framework itself, and compare these with the issues that the above heuristics address, one can come to the conclusions that all the above heuristics are reflected in the designed mechanism for the proposed framework. Thus the nature of the proposed framework and its components created the preconditions to ensure the legitimacy of the planning framework. This issue will be elucidated further in the next chapter.

CHAPTER 5

IMPLEMENTATION OF THE FRAMEWORK: A CASE STUDY ON THE MAPUMULO RURAL AREA IN KWAZULU NATAL

This chapter deals with the practical implementation of the planning framework in Mapumulo, a typical rural area in KwaZulu Natal. The implementation was done with the kind assistance of staff from the planning sections at Telkom SA, the sole public network operator in South Africa at the time of this implementation, and community representatives from the Mapumulo rural area under study. The Telkom participants came from different regions within KZN and represented different sections within the planning department of Telkom SA. The preparation for the implementation took more than 18 months of continuous interaction with the relevant stakeholders. A number of meetings with individuals took place as well as several more formal events happened. Apart from the two preliminary seminars that were given by the author to Telkom SA planners on various aspects of the research as it unfolded, three formal workshops were arranged in collaborations with Telkom SA, for the purposes of the experimental validation of the framework. The key contact persons at Telkom SA who facilitated the arrangements for the workshops were Mr. E. Smith, area manager of Regional Integrated Network Planning and Mr. A. Hoffmann, area manager for Technology Engineering (see Appendix B, Table B1). In addition, another workshop was held with community representatives from the Mapumulo area and Telkom, in order to obtain their perspectives on rural telecommunications thus covering all the important stakeholders in this experimental implementation.

5.1 The Structure And Process Of The Workshops

Since the implementation of the framework must be seen as a learning process, the author has implemented the planning as such and therefore one would not see the physical results of the planning. A detailed implementation of the framework all the way down to the installation of the infrastructure is beyond the scope of this work, due to the long time needed for that. The experimental implementation of the framework aimed, among other things, to prove the learning characteristics of the framework as a tool based on soft systems thinking. One must take cognisance of the reality that the extent of the implementation of the framework depends largely on the collaboration with the telecommunications network provider and operator, in this case Telkom SA, and this collaboration has to respect the company's constraints on its employees. In addition, arranging more than one meeting with community representatives for the sake of testing a research output requires scarce resources. Notwithstanding these constraints, the experimental validation of the framework was carried out by using the framework in a pilot planning exercise for rural telecommunications infrastructure for a rural area in KwaZulu Natal, with planners from Telkom SA and with representatives from Mapumulo.

In reference to Figure 4.4 and Figure 4.5 the framework has three essential parts: investigation of the current reality of the particular rural area with respect to telecommunications infrastructure, considering all subsystems as possible in the RTS, i.e. the formulation of the mess; the idealised design of the RTS considering the benefits to all stakeholders, i.e. the ends planning; and the leverage part consisting of the means planning, resource planning, and implementation and control. Upon reflection on the processes required in the different parts of the framework, it became evident that several workshops to implement the framework would be needed. Between workshops it was necessary to reflect on previous results before any further progress was made. For example, the need to consolidate the results of the formulation of the mess stage and to reflect on these before the ends planning had to be tackled. It was therefore decided to have four workshops for the implementation of the framework, with the understanding that more would be scheduled if it were necessary for the validation of the framework. The author facilitated all the workshops.

The first workshop focussed on the implementation of the formulation of the mess phase only. Apart from the primary reason of implementing the framework, the intention was also to use this workshop to gauge the commitment of the participants to non-traditional processes such as those involved in stakeholder analysis and rich pictures, so that one could address any shortcomings before the next workshop. The author's role besides facilitation was to write-up the results of the workshop, consolidate the rich pictures into one, and distribute these to the participants for reflection and input. It was therefore decided to allow for at least two weeks between workshops. Every effort was made to ensure that there was continuity in the attendance of the participants to subsequent workshops.

The second workshop focussed on the ends planning. In terms of the requirements of the framework the stakeholders should be present at this workshop, but this did not materialise due to Telkom's reservation at this stage to interact directly with stakeholders before assessing the framework. The results of the second workshop are therefore contributions from the Telkom planners only. Keeping in line with the principles of systemic intervention, a third workshop was subsequently arranged with stakeholders that were linked to the Mapumulo community and a few representatives from Telkom. The purpose of this workshop was to compensate for the lack of stakeholder representivity in the second workshop by focussing on issues covered in the workshop and gauging the stakeholders' response to the inputs made by Telkom. The fourth workshop dealt with the leverage phase of the framework. The next section will describe briefly the area of the experimental implementation.

5.2 A Profile Of The Mapumulo Area In KwaZulu Natal

A request was made to Telkom SA for the selection of a rural area for the trial implementation of the framework. It was decided to consider the Mapumulo region in Northern KZN. Appendix A, Figure A1 provides the geographical location of Mapumulo. The following information on the area was partly provided by Telkom SA.

Mapumulo is situated about 100km north of Durban and about 50km in from the coast. The district is adjacent to the Kranskop, Glenmill and Doringkop areas. The small central business district has a commercial mix consisting mostly of a Government Building, Police Station, Department of Works, Department of Education, Post Office, SPAR, Bottle stores, and a couple of small businesses. The existence of vendor stalls in the main street and the unkept condition of the place might be a source of concern for the local authority.

The establishment of a very large school complex, Vukile High School with catering, boarding facilities and 14 flats for staff has been built approximately 2km out of the town on the road to Kranskop. A hospital exists approximately 4 km from the town, approximately 1km off the main road. The whole area is inhabited by subsistence farmers. Many of the households are only accessible by foot. There has been an increase of schools and the odd shop throughout the area however, there is no reason to indicate a large increase in the foreseeable future. The inhabitants of the area in general can be categorized as low income, LSM 1,2,3 (LSM means living standard measure, while 1,2,3 are respective grades of the latter). It appears that there is very little likelihood that many will actually afford telephones. LSM is an indication of the living standard of communities in terms of descriptors such as the community size, number of motor vehicles in the household, whether there is electricity or water supply to the home, the kind of items in the household, domestic servants, and shopping habits (Williams *et al*, 1995: 34). This measure was devised by Market Research Africa (PTY) LTD and is used by Telkom in their planning of telecommunications services. There are eight LSM categories with one being the lowest income. Experience has indicated that applications for new telephones have been received by Telkom but often hardly have the services been installed when they are disconnected for either non-payment or some other reason. Also scattered within the area are approximately 10 sugar cane farmers on ± 20-30 hectares of land per farmer.

The total population of the Mapumulo exchange area has been recorded at 70371 and the number of households at 6702; this is an average of 10.5 persons per household. The majority of the Mapumulo exchange area is very poor particularly towards the extremities of large roads and into the hills and mountains where the people live off the land. The priority in all the areas visited is definitely running water, fuel, jobs, electricity, health services and adequate housing. The main means of transportation is taxi or bus and radio is the most important media. The sugar cane farmers on the other hand have high income generating businesses and the affordability forecast for them is very high.

5.3 Workshop One: Implementation Of The 'Formulation Of The Mess' Phase Of The Framework

The purpose of this particular workshop was to assess the process and the outputs of the implementation of the 'formulation of the mess' phase of the framework, for the Mapumulo area. The workshop was held on the 12th July 2001 at the Telkom SA Centre for Learning in Durban. The area manager for technology engineering was instrumental in getting the participants to attend and arranging the logistics for the workshop. As alluded to in chapter four, the responsibility for the deployment of rural telecommunications infrastructure in South Africa lies with Telkom SA who would initiate and finance such exercise. The custodians of the framework would be the planning sections at Telkom SA, and therefore the author requested that the participants be representative of the planning sections. These are the people that are involved with the planning of rural telecommunications infrastructure in one way or another. They are the ones, amongst others, that would use this framework in real life situations, if the framework was acceptable. Appendix B, Table B1, provides a list of the participants, their portfolios within Telkom SA and their contact details. The agenda for the workshop was as shown in Appendix B, PPT B1. First, an overview of the process shall be presented, and then a deeper analysis of what emerged from the workshop will follow.

Although there was frequent collaboration with Telkom SA during all stages of this research, it was decided not to assume prior knowledge of the planning framework on the part of the participants. This meant that an overview of the project in general and a detailed account of the framework itself had to be given at every workshop. Besides, it was expected that there might be some new persons present at some of these workshops. PPT B1 in Appendix B reflects an overview of the formal information that was presented to the participants in workshop one.

The concept of a RTS with its emerging properties (Figure 3.2) was explained to the participants. It must be noted that the traditional understanding of a RTS belonged to the functionalist paradigm, i.e. the technological infrastructure was looked upon as the RTS. Therefore the facilitator had to emphasise the novel approach of treating the RTS. An overview of the planning framework was then presented and it was explained to the participants that the second workshop would deal with the 'Ends Planning', a third would deal with the concerns of the local community and thereafter the final workshop would cover the implementation of the leverage phase, i.e. the 'Means Planning', 'Resource Planning' and the 'Implementation and Control'.

After an explanation of the process for the stakeholder analysis the participants were placed into three groups. Each group then engaged in a stakeholder analysis for the

Mapumulo area. In a nutshell the participants were asked to consider: Given the current description of the Mapumulo area who are the standard stakeholders, the fiduciary stakeholders and the silent stakeholders of the rural telecommunications plan and the envisaged rural telecommunications infrastructure. The facilitator emphasised once again that the exercise must be done in the context of the RTS as conceptualised in this thesis. The outputs of the stakeholder analyses for each group are shown in Appendix B, Table B2. Each group was then asked to report on what they produced, and clarify any stakeholders or related issues that gave cause for concern. After a concise explanation of the significance of the critically heuristic boundary questions to the legitimacy of the stakeholders, the participants were asked to individually (in plenary) reflect on the 'ought mode' and the 'is mode' and propose any changes to their lists of stakeholders. No changes were proposed.

The need for multiple perspectives on a complex problem situation was explained to the participants. In particular the Technical, Organisational, and Personal (T.O.P.) perspectives (see Mitroff and Linstone, 1993) on a problem situation were suggested as a way of meeting the need for multiple perspectives on the Mapumulo planning situation. In essence Mitroff and Linstone (1993) recommend appropriate inquiry systems (IS) that will facilitate the technical, organisational and personal perspectives. For this particular workshop it was deemed sufficient and effective enough to alert the practitioners to the significance of the T.O.P. perspectives in generating the rich pictures.

After an overview of rich pictures as a technique, describing the structure of the problem and the processes involved in it (see Checkland and Scholes, 1990), the participants were asked to regroup and, using the outputs of the stakeholder analysis and the multiple perspectives approach (TOP), attempt to draw relevant rich pictures for the Mapumulo situation. Three rich pictures were generated and these were consolidated by the author into a single one, which is depicted in Appendix B, Figure B2.

5.3.1 Discussion And Analysis Of The Formulation Of The Mess Process And Its Outputs

There were several reasons for arranging the participants into smaller groups. It would have been cumbersome to deal with eleven participants at one time. Besides the idea was to ensure that the participants were given sufficient opportunity to express their views, in keeping with the participative principle of the framework. Working in smaller groups rather than in plenary is more conducive to this goal. Formulation of the mess is primarily an interpretivist approach in this framework, and this implies that learning takes place throughout the process. Interaction in smaller groups facilitates this learning. Another reason for having different groups engaged in the same task is that one is able to make comparisons and triangulate results. The following subsections will deal with various aspects of the findings from the workshop.

The Issue Of Current Organisational Practice And Bias, And Preconceived Ideas, With Respect To Rural Telecommunication Planning

One of the tenets of the planning framework is that whereas the traditional approach to planning a RTS is predominantly an exercise in 'technology planning', the framework implies a holistic mix between technology and social planning. Therefore, while the participants had a considerable amount of experience in working with rural telecommunications, exposure to and dealing with a systemic RTS as depicted in Figure 3.2, was a new exposure for them. The participants had some intuitive idea of the various issues in the subsystems that may influence the provision of rural telecommunications, but did not realise the significance of the systemic structure and its influence on the planning approach.

The point that the current planning exercise is about planning a RTS whose emerging properties should be benefits to all stakeholders, and that this must be borne in mind throughout this exercise, was consistently emphasised during the workshop. However as a result of the experience of the participants there was sometimes a tendency to 'default' to the current way of thinking or doing business. Comments such as "this is what we would do" or "this is what Telkom would do" were sometimes encountered. However the facilitator simply had to remind them of their role as individual planners. The group dynamics was such that some individuals questioned the need for some of these biases. In addition, the techniques chosen in the formulation of the mess, such as the TOP perspectives, provided the stimulation for the participants to transcend their biases.

The Stakeholder Analysis

The results of the stakeholder analysis for the three groups are shown in Appendix B, Table B2. The intention in this experimental implementation of the formulation of the mess was, neither to finally produce an exhaustive list of all stakeholders, nor produce an accurate categorisation of the 'standard', 'fiduciary' and 'silent' stakeholders. Stakeholder analysis is not necessarily only for the purposes of finding the relevant actors for the rest of the planning phases in the framework. The idea here was to bring to awareness the scope and complexity of the planning problem in terms of it going beyond the technological domain. Nevertheless, the formation of the three different groups did help to identify a large number of stakeholders in a relatively short space of time, as shown in Table 5.1. The stakeholder analysis also indicated the kinds of information that one may need to find for further progress. It must be noted that some of the stakeholders were non-personified, such as 'large commercial expansion' and 'increase in schools'. These 'stakeholders' at least helped in exposing the complexity of the problem. In other words, the stakeholder analysis was also used as a methodological device to surface issues. It was necessary before further outlining the boundaries of the problem, which is discussed in the next subsection.

Table 5.1. The main categories of stakeholder groups that were identified by the participants. A more detailed list is shown in Appendix B.

Commercial enterprises
Education
Health Services - both private and provincial
Security Services
Local Government
The Community/households
Social organisations/NGO/Associations
Farmers
Environmental groups
Those responsible for parallel infrastructure
Traditional leaders/Community leaders

An important issue regarding stakeholder participation must now be dealt with in order to address any concerns that may arise, due to the participants in this workshop being restricted to Telkom SA planners. In reflecting on the RTS model in Figure 3.2 the ideal situation, in general, would require that stakeholders from all subsystems of the RTS be represented in the planning activities, if one wants to be totally inclusive. This is not always pragmatic, considering the extent of the RTS. However, it was proposed in the framework that in order to achieve similar aspirations of representivity, the planners from the telecommunications organisation would undertake a stakeholder analysis having in mind the interests of those that were not present at the first workshop. In addition, the formulation of the mess provided techniques that ensured a thorough identification of stakeholders like the categorisation of stakeholders and the selected subset of the Critically Heuristic Boundary Questions.

It was intended that once the stakeholders were identified, they would then be included, or at least represented in some of the other activities in the framework, especially the ends planning. The issue of representivity of the dispossessed, in the planning exercise for the purposes of empowerment, has already been theoretically justified. The degree of their involvement however depends on the their availability, amount of resources and other practical constraints, though it is imperative that as much inclusivity as possible be considered. An observation of the scope of the system of problems in the rich pictures shows that the rationale for inclusivity has been demonstrated in this pilot study. The situation can only improve with the participation of all stakeholders.

The Role Of The Chosen Subset Of Critically Heuristic Boundary Questions In The Formulation Of The Mess

The purpose of the subset of the Critically Heuristic Boundary Questions in the formulation of the mess phase of the framework is to ensure a comprehensive treatment by checking for discrepancies between the stakeholders identified and the answers to the boundary questions. Midgley (2000) emphasises the crucial importance of setting appropriate boundaries or boundary critique in systemic intervention because this has a direct influence on the extent of the comprehensibility of the intervention. The exclusion of certain stakeholders may have a bearing on the extent of the intervention.

The participants were given an opportunity to reflect on the boundary questions as selected in Table 4.3 and reproduced in Appendix B, PPT B1, and suggest changes to their list of stakeholders. No changes were suggested. However, it must be noted that there was a time constraint and according to the author there might have been a different result had there been more time for reflection. On the other hand, because of the profile and experience of the participants the first iteration of stakeholder analysis was substantially inclusive, thus the lack of changes after reflection on the boundary questions. Nevertheless the chosen subset of the Critically Heuristic Boundary Questions may not be considered as not necessary and in the opinion of the author it must remain in the framework because of its control function.

Technical, Organisational And Personal (TOP) Perspectives And Rich Pictures

The participants were asked to depict the 'mess' pertaining to the various issues that would contribute either positively or negatively to the provision of rural telecommunications infrastructure, to the Mapumulo area as they saw it. It must be noted that this was the first time that the participants engaged in the technique of developing rich pictures. However their task was made easier by the salient information (including three sample rich pictures) presented to them, the stakeholder analysis, which represented to a large extent the various issues that need to be considered, and the TOP perspectives. The three groups generated three rich pictures. For practical reasons the three rich pictures could not be attached to this thesis but a composite generated by the author is shown in Appendix B, Figure B2. The salient features of the three rich pictures will now be discussed.

It is usually expected that rich pictures are better representations of issues and relationships between these issues, rather than linear prose. In general, the metaphors used in the three rich pictures indicate the deep thought processes of the participants. There appeared to be a correlation between the group's stakeholder analysis and the issues reflected in the rich pictures as the group saw it. The complexity of the problem situation began to emerge, not only as a general RTS but also the unique contributions of the Mapumulo area to this complexity.

A significant observation is that the issues and relationships reflected in the rich pictures confirm the systemicity of the RTS as proposed in Figure 3.2. What began to emerge is that planning a RTS is not just about a technology system but it is also about developing a social system. Social issues such as health services, and education; cultural issues such as language, cultural differences and the protocol with respect to cultural leadership; economic issues, and regulatory issues, within the context of the Mapumulo area, were clearly evident in the rich pictures as part of the RTS.

A key purpose of the rich picture technique in the formulation of the mess stage in the framework is to assist and reflect the quality and depth of the thinking of the participants in as accurate a way as possible, but not necessarily detailed. The resulting representation is then meant to inform the rest of the activities in the framework. The rich pictures that were generated clearly showed the potential to satisfy these objectives. Not only are the systemicity and complexity of the particular situation demonstrated, but also the rich pictures gave an indication of the subsystems and any other issues that needed further investigation for the purposes of progress into the next phases of the framework. This particular exercise on rich pictures tends to suggest that it is advantageous to have more than one group generate rich pictures of a particular situation in order to obtain as comprehensible as possible picture of the mess.

It was mentioned in chapter four that the formulation of the mess as a whole activity is a key epistemological device in the framework that generates knowledge about what needs to be done. This result of this implementation of the formulation of the mess clearly shows the potential to realise such an objective.

Some General Comments On The Workshop

These will be summarised below:

- The formulation of the mess and in particular the rich pictures contributed to the creation of a broad, "helicopter" view of the entire problem, which is necessary as a beginning of the planning process.
- The formulation of the mess gave those that were present an appreciation of the extent of the problem. Usually the planners would narrowly focus on their specific technological domain.
- The formulation of the mess and in particular the rich pictures really demonstrates the distinctions between rural telecommunications and urban communications.
- One participant mentioned that he is looking forward to the next phase, i.e. the ends planning.
- In general the participants thought that the time spent at the workshop was a very useful learning exercise as far as rural telecommunications are concerned.

The emergent properties of the planning system i.e. the planning framework occur due to the way the methods and techniques are combined and implemented. Therefore a more rigorous evaluation was carried out after a more advanced implementation of the framework (refer to section 5.7).

5.4 Workshop Two: Trial Implementation Of The Ends Planning/Idealised Design Of The Framework

The purpose of this particular workshop was to assess the process and outputs of the trial implementation of the ends planning/idealised design phase of the planning framework, for the Mapumulo area. The workshop was held on the 17th September 2001 at the Telkom SA Centre for Learning in Durban. The area manager for technology engineering was once again instrumental in getting the participants to attend and arranging the logistics for the workshop. Appendix C, Table C1, provides a list of participants, their portfolio within Telkom SA, and their contact details. Every effort was made to ensure that the participants that were present in the first workshop, 'formulation of the mess' for the Mapumulo area, would also be present at the 'ends planning' workshop. This did not materialise fully due to their work commitments, some participants being out of town, some being transferred to different sections, and one person not employed by Telkom SA any longer.

However, most of the key decision makers in the planing environment at Telkom SA, such as the Area Manager for technology engineering and the Area Manager for regional integrated network planning, were present at both the workshops. In general, the participants in 'ends planning' workshop are directly involved in the planning of rural telecommunications infrastructure in KwaZulu Natal. Some of the participants are directly responsible for the Mapumulo area.

One of the intentions of this research project is to expose the custodians of rural telecommunications planning, in this case Telkom SA, to a systemic framework for planning of rural telecommunications infrastructure developed in this thesis. Engaging the custodians in a case study that uses the framework is an effective way of initiating a desired culture change. Therefore, although all the identified stakeholders were not present in the second workshop, an important objective was achieved by showing the Telkom participants in practice the powerful ideas of system thinking so that they can embrace them in their future work.

However, in order to adhere to a fundamental tenet of systems practice, that being the involvement of all key stakeholders in an intervention, a separate workshop was held with stakeholders from the Mapumulo area. This is discussed later in this chapter. Ackoff (1981: 123-124) mentions that in situations where unconstrained participation is not possible in the ends planning, a small group of professional planners serves as the core of the design team. This team then prepares a first scenario and a consultative group of stakeholders is set up. Through an iterative process of consultation with the stakeholder group a final design is prepared. To ensure that the goals of empowerment on the part of the community was not diluted by the fact that they would not be present in all the workshops, the author followed a principle posited by Ulrich (1998). In essence there has to be a witness or witnesses of the interests of those that will be served by the rural telecommunications infrastructure, but cannot participate in the intervention. In the Mapumulo case study the facilitator served as a witness of the interests of the stakeholders during the workshops with the Telkom participants.

The key output in the ends planning/idealised design stage for the Mapumulo area regarding rural telecommunications, is a vision of the ideal RTS that will provide all the benefits for all stakeholders with respect to the services that are possible through the rural telecommunications infrastructure, right now at present. Implicit in this output is the broad conceptual design of the appropriate telecommunications infrastructure. It must be emphasised that an improvement in the planning process is one of the most important products of idealised design. In addition, the benefits derived from idealised design also lie in the learning and creativity that result from engaging in the process (Ackoff, 1993). This is particularly important for a problem situation such as rural telecommunication planning, where the practice is the adherence to set procedures and methods that is insufficient to holistically address the issues in rural telecommunications infrastructure planning, design, and deployment.

The agenda for the workshop was as shown in Appendix C, PPT C1, slide two. Due to some of the participants being exposed to the planning framework for the first time, it was decided to review the development of the framework. An overview of the Systems Engineering approach was used to highlight the current practice in the planning, design, and deployment of telecommunications networks, and its inadequacies in addressing the problem situation at hand (see Appendix C, PPT CI, slide 3). The participants noted with interest that although Systems Engineering catered for a 'knowledge and information dimension', emphasis is always placed on the time and logic dimension. It was also agreed that Systems Engineering was well suited to an optimisation paradigm, which has features different from the problem situation at hand.

The RTS as proposed in this thesis was explained to the participants. The sociotechnical nature of this system and the consequent need to go beyond the technological issues was emphasised. A comment by one of the participants that was exposed to this research for the first time reminded one of a common perception prevalent, or that used to be prevalent, among rural telecommunications practitioners. It was mentioned that the "rural telecommunications system accurately represents what Telkom SA does - Telkom SA does take social factors into account", and so regards rural telecommunications as a social issue. However, while this may be true, the extent of the previous understanding of the social issue by the telecommunications provider was very narrow. Besides, the current practice in the roll out of rural telecommunications infrastructure is in tension with the perception of social issue. The facilitator also emphasised the systemic nature of the RTS and how this should affect practice, which is currently lacking.

After the planning framework was explained to the participants, a review of the results of the 'formulation of the mess' workshop was carried out. Participants were particularly requested to revisit the rich picture (Appendix B, Figure B2) to see whether they agreed with how the problem situation with respect to telecommunications planning for the Mapumulo area was depicted. They were also invited to enhance the rich picture if they wished (see Appendix C, PPT C1, slide seven). While there was general agreement with the rich picture, three further issues were raised.

The first issue concerned the presence of the large KwaSiza Bantu mission station that was not reflected in the rich picture. It has, inter alia, its own agricultural enterprise, community radio station, and a conference centre that can accommodate approximately 1000 people. There were some reservations expressed by some participants as to whether this mission station fell within the Mapumulo area or the neighbouring Kranskop area. Irrespective of the location of this mission station, the point was an important one. Usually, demand is driven by government departments such as hospitals, schools, prison, and local government offices, but for the area where the mission station is situated the demand for high quality service and wider bandwidth was driven by the mission station. Of course this lead to a situation where the unusual demand was met without appropriate planning for that rural area, or any structured roll out with respect to telecommunications infrastructure. What this means is that this high quality and high capacity network is not used effectively and efficiently for the benefit of the surrounding communities.

The second issue concerned the future competition that Telkom SA would face as a public network provider. The South African government has committed to licensing a second public network operator as of 2002, and so Telkom SA needs to balance social responsibilities with return on investment. The planners in KwaZulu Natal therefore have to maximise an internal rate of return. It was mentioned by the Area Manager of regional integrated network planning that the government allows ESKOM, the sole Electricity utility in South Africa, a subsidy for providing services to certain rural areas, but there is no such subsidy for Telkom SA, or for telecommunications to rural areas for that matter. However, one must keep in mind that Telkom being a former parastatal was given certain obligations to meet when their monopoly as a private company was extended. It was suggested that the rich picture include 'a big black cloud on the top of the page called the competition cloud'. This was another opportunity to explain to the participants the value in a systemic framework for planning of rural telecommunications infrastructure - that a systemic approach mandates the consideration of 'conflicting' interests in the planning process and that the emerging properties 'benefits to all stakeholders' have to be reconciled with the various boundary judgements made.

The third issue concerns the new Integrated Development Plan (IDP) for the Metropolitan Councils in South Africa. In a nutshell, this document calls for an integrated approach to general planning of a particular area, on the part of metro councils. However this is only at document level at the moment. Some of the participants felt that the IDP should be reflected in the rich picture. The implementation of the IDP document will certainly contribute to a holistic approach to the planning, design, and deployment of telecommunications infrastructure in the Mapumulo area. Currently there is no co-ordination or even consultation between the different agencies that are responsible for the various infrastructures. It still needs to be seen how this document will become a reality but the experimental implementation of this framework indicates the interest of the stakeholders in a holistic approach to development.

As mentioned earlier, this workshop dealt with *Ends Planning/Idealised Design for the Mapumulo RTS.* The salient aspects of ends planning/idealised design were discussed with the participants. Thereafter the participants were split into groups as per Appendix C to engage in the idealised design process. In terms of planning as creating a future RTS through the deployment of telecommunications infrastructure, it was agreed that this part of the planning framework was crucial. Both the constrained and unconstrained design was carried out. In chapter four it was suggested that conceptual modelling from Soft Systems Methodology (Checkland and Scholes, 1991) may be used as a technique to facilitate thinking about relevant systems that would be necessary for development at Mapumulo. However, due to the profile of the participants, the author deemed the use of conceptual models as unnecessary. Rather a set of questions pertaining to the constrained and unconstrained design was posed to the participants, concerning the Mapumulo area.

An important issue was raised by one of the participants at this point. What is the purpose of idealised design when there are financial constraints regarding the telecommunications infrastructure for the Mapumulo area? In fact this seemed to be an issue with other participants as well. The author explained that an idealised design is not an ideal or utopian design, which is perfect and therefore will not need continuous improvement. Rather, the intention is to find the best ideal seeking RTS that the participants can conceive of for the Mapumulo area. In the current way of planning, the budget plays the initial deciding role as to what infrastructure is deployed. This usually leads to inefficient use of infrastructure as the infrastructure expands.

One contribution of idealised design is that, once the best ideal seeking system is conceived, the limited financial resources may be allocated in such a way that the realisation of the best ideal seeking system may be achieved over time. This is of crucial importance in a systemic approach. Furthermore, the idealised design could also serve as a motivation and justification for more resources from the decision-makers and managers of Telkom SA, and perhaps even from Government or other agencies. It is difficult on the part of government and Telkom SA executives not to support a convincing plan that guarantees the emerging properties of the RTS.

5.4.1 Constrained Idealised Design For The Mapumulo Area

The first exercise undertaken by the participants was an attempt at the constrained idealised design. Two main questions were posed to the participants as a trigger for the individual group discussions. In the context of the RTS and its emerging properties, the participants were asked the following questions:

- Assuming that the external environment to the RTS at Mapumulo and the internal environment at Telkom SA do not change, what systems pertaining to the RTS would the participants like to see at Mapumulo? The external environment included issues such as the parallel infrastructure, government policies and regulations, and some of the issues that were reflected in the rich picture. The internal environment at Telkom SA included issues such as the internal rate of return, the preferred technologies, the current planning process, and the budgetary constraints. It was also explained that the systems chosen must be technologically feasible, operationally viable within the current environment, and must be adaptable to change.

- The participants were then asked to specify what rural telecommunications infrastructure is needed to support and sustain these systems. Due to time constraints the participants were asked to focus on the core infrastructure, rather than detail support systems. It must be noted that the primary intention of the trial implementation of the framework is to gauge the learning that takes place during the process, rather than the production of outputs ready for implementation.

The results of the constrained design are tabulated in Appendix C, Table C2. Both the systems that the participants would like to see at Mapumulo and the supporting telecommunications infrastructure are shown, for the four different groups. It must be mentioned that this kind of an exercise, being a first time experience for all the participants, was not an easy task. The facilitator had to provide assistance to the individual groups. The four groups produced similar results although the number of systems varied. Table 5.2 provides a summary of the systems that were mentioned, and Table 5.3 provides a summary of the core infrastructure that was suggested to support these systems technologically. These results will be further discussed after the next section once the results of the unconstrained design are presented.

Table 5.2. Summary of systems pertaining to the RTS, resulting from the constrained design that participants would like to see in the Mapumulo area. (A more detailed account is found in Appendix C).

Health Care Tele-medicine, video conferencing, POTS
Security (police, military, and private) POTS, video surveillance
Education POTS, payphones, Distance learning
Banking POTS, IT/Internet,
Services (Government, police, post office) POTS, IT/Internet, radio
Enhanced Services Broadcasting (audio/video) over telecommunications network
General population GSM, POTS, IT/Internet, payphones
Information Systems such as GOVNET Private data networks, paging, and telemetry

Table 5.3. Summary of core technologies that are required to support the systems mentioned in the constrained design, Table 5.2. (A more detailed account is found in Appendix C)

VSAT Radio
Switch (accommodation, power, airconditioner) and data POP
Core transport (fibre and microwave)
Distribution primary - fibre, copper, microwave
Distribution secondary - wireless local loop (WLL), copper, point to point or multipoint, mobile, satellite.
Content Server
Broadcast Transmitter

5.4.2 Unconstrained Idealised Design For The Mapumulo Area

After reviewing the results of the constrained design (in the previous section) in the individual groups the author realised that some of the participants were confused. It was found that in some cases the participants were not too clear between the constrained and unconstrained design. However, after clarifying the various issues, in plenary, the participants felt more competent to review their constrained design and complete the unconstrained design. The participants were asked to focus on two questions while keeping in mind the emergent properties of the RTS. The first question was "What systems pertaining to the RTS would they like to see at Mapumulo, assuming that they could change the containing system?" The changes, if any, in the containing system, i.e. the environment within Telkom SA and the external environment to the rural telecommunications system had to relate to the performance of the system. The second question dealt with the supporting telecommunications infrastructure. The participants were encouraged to study the rich picture and bear in mind that the idea is to leverage the Mapumulo area from its current reality to a chosen idealised design, within the constraints of telecommunications infrastructure. The detailed responses are recorded in Appendix C, Table C3, and a summary of the responses is shown in Table 5.4 and Table 5.5.

Table 5.4. Summary of systems pertaining to the RTS, resulting from the unconstrained design that participants would like to see in the Mapumulo area. (A more detailed account is found in Appendix C).

Health Care Tele-medicine, video conferencing, POTS, IT/Internet, paging, radio
Security (police, military, and private) POTS, video surveillance, radio
Education POTS, payphones, distance learning, tele-education, IT/Internet
Banking POTS, IT/Internet,
Services (Government, police, post office, emergency services) POTS, IT/Internet, radio
Enhanced Services Broadcasting (audio/video) over telecommunications network
General population GSM, POTS, IT/Internet, payphones
Information Systems such as GOVNET Private data networks, paging, and telemetry

Electric power available to all
Wide video surveillance For example for Fire warnings in the sugar cane farms.
Water reticulation to all schools and hospital
Improved roads or access
Library linked to video on demand
Flexible billing Customised packages such as prepaid system for high bandwidth.

Table 5.5. Summary of core technologies that are required to support the systems mentioned in the unconstrained design, shown in Table 5.4. (A more detailed account is found in Appendix C).

Sharing infrastructure with other utilities
Switch (accommodation, power, air conditioner) - ATM POP, DSLAM
Core transport – Fibre/DWDM, Ring redundant
Distribution primary – fibre to the curb, copper/xDSL, microwave to the curb
Distribution secondary - wireless local loop (WLL), copper, point to point or multipoint, mobile, fixed GSM, satellite, xDSL
Content Server for distance learning or entertainment
Broadcast Transmitter

5.4.3 Analysis Of The Constrained And Unconstrained Design

The constrained design from the four groups were very similar, although in the author's opinion, some of the systems should be more appropriately placed in the unconstrained design, such as broadcasting over telecommunications network. There are legal issues constraining this service at the moment. However, there was consensus among the participants that health care, security, education, business, accesses to information systems, and POTS were the key development issues that the telecommunications planners should focus on, if the emerging properties of the RTS at Mapumulo are to be realised. The challenging issues though are designing telecommunication infrastructure systems that will give maximum effect to these systems that lead to development, within the current constraints. The possible telecommunications infrastructures are also shown in Table 5.2, while Table 5.3 lists the possible technologies that could be used to support this infrastructure. The constraints that were identified by the participants included the following:

- Politics seemed to be a strong constraint. This included the politics among the other service providers, politics among local government officials, politics within Telkom SA, and politics at national Government level.
- Closely linked to politics are policy issues. Policy includes issues such as monopoly versus liberalisation, the available frequency spectrum, tariffs, and roll out issues. Policy constraints within Telkom SA also surfaced although they were seen as weak constraints.
- The lack of parallel infrastructure such as electricity supply was regarded as a technological constraint. The availability of electric power would alleviate the need for solar panel that is prone to theft.
- Cost or budgetary constraints.
- It was interesting to note that the lack of knowledge was regarded as a constraint. When asked to clarify, the participants mentioned "all kinds of knowledge" – knowledge about the Mapumulo area, knowledge about the future and knowledge about planning.

There were many similarities between the constrained and unconstrained design. One would expect this to be so because the constrained design could be regarded as a subset of the unconstrained design in many situations. There were also significant differences. According to Ackoff (1993), the power behind the constrained and unconstrained design is that the results show that most of the obstacles between current reality and the idealised vision do not lie in the environment.

Some of the issues or systems mentioned by the participants in the unconstrained design had very little to do with the provision of telecommunications infrastructure, for example, "water reticulation to all schools and hospitals". However it was included in Table 5.4 for two important reasons. First the identification of these issues does reflect holistic thinking, and secondly, one needs to consider whether one can expect any development at all by deploying telecommunications infrastructure if other services such as water reticulation are a basic essential for any development in Mapumulo. It has already been mentioned in this thesis (chapter two) that telecommunications by itself only is hardly a trigger for socio-economic development.

There were two other systems that were mentioned in the unconstrained design but not in the constrained design that are worthy of further comment: An enhanced library system ("library linked to video on demand") and flexible billing (see Table 5.4). The author had the opportunity of visiting the local library in Mapumulo and it has a long way to go in terms of meeting the usual standards of small town libraries in South Africa. As a starter for improvement, the library could be electronically linked to the one that is in much better condition, approximately 50 km away. In addition, the participants suggested the long-term solution of having a central content server and feeding a number of small rural towns in the vicinity of Mapumulo.

One of the major challenges in managing telecommunications service to rural communities is being able to deliver a telephone bill to the appropriate address. Physical addresses and direct postal service are rare in rural areas. Mapumulo is no different. Even when bills are received it is difficult for the service provider to ensure payment. A flexible billing system such as prepaid cards will ameliorate this problem for both POTS and high bandwidth services. It is interesting to note that the GSM service providers (cell phones) have a prepaid system ("pay as you go"), but is not only expensive compared to the fixed line service, it is also more expensive than the usual GSM contract service.

At the level at which the ends planning was implemented, the participants were not required to delve into the configuration of the systems and the technology infrastructure. Therefore the differences between the constrained and unconstrained design with respect to the telecommunications infrastructure subsystem is not explicit. However, there will be major differences when one gets to the level of actual design and deployment. At the end of the discussions on the constrained and unconstrained design, the participants agreed that while there are definite constraints beyond the control of the Telkom planners affecting the deployment of essential telecommunications services in Mapumulo, an appropriate planning system will help achieve much more than what is currently the practice. It must be noted that finding the most appropriate technologies for Mapumulo was not really an issue. The participants mentioned that the real problems are due to softer issues.

A question that kept popping up in the mind of the facilitator towards the end of the constrained design was, whether the Mapumulo community would want some of the telecommunications infrastructure systems mentioned by the Telkom participants. This was the appropriate time to raise two ought mode questions from critical system heuristics: Whose interests ought to be served in the planning of telecommunications for Mapumulo? Who ought to be involved as planners? The response from the participants was as expected, indicating the need for involvement of the Mapumulo community which indicated the beginning of cultural changes in the minds of the present participants from Telkom, who acknowledged that the idealised design would be far more appropriate if the relevant stakeholders were present.

Two final questions were put to the participants: What would the infrastructure look like if it were planned in the usual way? What criteria would be used? These were loaded questions and therefore required far more time than was available. However, the responses boiled down to the infrastructure being rolled out according to the targets set by Government and according to demand. Some participants could not reconcile the fact that Telkom has rolled out massive amounts of infrastructure, with the need for a planning framework or in particular ends planning. The ideas encapsulated in Figure 5.1 resolved the issue.

It is far more beneficial to the rural community to slow the pace of rollout, if necessary, and move towards the ideal RTS than to deploy massive amounts of infrastructure according to traditional planning, moving in an unknown direction. One must note that the ideal design of a rural telecommunication system is just that, ideal, and therefore will not be achieved, but the three pillars of IP, holistic, participative, and continuous planning will ensure that the RTS will move in the ideal direction.

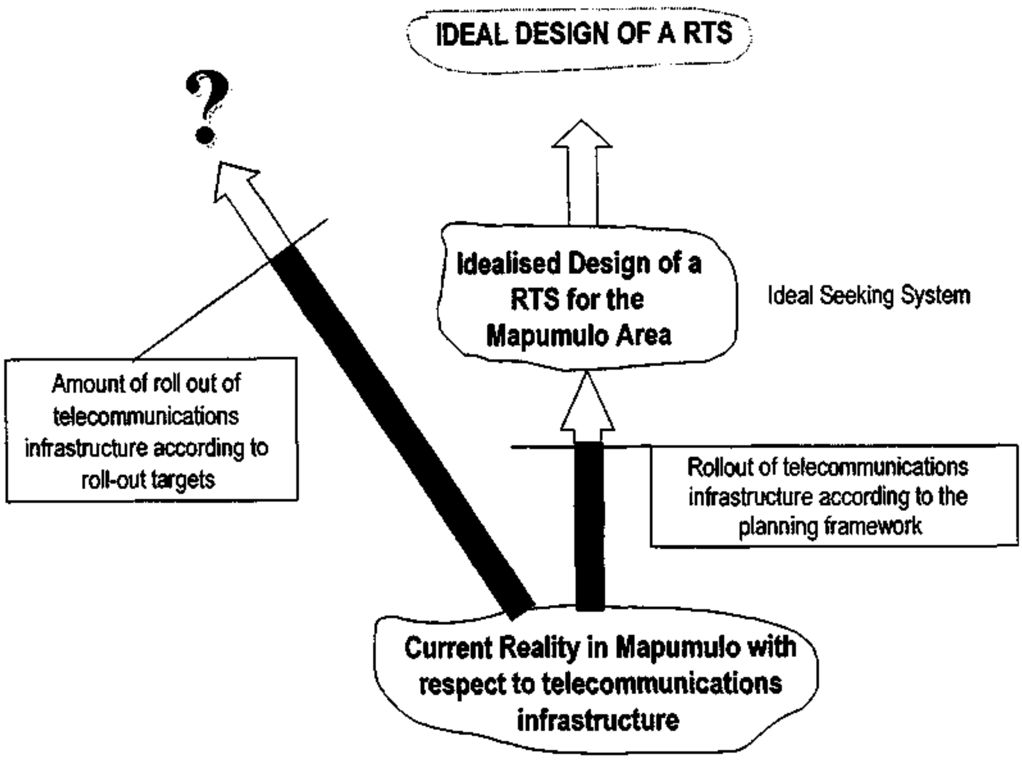

Figure 5.1. Difference in expectations of infrastructure rollout between the application of the framework and the current way of planning

As mentioned before, the facilitator would have preferred to have a broader range of stakeholders identified in the first workshop (see Appendix B, Table B2) to participate in this workshop. However, Telkom SA would not engage, in a workshop with the stakeholders, for the purposes of planning, at least at the time of these workshops, until they have experienced the implementation of the framework. One must take cognisance of the history of Telkom SA, its organisational culture, the negative perceptions about Telkom SA by the general public and the impending liberalisation of the telecommunications network provision in this country. While some of the planners would have welcomed the opportunity to engage in a workshop with the identified stakeholders, this would have been in conflict with current organisational policy. However, a third workshop discussed in the next section aimed at ensuring that the stakeholders was part of the practical implementation of the planning framework, and that their important and necessary contributions were not lost.

5.5 Workshop Three: A Meeting With Stakeholders From The Mapumulo Area

Arranging a stakeholder meeting in the Mapumulo area provided some new challenges. In addition to the protocol that exists within the community regarding the access to key stakeholders, communities in rural areas have become suspicious of 'consultants', for good reason. The fact that the author lacks knowledge of the Zulu language was also an inhibiting factor in setting up the workshop. However, after much negotiation with the Community Relations Department at Telkom SA in Durban, it was agreed that Mr. Vusi Mthethwa, a consultant in 'Regulatory and Government Relations' within Telkom SA, would assist in arranging a meeting of relevant stakeholders in the Mapumulo area. As part of his normal work duties Mr. Vusi Mthethwa liaises with the people in the 'North Coast and surroundings' that include the Mapumulo area, concerning telecommunication issues.

The background and objectives of this research project and the objectives of the intended workshop were explained to Mr. Mthethwa, and the list of stakeholders, as reflected in Table 5.1, that one hoped would be present at the workshop, was forwarded to him. Some dates for the workshop were suggested to Mr. Mthethwa but he explained that in terms of protocol one could not just approach members of the community and suggest dates for a workshop. The correct practice from the point of view of the community would be to first approach the local Chief or Traditional Leader or someone who has the respected and legitimate authority, and then request a date for the workshop.

A preparatory visit was made to the Mapumulo district municipal offices by the author and Mr. Mthethwa, who had already arranged an appointment with the deputy mayor of the Mapumulo Municipality. After meeting with him, and consulting the municipal manager's office the workshop was finally arranged. The key in securing a meeting in the community with relevant stakeholders is to find the most appropriate channels in the community structure, and to convince those responsible of the benefits to the community from such a meeting. Once the proper protocols were followed, the municipal manager's office was keen to set up the workshop. The author was impressed with the logistical arrangements and with the profile of the participants that did finally attend the workshop.

Appendix D, Table D1 provides a profile of the participants that attended the workshop.

Although there were no direct representatives from business, education and traditional leadership when one considers the list of stakeholders mentioned in Table 5.1, the participants did however represent a significant portion of the stakeholder set. Business activity in Mapumulo is relatively very low and it is critically uneconomical for the owners of these businesses to sacrifice a morning at the workshop. The deputy mayor who works very closely with traditional leaders in the area, and some of the participants who had first hand experience and knowledge about education issues and business activities in the area, made up for the lack of direct representation from business, education and the traditional leadership.

The workshop was held at the Ilembe offices of the regional council on the 7th November 2001. This venue was deliberately chosen due to its close proximity to the taxi rank. During the preparations for the workshop the author confirmed the need for an interpreter/translator from English to Zulu and vice versa. A Zulu-speaking colleague of the author, who is also engaged in rural telecommunications research, proved to be the most appropriate person for the task. The workshop was conducted in English and Zulu. Appendix D provides detailed information on the participants of the workshop, the agenda that was followed, and the results of the first round of stakeholder analysis, i.e. the aggregated results of the group work.

Immediately after opening the workshop the representative from the health sector requested some time from the author to discuss, among the participants, an important and urgent issue regarding the outbreak of Anthrax among some of the animals in the area. This was an opportune time to discuss such an important issue, as it is usually difficult to communicate messages or call urgent meetings, due to the lack of infrastructure. This situation was ironical in the sense that the workshop was convened to discuss issues about telecommunications in the area. This delayed the actual workshop by about 20 minutes.

After providing an explanation of the research project, its background, and the main goal, suspicions prevailing among the participants surfaced. Questions pertaining to the final outcome of the workshop in terms of benefits to the community, the choice of the Mapumulo area for the workshop, and the need for the kind of participants that were present, were raised. It was only when the Deputy Mayor responded after some discussion and stated that he supported the workshop and therefore played a role in securing it, did the participants seem to have settled down. Explanations on the objectives of the workshop clarified the issues even further. The following were the objectives of the workshop as presented to the participants: -

- "We want to obtain first hand knowledge and understanding from the Mapumulo stakeholders about development issues in the area."
- "We want to learn about the perceptions of the community regarding telecommunication issues."
- "Does the community have an understanding of all the advantages of telecommunications service or just the plain old telephone service (POTS)?"
- "We want to obtain an idealised design of rural telecommunications for the Mapumulo community."
- "We want to see how the community perceive what Telkom has done in the previous workshops."

5.5.1 A Review Of The Results Of The 'Formulation Of The Mess' Phase Of The Framework With The Local Community

Review On Stakeholder Analysis And The Boundary Judgments Questions

After a contextual overview of the planning framework based on the Mapumulo area, the participants were divided into four groups and were requested to discuss and then list those people or organisations they think are or would be stakeholders of the RTS in Mapumulo. The groups were chosen randomly in order to minimise groupthink, and to ensure that people were given more space to participate. The depth of analysis varied amongst the groups from a relatively comprehensive list of stakeholders to a list that had very little to do with stakeholders, but did contain important information such as "applications were not considered by Telkom" and "they (Telkom) must have a depot here (at Mapumulo)". Table 5.6 is an aggregation of the various efforts.

Following a plenary clarification of the various efforts, the participants were asked to consider the following four 'ought mode' questions based on critical systems heuristics: -

A. Whose interests ought to be served in the planning of telecommunications for Mapumulo?
B. Who ought to be the decision-maker/s?
C. Who ought to be involved as planner/s?
D. Who ought to be witness to the interests of those affected but not involved? That is, who should argue the case of those who cannot speak for themselves but maybe concerned?

The main purpose for these questions was to ascertain whether there were any discrepancies between the responses to these questions and the stakeholder analysis. If the goals of emancipation were to be addressed, then one needs to ensure that relevant stakeholders have a voice.

Table 5.6. Results of the stakeholder analysis undertaken by the Mapumulo community representatives during the telecommunications planning workshop. (Texts in Italics are added by the author.)

Traditional Leaders Amakhosi, Izinduna, Izinduna's Councillors, Ward Councillors
Community Leaders Ward Councillors, Development Committees, Business, Churches
Government Departments Local Authority, District Councils, South African Police Services, etc
Community *Grass roots level*
Other Service Providers *Such as: Eskom, Telkom, and GSM Providers*
Farmers *Includes the subsistence and professional farmers*
Churches *Includes the Kwa Siza Bantu Mission*
Business Owners *Usually SMME*
Non Governmental Organisations and Community based Organisations

In response to the first of the chosen subset of Boundary Judgment Questions, "Whose interest ought to be served?" the participants mentioned:

- The Mapumulo community

- Service and delivery departments in Mapumulo such as the South African Police Services, the health clinic/hospital, schools, the Magistrate's office, and other state departments in the area.
- After some prompting by the author and some discussion, the participants agreed that the interests of the physically challenged in the area, such as the hearing and vision impaired, must also be served. These could be regarded as the silent stakeholders. The author mentioned the availability of the TELDEM telephony system that caters for the hearing impaired.

In response to the second question "Who ought to be the decision makers?" the following responses were received: -

- All the stakeholders
- The Municipality
- Other infrastructure service providers such as the power utility ESKOM.
- The traditional leaders

In response to question three, i.e. "Who ought to be involved as planners?" the participants agreed that it should be the same as those people that are proposed as the decision-makers. In response to question four, i.e. "Who should argue the case of those who cannot speak for themselves but maybe concerned?" the participants believed that it should be a representative from one of the concerned groups.

Analysis Of Responses To The 'Ought Mode' Boundary Judgment Questions

In general, the responses to the ought-mode questions seem to correlate with the results of the stakeholder analysis. However, the participants raised some issues that are noteworthy. In their responses to the first question the participants did not mention the interests of Telkom and the interests of the future generation (silent stakeholders). While it was agreed that the interests of all silent stakeholders must also be included in their responses to the ought-mode questions, they were reserved in their enthusiasm for the interests for Telkom. It is also important to note at this stage that the participants regarded Telkom as *the* telecommunications provider for the area. An interesting conclusion can be drawn from this observation. The participant's worldview is such that they perceive telecommunications service as a developmental right like any other service such as roads or electricity. There was certainly no indication that they expect these services to be free of tariffs, but they did not regard the interests of Telkom SA as being important. It was the author's observation that the participants still regarded Telkom SA as an agent of Government services, and had little idea of the privatisation issues surrounding the telecommunications sector, and the cost implications of providing telecommunications services to Mapumulo. More will be said under the analysis of the rich picture, later in this section.

While the responses to the second ought-mode question may be regarded as enthusiastic, it may pose a problem for decision-making about rural telecommunications services if all stakeholders are regarded as the decision makers. However, the participants mentioned two important points during this session that indicates clearly the rationale behind their suggestions. The first point being the need for integrated development in the Mapumulo area. It was emphasised that other infrastructure providers should be included as part of the decision-makers on rural telecommunications infrastructure provision. Secondly, the need for a 'bottom-up' approach within the community was also emphasised. Permission needs to be obtained from traditional leaders, who oversee large tracts of rural land, for the installation of telecommunications infrastructure. What these points allude to is the need for a systems thinking approach to planning of telecommunications infrastructure for the Mapumulo area. While it is not practical to include all those mentioned as the decision-makers, the author contends that the elements of the planning framework do satisfy the intentions and desires of the stakeholders. The extent to which these intentions and desires are satisfied will depend on the commitment of those charged with the responsibility of planning, to the principles of the framework. The response to question three also supports this position.

A Review On The Rich Picture That Was Developed By The Telkom Participants

The next session of the workshop focussed on the developmental issues in the Mapumulo area, and how could telecommunications help with the development of the community. It was envisaged that this discussion would lead to an analysis of the rich picture developed by Telkom and thereafter inform the idealised design process. The participants were asked to think about the urgent and important development needs in the Mapumulo area with a view to finding out the role of telecommunications in the development of Mapumulo. The following issues were mentioned: -

- Unreliable communications network

- There are parts of the community were there is no infrastructure at all
- The roads are in extremely poor condition.
- For those people that do have electricity, the allocated amperage is insufficient. There is not enough power to supply basic appliances such as a stove.

It was not easy to keep the discussion rolling during this session. The facilitator sensed that this was due to the participants finding it difficult to link development with telecommunications. The facilitator posed some trigger questions based on developmental issues raised by the Telkom planners during the 'ends planning workshop', such as health and security issues. The feasibility of tele-medicine as an example was offered for consideration, but the representative from the health sector felt that there are far more pressing needs than 'fancy technology', such as basic telephone services, clean water and decent roads. This was a general feeling amongst the participants.

This is a significant response from the participants in that it does not only emphasise the need for integrated planning, but it also highlights the importance of planning the telecommunications infrastructure in such a way that it is flexible with respect to services and upgrade of the telecommunications network. One must also bear in mind that, judging from the discussion, most of the participants were not exposed to how telecommunication technology could in fact assist in development of the area. What did become clear during the workshop was that the participants saw enhanced technology services as a luxury. The participants were certainly not against enhanced technology services. They recognised the need for Internet facilities in schools for example, the issue is dealing with the priorities in the area.

During the first two workshops with Telkom SA two key issues, amongst others, were raised: theft of Telkom's hardware and affordability of telephone service. The participants were asked to respond to these issues. The participants seemed surprised at first but then conceded that the theft (of solar panels for example) is carried out by people that do not reside in the Mapumulo area. Some of the participants speculated that these were no ordinary thefts, but are linked to people who have a vested interest in selling more equipment, or the maintenance of the installation. Whatever the facts are, it seems that nobody is addressing the problem of theft. With respect to the issue of affordability, the participants believed that if development were taken seriously in the Mapumulo area then affordability of telecommunications service would not be an issue. There were more issues raised during the analysis of the rich picture (Appendix B, Figure B2.) that the planners from Telkom SA developed.

Following an explanation of rich pictures and an overview of the issues depicted in Appendix B. Figure B2, the participants were asked for their comments. The participants seemed to understand in a relatively short time what this particular rich picture was all about and seemed to relate to most of the issues. However, several issues were raised, although not all of them are directly related to telecommunications.

- The soccer field is still being developed and the participants seemed cynical about its completion. However the metaphor is still valid in that it represents sport and development.
- The Hospital deals mainly with primary health. The health sector representative commented that there is a need for basic infrastructure (including telecommunications) in the hospital.
- All the participants were most displeased with the term "Tribal Chiefs", which was a label coined by the apartheid system and has some uncivilised connotations. The participants gracefully recommended that that be changed to "Amakhosi" (Traditional leaders).
- The participants did not concur with the Telkom planners' perception of crime as a problem in Mapumulo, especially the representative from the South African Police Services. He was quick to raise the question "high crime in comparison to what"? While there are criminal activities present the participants did not think that Mapumulo is a high crime area, at least compared to the nearest town of Stanger.
- The issue of theft of Telkom's hardware was raised once more, and it was mentioned that maybe the contractors are involved, rather than members of the community. The participants felt strongly that one cannot generalise the crime issue, and it is the lack of consultation that leads to the wrong perceptions.
- On the issue of subsistence farmers, the agriculture representative mentioned that Mapumulo does not receive any Government subsidy, whereas the commercial farmers do. At least, he felt that there should be some skills training from Government.

- The service station shown in the rich picture is not in Mapumulo, according to the participants. It is on the main highway leading to Mapumulo. However, one must note that in terms of telecommunications network planning the planners consider an exchange area rather than just the Mapumulo community or village.
- According to the participants, the government buildings including the South African Police Services and Correctional Services do not have enough telephones. The representative from correctional services mentioned that they have been waiting for five years for more telephones. The lack of telephones is not necessarily due to Telkom's planning, but could also be attributed to Government's limitation on the budget. This needs to be investigated further.
- When asked if there is anything else that they would like to add to the rich picture, some of the participants mentioned the lack of a mortuary. Apparently the facility at the clinic/hospital is inadequate. Although this is not really a telecommunications issue, it is nevertheless a development issue especially when one considers the high death rate due to HIV-AIDS and the importance that the communities attach to their ancestors and the deceased.

5.5.2 A Review Of Ends Planning With The Local Community

The final phase of the workshop focussed on aspects of idealised design for the Mapumulo area. It was intended (see agenda in Appendix D) to attempt both the constrained and unconstrained design, but the author's assessment of the situation dictated that the process be simplified. It became evident during the workshop that the participants had little knowledge of telecommunications systems and how this can help to stimulate development. The discussion therefore did not include a constrained design and possible telecommunications infrastructure. Instead, the participants were asked to make the assumption that unlimited resources were available and suggest ways of improving the Mapumulo area, with respect to systems that are linked to telecommunications. As a way of moving the discussion forward, the participants were asked to comment on some of the results of the idealised design produced by the Telkom planners (see Appendix C). There were some significant differences in the views of Telkom and the workshop participants and these will be discussed at the end of this section in the summary of the workshop. The participants made the following comments: -

- The participants stressed the need for more direct consultation with the community. They regarded this as the highest priority in any planning and stated categorically that one cannot determine the needs of the community without direct consultation.
- Education and health were regarded as equally important and should be given a high priority.
- Although the participants regarded Mapumulo as a relatively low crime area, they did mention that security was a very important issue as far as development was concerned. It was also mentioned that security issues impact on consultation in that people would not attend consultation meetings if they did not feel secure.
- It was also mentioned that when people in the community do witness criminal activities, they could not report the incident quickly enough due to lack of telecommunications service. It was suggested that there should be more public telephone facilities with toll-free numbers.
- Continuing on the issue of security the participants mentioned that the community should not rely on the South African Police Services, but rather the community as a whole should be involved in security. The idea of the 'community policing forum' (CPF) was suggested and as a starter all the Ward Councillors and Community Leaders should be 'connected'.

5.5.3 Evaluation Of The Third Workshop

The workshop concluded with an evaluation of the morning's proceedings and was designed in such a way that one would be able to ascertain the benefits accrued to the participants, and to the framework, or indirectly the emerging properties of the RTS in Mapumulo. The evaluation focussed on two issues. Firstly, the impact of the workshop on the participants' understanding of the various issues that complicates the provision of telecommunications to the Mapumulo area, and the interdependence between telecommunications and the improvement of other services such as health and education. This will also determine the integrity of the participant's contributions during the workshop, for if the workshop left the participants confused then the validity of their contributions is questionable.

Secondly it was important to ascertain the opinions of the participants on the potential of such a workshop to contribute towards better telecommunications infrastructure and consequently improved development for Mapumulo. This will have a direct bearing on the appropriateness of the framework and the methods and techniques used in the workshop. One must note once again the profile of the participants (see Appendix D). Almost all of the participants hold responsible office and have first hand knowledge of the Mapumulo area. Their assessment of the workshop therefore will be significant.

In searching for an appropriate technique for the evaluation that will be simple to administer in a short space of time, easy to understand by the participants, reflect the views of each participants, and provide an avenue for clarification of responses to the evaluation, an evaluation instrument from Senge *et al* (1994: 400) was adapted for the workshop. Graph D1 and Graph D2 in Appendix D depict the final results of the evaluation. The instrument consisted of a question on an issue with answers on a seven point Lickert-type scale. The participants were asked to choose a number by secret ballot that reflected their assessment. The responses were then tallied on to a flip chart with assistance from one of the team members. According to Rick Ross in his paper published in Senge *et al* (1994), "any score less than four is bad news because people feel more harshly than they would say". He recommends that people should be given an opportunity to explain why they voted below four.

With respect to the first issue in the evaluation, the participants were asked to respond to the statement: "This workshop has improved my understanding of telecommunication issues in Mapumulo". The seven-point scale went from "no improvement in understanding at all" to "great improvement in understanding". The responses are shown in Appendix D, Graph D1. Although one of the participants scored a one and two participants scored a three, the overall results reflect a significant improvement in understanding among the participants. The facilitator asked if those who voted below four would like to explain their assessment. There was no response. In the author's opinion, the score of one could be due to a misunderstanding of the evaluation or a misinterpretation of the value attached to the number one. It seems unlikely that this participant did not benefit from the workshop at all judging from the results to the next question.

For the second issue the participants were asked to respond to "I think a workshop like this can help provide better telecommunications for Mapumulo and greater development for the community". The seven-point scale went from "this workshop won't make any difference at all" to "this workshop can make a major difference". The results as shown in Appendix D, Graph D2, suggest that a workshop such as this is vital for the planning of telecommunications infrastructure for Mapumulo. It is interesting to note that none of the participants scored below four. It was not feasible to evaluate specific techniques used during the workshop because these were not made explicit in its implementation; however, this opinion was formed apparently by the combination of techniques used.

5.6 Some Overall Remarks On The First Three Workshops

In summing up the trial implementation of the framework thus far, three workshops were held. In the first workshop, the Telkom planners attempted the formulation of the mess with respect to the provision of telecommunications infrastructure for the Mapumulo area. The second workshop, also with the Telkom planners focussed on the ends planning, in particular the constrained and unconstrained design. The purpose of the third workshop with relevant stakeholders from Mapumulo was to gauge their responses to the outputs of the first two workshops. The author would have preferred to have all the stakeholders present in the second workshop as suggested in the planning framework, but this did not materialise, for reasons already mentioned. However, it has been shown in practice that the alternative solution provided through the third workshop did reveal useful knowledge for this planning problem. Much of the results of the workshops have already been covered. The intention of this section is to tie-up some loose ends and to provide further overall perspectives on the process thus far in the context of the principles of the framework.

This was a relatively not too complex case study concerning the constraints of time and cost and it was relevant for the purpose of testing the validity and legitimacy of the framework. It is difficult to predict in advance how long it will take, or how many workshops are required to obtain the best possible results as these depend of the learning achieved in individual workshops. This is due to the fact that the proposed approach is also a learning framework, designed to cater for the varying complexity in telecommunications planning among the different rural settings. Planning is also an iterative process and it is expected that the proposed planning framework itself and its usability will improve with time and further implementations. Some significant conclusions can now be drawn from the case study thus far.

In comparison to the traditional way of planning rural telecommunications infrastructure, which is characterised by the 'predict and prepare' and optimisation paradigm, the suggested planning framework calls for a culture change amongst the telecommunications network operators and planners. It was encouraging to note in the implementation of the framework that the participants, many of who are Telkom planners, were eager to learn and change their worldviews. There are two possible reasons for this.

Firstly, there is a realisation and acceptance that the provision of telecommunications infrastructure to rural areas in KwaZulu Natal is not simply a technological problem. This is evidenced by the stakeholder analysis and the rich picture. It is a complex messy societal problem and there is something radically wrong with the current way of planning. Despite the 'massive rollout of infrastructure' according to Government imperatives, there is a high churn rate and the development amongst the communities is perceived to be below expectations. In other words the emerging properties of the RTS is hardly evident.

Secondly, since the democratisation of the governance structures in South Africa, it has become almost mandatory and sometimes fashionable to engage in prior consultation with the communities that one intends serving, in the name of legitimacy. The author suggests that a key to legitimate practice is to apply a systems approach. Then boundary considerations in terms of the planning framework will mean that the planners engage in deep consultations with the community that they want to serve with the telecommunications infrastructure. The Telkom planners are looking for a process that will empower them for such practice. The fact that they did not want to initially engage with the Mapumulo community is understandable considering the internal practices of the organisation. Currently there are specific portfolios that deal with the community and this practice isolates the planners from direct contact with the community. However, a genuine change process is a learning process, and the planning framework has facilitated deep learning within the telecommunications service provider. During the implementation of the framework the Telkom planners were able to learn that the systems approach to planning, can ensure that both the telecommunications operator and the stakeholders of the RTS benefit from the infrastructure. It is the quality of the planning that matters rather than the speed and amount of infrastructure that is rolled out.

There were also other significant observations from the workshop with the Mapumulo community representatives than that already mentioned. Working with stakeholders whose spoken language is not the same as the planners' (i.e. English) is a challenge. For the case study the author used a colleague as an interpreter. While this is not the best solution it did suffice for the purposes of the workshop. A long-term solution is perhaps training the current planners in the relevant languages or hiring planners that can cope with the relevant language. The community liaison persons are usually well versed with the local language, but they may not have the necessary telecommunications knowledge, as was evident in the case study, that is required for a meaningful engagement with the stakeholders. Besides, the author suggests that it is vital for the planners to have first hand knowledge about the community dynamics that is prevalent in the rural area that they want to service.

Also evident in the case study was the lack of knowledge pertaining to the advantages of telecommunications among the community representatives. This is to be expected and this was evidenced by the difference in technological systems that was suggested by the community and the Telkom planners. These are people that have never been exposed to the full spectrum of telecommunications services and its impact on development. One did not also have this knowledge in the early days of the telephone invention. The relevant actors, including the planners must responsibly develop this knowledge and the demand for services, otherwise the community will think only in terms of POTS or basic services. While there is nothing wrong with this, the full potential of telecommunications services to impact development and provide benefits to the operator as well will not be realised.

The implementation of the framework thus far has generated significant knowledge and provided a much clearer picture of the mess that the planners has to deal with in the deployment of telecommunications infrastructure for the Mapumulo area. The last part of the framework focuses more on the operational issues of planning, i.e. the means and resources required to move from the current reality towards the idealised design, and how does one now deploy the infrastructure such that the idealised design gives effect to the emerging properties of the RTS. The author is not suggesting that no learning will take place during this phase. To the contrary, ISM/IM is also conducive to learning. However, the emphasis in this part of the framework is on the functionalist's aspects of the planning. ISM/IM was chosen as the appropriate methodology to deal with the complexity inherent in this final phase because it provides focused guidance towards reaching the planning goals. This is discussed in the next section.

5.7 Workshop Four: Trial Implementation Of The Leverage Phase Of The Planning Framework With Rural Telecommunications Planners

5.7.1 The Purpose Of The Fourth Workshop

The leverage phase of the planning framework deals with issues pertaining to the means and resources required to move a particular rural area from its current reality, with respect to rural telecommunications, to its idealised design, and the implementation and control of the plan. The framework recommends that ISM (Warfield, 1976) which is part of the methodology of IM (Warfield and Cárdenas, 1994), and current systems engineering processes be used in the leverage phase. The final operational aspects such as the final technology design and deployment and commissioning of the network that are used by the network operator, are based on Systems Engineering and project management principles and are well tried and tested. This workshop therefore only dealt with those leverage aspects that were needed to achieve the idealised design, only at a level where the knowledge generated thus far with respect to the idealised design, and the complex issues inherent in the mess was structured in such a way that the planners could move towards technology engineering, and the design of other human activity systems, using current techniques (refer also to section 1.3 'Scope, Assumptions and Delimitation of the Research'). In this workshop only the means planning was done using ISM. This was sufficient to demonstrate the suitability and power of ISM in dealing with the leverage phase.

The workshop was planned in line with the recommendations of, and held in a setting conducive to IM. The author requested from Telkom SA the presence of approximately ten people that are deeply involved in telecommunications planning for rural areas. The area manager for Regional Integrated Network Planning and the area manager for Technology Engineering assisted in the identification of these participants (henceforth also referred to as planners). The final list of seven that did attend the workshop is shown in Appendix E, Table E1. Also reflected in Appendix E is the workshop agenda (DOC E1).

The workshop commenced with a review of the goals of the research and the planning framework. Thereafter the important issues that emerged from the previous three workshops such as the rich pictures and idealised design were discussed. More emphasis was placed on feedback from the Mapumulo workshop, which the author provided. The stakeholder analysis and the issues relating to the idealised design that emerged during the Mapumulo workshop, as discussed in the previous sections, were part of the handouts given to the participants (Appendix E, DOC E2). It was interesting to note that the planners did not argue against or defend any particular position, but rather concentrated on listening to 'the other side' and learning. Their response to the community's perception of Telkom SA is noteworthy: The planners understood the perceptions and expectations of the community that Telkom SA is a parastatal and therefore should provide services in a similar fashion to the other service providers such as those that are responsible for power and roads. There was general agreement that this issue has to be addressed if the emerging properties of the rural telecommunications are to be realised. The means planning which is discussed below shall clarify these issues further.

5.7.2 The Use Of Interpretative Structural Modelling For The Means Planning

An overview of ISM was given in section A.3.7 in Appendix A of this thesis. In a nutshell ISM was chosen as a method for the leverage phase because of its ability to use Relational Theory to structure any knowledge generated in an inquiry and unpack chosen elements of a mess into a suitable structure for implementation of the system of concern in the real world. The key rationale for the choice of ISM is its ability to deconstruct or structure elements maintaining the relationships between these elements. In other words maintaining a certain level of systemicity. Of course one is not able to consider, for the purposes of practical implementation, all elements with all of the relationships among them in a complex system of concern. However, ISM does offer a wide range of relationships and representation systems that one could choose from to facilitate holistic decision-making.

There are three basic stages in the idealised design process, selection of a mission, specification of the desired properties of the design and idealised design of the system (Ackoff, 1981). Very often the ends planning in IP become the means planning or the means planning often refines and enhances the ends planning (Midgley, August 2001, pers. comm.*). This was the experience in this intervention and therefore one would find some iteration between the ends planning and means planning. IP was originally intended for corporations, and therefore it can be expected that different applications will need different approaches within the philosophy of IP. A mission statement might seem out of context in this case study, however, the purpose of the Mapumulo RTS is defined to be the development of that community, so the following mission statement was suggested to the planners as a way forward to the means planning:

> "The deployment of telecommunications infrastructure to the Mapumulo area to support the human activity systems, such as the health, education and security, that were identified by the stakeholders for the sustained development of the community".

The planners accepted this statement but suggested that the word 'telecommunications' be replaced with 'communications'. The planners also accepted the fact that 'sustained development' implied return on investment for the network operator and therefore this mission statement was consistent with the emerging properties of the RTS, i.e. benefits to *all* stakeholders.

This mission statement set the stage for a deeper reflection on the ends planning done thus far so that the various issues that surfaced during the Telkom workshops and the Mapumulo workshops could be clarified, especially with respect to whom the planning ought to serve. There was agreement amongst the planners that the properties of the idealised design or ideal RTS are encapsulated in the emerging properties of the system, i.e. benefits to all stakeholders, and therefore the means planning must seek to reflect this. A summary of the issues that surfaced with the Telkom participants during the previous workshops, and at the Mapumulo workshop is shown at the end of Appendix E, DOC E2, and this was used to launch the interpretive structural modelling for the means planning in the leverage phase.

The Windows version of the ISM software, which was obtained from Dr. John Warfield, was used for the ISM session. In this session the planners had to seek an accommodation between the Telkom design and the Mapumulo design in the context of the mission

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statement and find ways (means) of moving the current reality to the accommodated idealised design. This is a complex task that was made simpler by the ISM process. The planners were requested to brainstorm the following triggering question required by the ISM process/software to start the process (refer to Appendix E, DOC E3): -

> "In the context of the mission statement and the key property of the ideal system being 'benefits to all stakeholders', what are the means that are needed to move Mapumulo from its current RTS to its idealised design, with respect to telecommunications infrastructure?"

Each means (element) was fed into the computer and the software catered for further clarification of each input if required. A total of 21 means were accumulated, as shown in Appendix E, DOC E3. Usually the facilitator would use the Nominal Group Technique or DELPHI (Delbecq *et al.*, 1975), as prescribed by the interactive management process to rank the elements if there was a large number. This was not necessary in this case as it was decided that the generated list of elements (means) is plausible and sufficient for the purposes of the case study in that if the means were implemented, the resulting RTS will be a reflection of the idealised design.

Although the process was relatively simple thus far, the planners were intrigued with the results. These were quite different to the traditional technology or network systems that would have emerged through the traditional approach. The set of means generated, covers both technological systems and soft systems such as "provide education about Telkom as a network provider". The next cognitive barrier was making sense of the set of means so that the planners could move closer towards implementation. ISM offers various structural relationships and the first one chosen was the categorising of the elements. With the aid of the software the planners were requested to consider the following categorising relationship in the context of telecommunications infrastructure deployment:

> "Are element A and element B in the same category"?

The following question, as an example, is then posed to the planners, with the aid of the computer: -

> "In the context of telecommunications infrastructure deployment are 'provision of broadband services for the health sector' (element 1) and 'provide more payphones' (element 18) in the same category"?

The participants were asked to deliberate this question and in this particular case the response was 'no'. All elements in the means set were considered in this fashion and the results are detailed in Appendix E, DOC E4. In summary the 21 elements/means were finally categorised and labelled as follows: -

A. Digital services

B. Security and surveillance

D. Parallel infrastructure

E. Billing system

F. Community relations

G. Social responsibility

H. Universal service

At first there were eight categories A to H. After reviewing the results the planners combined category C into A and therefore category C is not shown in the list. It must be emphasised that the essence of the last process is not the mechanical categorising of the elements but the learning that takes place while discussing each question that the computer poses. Therefore the cognitive burden was further reduced through the discussions that took place and by the final category sets. Appendix E, DOC E5 shows the list of all the comparisons that were made among the elements that generated the above categories. From a management point of view one has various options in dealing with the above categories, such as allocating the categories as portfolios to the planners, however this was not the focus of this exercise.

Finally the planners then chose to structure the elements according to the relationship: -

In the context of the development of the Mapumulo community "Is element A more important than element B"?

The cognitive burden was further reduced by the discussing that took place during the individual comparison of means and the prioritising in terms of their significance to the development of the Mapumulo community. A 'stage set' format was requested from the software and the final structure is shown in Appendix E, DOC E6. Appendix E, DOC E7 shows the results for the individual structuring of the elements. The stage set could be further expressed in terms of Figure 5.2 for more clarity. The numbers represent the respective elements of the means set and the arrows represent the relationship 'more important than'. For example, element 9 ('investigate the availability and quality of roads') and element 14 ('devise a system for including other service providers in the decision making process') influence each other (cyclic) and therefore are placed in the same box. According to the diagram these two elements are more important than element 4 ('broadband services for banking and e-commerce').

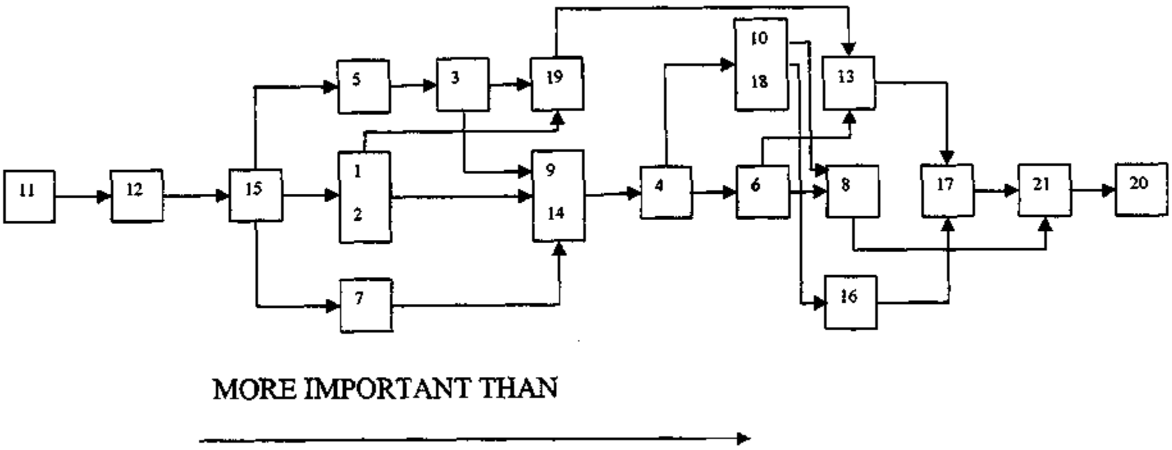

Figure 5.2, Graphical representation of priority structure of the means plan for the Mapumulo area. The numbers represent the means (refer to Appendix E, DOC E6)

Through advances in decision support software, decision making for the allocation of resources such as finance and technology is now a much simpler process. In fact ISM could be used even further to obtain a resource allocation plan and an implementation plan, amongst other things. There was no need to engage in these exercises because the ISM/IM process had sufficiently been experienced, and its power in dealing with complexity has been verified. The planners also agreed that the ISM/IM outputs thus far made it conducive for the use of some of the well-tested Systems Engineering and project management techniques in taking the process further towards design, commissioning and control.

The workshop ended with an evaluation of the Telkom workshops that were held and the planning framework, by the Telkom planners. It must be noted that it was only after the ISM sessions that the planners could finally appreciate the impact of a systems thinking approach to the planning of rural telecommunications infrastructure. They were able to see for example, how one could finally generate a plan in the absence of reliable tele-traffic demand forecasting.

5.8 Evaluation of the Rural Telecommunications Planning Framework and Workshops held with Telkom SA Planners

The experimental validation of the planning framework was conducted over four workshops, three were held with the Telkom planners and one with the stakeholders from the Mapumulo area. An evaluation of the Mapumulo workshop, and implicitly parts of the framework (the formulation of the mess and the ends planning), by the participants was already discussed in section 5.5.3. In preparation for the workshops with the Telkom planners the author decided that an evaluation of the workshops and more explicitly the framework itself, by the planners, would only be sought once the author felt that the planners were in a position to gauge the framework holistically. An evaluation of the workshops/framework by the planners was therefore conducted at the end of the last workshop.

The purpose of the evaluation was fourfold: -

- To gauge the potential of the framework regarding the generation of relevant knowledge and the promotion of learning among the planners.
- To gauge the user-friendliness and the power of the methods and techniques within the framework to expose and understand relevant issues.
- To gauge the adaptability of the framework into current planning practice.
- To compare the framework with current planning practice with respect to the promotion of development within the rural community.

Six questions were formulated around the above purposes. A seven-point Lickert scale was used to gauge the individual responses to the questions. Appendix F shows the questions that were formulated and the tabulation of the individual responses by the seven participants to these questions (Appendix F, Table F1). The respondents were those that were present in the fourth workshop as reflected in Appendix E. The scores shall now be analysed according to the individual questions (refer to Appendix F).

Question 1: Did the workshop/s widen your knowledge of the issues involved in rural telecommunications planning?

The Lickert scale used to categorise the answers ranged from 'totally confused' to ' great understanding'. Five of the planners responded with a score of six, and the other two responded with a score of five. This suggests that the workshops brought about a significant improvement in the understanding of rural telecommunications issues among the planners.

Question 2: Did you find the techniques/methods used in the framework, such as rich pictures and the idealised design easy to understand?

This Lickert scale ranged from 'extremely difficult' to 'extremely easy'. The scores ranged from four to seven. A score of four was specified as 'moderately acceptable'. An analysis of the scores suggests that the planners were able to grasp the methods and techniques in the framework without any significant difficulty.

Question 3: How did you find the techniques/methods used in the framework, such as rich pictures and idealised design with respect to their power in highlighting or exposing relevant issues?

The Lickert scale was chosen to range from 'total waste of time' to 'extremely powerful'. The scores tend to aggregate towards a six, which confirms the power of the techniques and methods in the framework in surfacing complex issues.

In contemplating the responses to the above three questions, the author suggests that the responses are consistent i.e. there is no contradiction between the responses in terms of the intensity of the scores. In general it was the simplicity of the techniques and methods used from the framework in the workshops, and their power in exposing and structuring complex issues, that facilitated the extent of the learning among the planners. Therefore one can conclude that the user-friendliness and the potential of the framework to deal with complex issues have been established.

Question 4: If the conditions were appropriate for the use of such a systemic planning framework i.e. if Telkom put in place the necessary conditions and resources for the use of the framework, do you think it could improve the current planning process with respect to better results?

The Lickert scale ranged from 'it will have a negative impact' to 'great improvement'.

Four of the planners felt that the framework could bring about a great improvement and therefore scored a seven. The other three ranged between five and six. This result is significant in that the responses also indicate an acknowledgement that the current planning processes are far from desirable and consequently there is a need for a planning framework such as the one implemented during the workshops. These results demonstrate the acceptance of the framework by the infrastructure planners and together with the responses of the community stakeholders in the third workshop they show the experimental proof of the legitimacy of the framework.

Question 5: How easy will it be to adapt or merge the planning framework with some of the current processes that you use in planning rural telecommunications infrastructure?

The Lickert scale ranged from 'impossible' to 'extremely easy'. This question had a diverse set of responses. Three of the planners responded with a three, two responded with a seven, and the others responded with a five and a six. It is therefore difficult to draw any significant conclusions from these responses. It would have helped if one could match the score to the planner but this was an anonymous assessment. However some remarks are still pertinent.

As mentioned in chapter two of this thesis, the current planning practices relates to a more functionalist paradigm and so the current processes in the planning centres around a predict and prepare approach. Therefore while the responses in question four highlights the need for this framework, the acceptance of this framework into their current practice calls for a paradigm shift among the decision makers. As a start, the acceptance of the framework may mean a restructuring of the planning department. However, it is the author's experience and knowledge that some of the current systems engineering practice will enhance parts of the leverage phase of the planning framework. In general, the responses to question five suggest that it will be moderately easy to merge the framework into current practice.

Question 6: With respect to planning rural telecommunications in South Africa with the primary intention of triggering development in that area, how would you rate the planning framework compared to the current approaches in planning?

This question is most significant in that it was the need to have a primary focus on the development of the community in the planning of rural telecommunications for that community that led to this research. The planning framework was therefore developed with the intention of addressing many of the deficiencies inherent in current practice, especially with respect to development. The Lickert scale ranged from 'the current planning methods will ensure greater development' to 'the planning framework has a greater chance than current practice of triggering development'. The scores ranged from five to seven. Not only did all the planners feel that the planning framework is better than the current approach with respect to triggering development, three of the planners scored a seven, and one scored a six, suggesting the potential contribution of the framework towards a genuine improvement on current practice with respect to achieving the goals of development.

It must also be noted that throughout the workshops with the Telkom participants there was a general feeling of initial pessimism towards the possibility of ever realising the successful deployment of telecommunications infrastructure in terms of the goals of development. This is due to their experience over the last two years where there was a high churn rate of access lines and little change in the respective rural areas with respect to development. The author therefore suggests that the responses to question six, especially the three fives are perhaps more conservative than needs be, due to this pessimism.

The following informal comments made by the planners that were present in the fourth workshop further enhance the positive formal responses regarding the potential of the planning framework: -

- A general comment among the planners was that the whole exposure of, and participation in the trial implementation of the framework, was a tremendous learning experience for themselves.
- The area manager of the Regional Network Integrated Planning mentioned that one is able to train an artisan, for example, to perfect a skill, but in his experience one cannot say that one has perfected the art of planning. As soon as one acquires knowledge that allows them to be regarded as a specialist (in planning), the environment changes and one has to sometimes start all over again. These workshops and the framework have given the planners new insight into planning.
- One senior planner mentioned that she has been working on a project and that she will now have to make some important changes to this project as a result of the workshop,

the following day.

- The comment at the close of the workshop that this planning framework should have been available before the start of the massive rollout of networks to meet government's imperatives was supported by most of the planners.

5.9 Reflections On The Case Study And Some Lessons Learned

The output itself of this research could be regarded as a systemic intervention into the problem situation of providing telecommunications infrastructure to rural communities. There are two fundamental but related aspects to this intervention: The infrastructure planners and the planning situation, and the development of the rural community itself as a spin off from the RTI. Attention will be focussed on these two aspects. In the previous chapter it was mentioned that the planning framework is essentially a soft systems framework and that learning is fundamental if the framework is to be regarded as useful. This section can be regarded as a conclusion of the practical validation of the framework with respect to its learning objectives. Although some learning outcomes were already mentioned in the sections covering the different workshops, this section shall consolidate all of these with the intention of providing a more in depth discussion on the learning that was achieved, and related issues.

In dealing with methodological pluralism in a systemic intervention Midgley (2000) presents a model for critical reflection when learning about methodology and methods. The model pays attention to three challenges to methodological pluralism raised by Mingers and Brocklesby (1996): paradigm incommensurability, the cultural problem, and the psychological problem. Midgley points out that learning is a process over time and increases with practice and therefore stresses that his model is an ideal learning practice, meaning that one should at least aim towards this practice. The model consists of several layers, one of which is "reflections on practice" that emphasises the importance of feedback from practice to methodology. The author shall now attempt to reflect on the way the various components (methods and techniques) of the framework worked together (or did not) in the case study. This will serve two related purposes: The following analysis exploring the learning that took place provides a basis for validation of the proposed approach for planning of RTI as a soft learning framework. It will also outline possibilities for the further refinement of the framework in future implementations.

The first issue, that of paradigm incommensurability was discussed earlier in the thesis in chapter four and will not be treated in detail here. In keeping with the position taken in this thesis it was demonstrated in the case study how the softer issues raised during the formulation of the mess stage were interpreted and allowed to inform the harder issues in planning during the leverage phase. In attempting to address the psychological problem Midgley (2000) emphasises the importance of learning over time, starting from whatever knowledge the intervener/s have at the start of the intervention. Little is said in the same source about the cultural problem but an important point raised is that cultural acceptance is related to whether or not methodological pluralism is perceived as adding value to the intervention. In the case study the author facilitated the workshops with the RTI planners. With respect to the psychological (and perhaps cultural) barriers to multi-paradigm multimethodology the consultations and seminars held with the RTI planners over a period of 18 months served as part of the education/learning process that contributed to their acceptance of methodological pluralism. In addition, the responses to the questionnaires as discussed in the previous section, and the general responses mentioned in the discussions of the workshops, all demonstrate further the tendency of the RTI planners towards methodological pluralism. The following discussion shall deal with more specific issues.

The first reflection is about the fact that the complexity of rural telecommunications infrastructure planning demonstrated the need to apply a mix of methods following critical systems thinking principles and along the lines of its recently proposed strand of multimethodology (see Mingers and Gill, 1997). The implementation justified the need to provide a planning framework promoting rural development based on critical systems thinking because of its emancipatory nature. The mixing of methods was based on another principle of critical systems thinking, related to acknowledging awareness of methodological pluralism. The methods chosen here were each contributing according to their strengths to the framework for planning of RTI suggested here. The facilitator felt that the participants in the workshops considered as natural the links between the various stages of the planning framework no matter that they employed techniques from different paradigms.

The chosen dominant systems methodology of IP proved to be an appropriate systemic guide to the planning process. Despite the number of workshops with their various activities the methodology of IP kept the processes intact and connected. It paved the way for moving from an initial situation of uncertainty, characterised by a system of problems to a stage where the complexity was managed to the extent of facilitating appropriate action for the purposes of appropriate RTI deployment. Of course, the mixing of methods and techniques within this dominant methodology was vital for achieving this goal. One of the practical advantages was that the workshops could be arranged around the different phases of IP. This is an advantage because the formulation of the mess workshop for example may be regarded as an intervention in itself, and the learning that took place among the planners during this stage influenced their activities in the rest of the planning phases. The author suggests that one of the enabling factors that led to results at this phase of planning was the defocus on the technology issues. In particular, the concept of the RTS (figure 3.2), which was presented to the planners for consideration, helped to focus their minds on the other subsystems of the RTS.

The stakeholder analysis further enabled the planners to delve deeper into the RTS. Although the original intention of the stakeholder analysis was to identify who should be involved in the rest of the planning, it served as a means of boundary critique in terms of the extent of the systems of concern and the complexity of the problem. The range of stakeholders identified together with the 'non-personified stakeholders' (and the rich pictures) suggest that the idea of rural telecommunications planning as really planning for a complex socio-technical system was becoming evident. One must assess this in the light of the fact that most of the planners came from a technology planning background.

The categorisation of the stakeholders into standard, fiduciary, and silent was carried out (see Appendix B). Initially there was some confusion amongst the participants over what these categories meant and therefore the inconsistencies with the categorisation amongst the group. In retrospect it would have been useful to first engage the planners in a simple listing of relevant stakeholders and then compared this to the 'categorising technique'. This would have established the practical importance of this technique, although it is theoretically justified (chapter four). In Section 5.3.1 it is mentioned that the reflections on the boundary questions in relation to the stakeholders identified did not produce any changes to the list. Although the experience (due to their continuous exposure in the past 18 months to the development of this framework) of the planners is sited as a possible reason, the author wonders whether the categorisation of stakeholders served the same purposes as the boundary questions. This needs to be investigated further as the framework is refined in practice. If this is the case then the inclination would be to retain the boundary questions rather, due to the emancipatory connotations. In the workshop with the Mapumulo community the categorisation technique was not used but a subset of the boundary judgment questions were used to ensure comprehensive thinking with respect to the relevant stakeholders. The results were encouraging as indicated by the stakeholder list in Table 5.6. This further highlights the power of the boundary questions and is perhaps an indication that the techniques used in the formulation of the mess could be restricted to the boundary questions for the stakeholder analysis, and the rich pictures.

The rich pictures generated did include many perspectives on the problem situation. This could also be attributed to the comprehensive stakeholder analysis. The idea of working in smaller groups when developing the rich pictures seemed to be a fruitful one in that both, during the development and the report back session there was an opportunity for the planners to learn not only about the technique of rich pictures but also make a deeper contribution to the formulation of the mess. Judging by the rich pictures generated and the general comments by the planners mentioned in section 5.3.1 one can conclude that the techniques in this phase, in particular the exposure to the RTS, the stakeholder analysis, and the rich picture complemented each other towards providing an output that would facilitate the next phases of the framework, and at the same time facilitated significant learning among the participants. There is a particular significant role that the rich picture played in this case study. It represented a fairly deep and accurate picture of the worldview of the Telkom planners to the Mapumulo participants. Although it would have been more desirable for joint participation in all workshops, the rich picture did facilitate a thorough interrogation of the Telkom planners' vision from the point of view of the Mapumulo stakeholders, represented by the facilitator.

It has been stated in the previous chapter that IP does not provide a method/technique in the formulation of the mess stage that is suitable to the problem at hand. However, the mixing of the mentioned techniques to produce the formulation of the mess during this part of the intervention certainly enhanced the IP methodology.

The general thrust of the next phase of the workshop, ends planning, followed the idealised design as recommended by Ackoff (1981, 1993). It included the constrained and unconstrained idealised design. The framework recommended conceptual modelling from SSM as a technique for moving this phase forward. Although the technique was not followed explicitly, several potential relevant systems were identified. This was despite the confusion with the constrained and unconstrained idealised design. One of the reasons for using this technique here was to ensure that the planners did not fall into a traditional way of thinking citing excuses such as security, lack of payment, and policy for a restricted number of relevant systems. In retrospect, identifying systems on the criteria of technological feasibility and operational viability with due consideration to the issues raised in the rich picture would have been just as effective and simpler. An important point to consider is that at this stage the relevant systems must be separated from the dedicated technology that would support these systems, otherwise one falls into the trap of letting one's preference to a certain kind of technology bias the choice of relevant systems. The results indicate a deep focus on services rather than the technology (although the community had their own views on some of the proposed services in the follow up workshop) Once again, the continual consultation with the planners during this research probably alerted some of the participants to the intentions of the framework and stimulated them towards a more holistic thinking. Therefore, in the light of the nature of the relevant systems identified CSH was not necessary in this case.

In the application of IM during the leverage phase of the planning it was found that some of the techniques in IM would have been also conducive to the ends planning phase. However, this is valid only if the participants come from the planning ranks of the telecommunications network provider. It is expected that in future implementations of the framework there will be a wider representation of participants involved in this phase and therefore IM may not be as conducive.

ISM/IM enhanced the methodology of IP with respect to the leverage phase. It facilitated the transition from the complex messy issues in the previous phases to intervention in the real world with respect to the provision of RTI. Whereas in the previous stages the systemicity was at a conceptual level (refer also to SSM) ISM/IM helped to transfer this systemicity into the real world i.e. the Mapumulo area. An interesting observation during this phase of planning was that the ends planning and means planning were inextricably linked in certain cases. For example, the desire to address the health issues immediately led to the notion of a telemedicine system. This suggests that the boundary between the ends planning and the means planning is actually arbitrary.

The case study did not go as far as the design and implementation of the technological infrastructure subsystem for reasons already mentioned. What was evident during this phase of the planning was that the outputs of the ISM/IM session paved the way for the design and implementation of the telecommunications technology using traditional methods such as Systems Engineering and in-house processes. In addition, one was now able to assess the appropriateness of these in-house processes in the light of the structures generated by ISM/IM. More specifically, the particular structure that was generated (Figure 5.2) informs the activities and processes that should follow for the design and implementation of the various components of the network.

One of the reasons for choosing a critical systems thinking approach to the framework was the emancipatory aim (which is linked to development of the community) of the planning exercise and the RTI, therefore the requirement in the framework for the participation of as much stakeholders as possible. Fay (1987: 205) defines "emancipation" as "a state of collective autonomy in which people have the power to determine rationally and freely the nature and direction of their collective existence". Fay points to the work of Freire (1973) who coins the term "conscientizacao" which is interpreted by Smith (1976:3) as a "co-operative search for answers to unsolved problems faced by a group of people". Fay links his "emancipation" to "conscientizacao". How did the fact that not all stakeholders were present in all the workshops impact on the learning and the envisaged aims of the planning framework? This was a practical constraint imposed by the realities of the previously existing planning practices at Telkom and by the impossibility to involve physically representatives of the local community in every workshop due to their availability. That issue was beyond the control of the author, at least at the time of the workshops, and was cause for concern. In trying to resolve this challenge of the unavailability of all stakeholders in every workshop one had to ensure that whatever alternative is found it had to strive to meet with the aims of emancipation. It can be stated that this aim was met through the consultation with the community in the third workshop and the report back to the Telkom planners. This was an alternative also suggested by Midgley (August 2001, pers. comm.*) for situations such as these.

It is difficult to envisage what would have happened, with respect to learning, if the community stakeholders participated with the planners in all the workshops. One can only speculate. However, significant learning did take place throughout the workshops and the author argues that the conducted workshops did have some emancipatory benefits both for the planners and the community. The results of the formulation of the mess, and the results of the ISM/IM session indicate the recognition by the planners of the need to plan RTI for the development of a socio-technical system (and the implications of such a system).

The issue that needs to be pursued and perhaps could be regarded as scope for further research is the impact of this type of planning on the internal rate of return for the telecommunications operator, in this case Telkom SA. One expects that there will be a tension between the emancipatory benefits and the need for a return on investment on the part of the telecommunications operator. A proposition in this thesis was that there is a greater chance of realising the emerging properties of the RTS i.e. benefits to all stakeholders with the implementation of this planning framework. Indeed, this is an ideal aim that the framework strives towards, but at least the societal intervention (systemic intervention) has started.

Apart from the fact that the community was given an opportunity to contribute to the formulation of the mess and the ends planning and, more importantly, these were taken into consideration by the Telkom planners (see fourth workshop), there was also the educating of the Mapumulo stakeholders as to the benefits of telecommunications infrastructure. This knowledge could lead to a concerted effort by the community to pressurise the powers that be to ensure that they invest in relevant telecommunications systems for example. This knowledge, together with the satisfaction of being part of the planning process, could also lead to more ownership of the infrastructure, and therefore resolve some of the security issues with respect to telecommunications equipment.

In concluding this section and this chapter, the framework principles (Table 4.1) shall now be revisited in the light of the results of the case study. The following bullet points correspond to the numbering of the framework principles in Table 4.1.

1. The framework is intended to be systemic in nature by design but the full benefits of this systemicity in relation to the emerging properties of the RTS can only be assessed after the real world deployment of the telecommunications infrastructure. However,

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elements of the emerging properties with respect to benefits from the planning itself were evident as discussed above and in the sections covering the workshops.

2. IP as the dominant methodology and ISM/IM provided the necessary rigorous planning guidelines. This is linked to the next point.
3. It has already been established how the techniques worked together in moving from a complex messy situation to implementation in the real world. In particular, the strengths of stakeholder analysis, CSH and rich pictures from SSM proved to be an appropriate combination of approaches. ISM/IM provided the much-needed enhancement to IP for the leverage phase.
4. Although the preferred stakeholder participation was not possible in this particular case study the framework was conducive to an alternative solution. An entire workshop was dedicated to the Mapumulo stakeholders and the responses were considered by the planners. In addition, through the progress from the stakeholder analysis, rich pictures to the implementation and control, one was able to ensure either implicitly or explicitly that development goals were considered.
5. The fifth principle has been covered through the implementation of the framework. The framework proved to be adaptable. It was mentioned in the above sections that some of the techniques such as conceptual modelling were adjusted to suit the situation. The framework promoted also learning on the side of the participants in its implementation about the problem situation and contributed to the greater understanding of its role for rural development amongst the stakeholders involved. The implementation on the case study discussed here demonstrated its relevance for rural telecommunications planning and hence its experimental validation following the ideas of Checkland (1995) on validation of soft systems models.
6. Wide ranges of issues (Appendix C, workshop two and three) were considered in the planning.
7. Systems Engineering and in-house process are catered for in the framework. However, the practical implementation of these was beyond the scope of this thesis.

The next chapter shall tie up the various threads of the research as to how the main goal of this research was accomplished, bringing the thesis to a close.

CHAPTER 6

CONCLUSION OF THESIS

Any situation that adversely affects a community or society gives rise to a societal problem. Likewise, the total lack or neglect in providing adequate infrastructure to a rural community, which would facilitate the development of that community, could give rise to a societal problem. Warfield (1976) states that our mental models of societal problems are usually inadequate representations of poorly understood systems. Nevertheless they form a basis for action to either bring about improvement or amelioration of the problem situation. Telecommunications, in general, is meant to serve society. In rural areas, especially those that are underdeveloped, telecommunications infrastructure plays a more significant role in the primary development of the people and the area. Chapter two of this thesis covered some of the developmental aspects of rural telecommunications. Yet, the planning and design of rural telecommunications infrastructure, at least in developing countries, is regarded as a predominantly technology issue, complicated by economic issues. This research was based on the assumption that the problems associated with the provision of rural telecommunications infrastructure, which includes the more recently coined 'information communication technologies' (ICTs), are societal problems which are characterised by a complex system of interacting issues called a 'mess', following the accepted terminology used in systems thinking.

There are several problems that must be considered when dealing with complex messy situations. The substantive aspects of the complex situation must be understood. The elements of the situation and the interrelationships among them must be identified and the knowledge gained must inform any necessary action. A second problem is one of developing a shared understanding among the stakeholders of the situation who will have multiple perspectives on the problem situation. A third problem is harnessing the shared understanding into an organised form of knowledge that would lead to a program or framework for action that is flexible and adaptable to the changing circumstances. The final challenge is one of influencing new policy, plans and decisions for the improvement of society. Such were the features experienced during this research journey. This final chapter shall attempt to highlight how the goals of the project were achieved, and some directions for future research.

6.1 How Were The Goals Of The Research Achieved?

The goals of this research are made explicit in section 1.2 of this thesis. The main goal that guided the research was to develop a framework for the planning of rural telecommunications infrastructure in developing countries. Section 1.4 of this thesis discussed the research approach and the methodological principles that guided this research towards the attainment of this goal. The essential elements of the research approach were the framework of ideas that encapsulated the knowledge about the problem being investigated, and the relationship between the research goals, the methodology, and the methods and techniques used to achieve this goal following Checkland and Holwell, (1998). This section shall attempt to explain how the goals of this research were achieved in the context of these essential elements.

Preliminary research on this project indicated that the systems approach would play the key guiding role in the development of the framework. An investigation into the factors affecting the planning and design of rural telecommunications infrastructure within KwaZulu Natal and internationally was set as a first sub-goal. Two research methods were used in achieving this sub-goal – the traditional literature survey and the interviewing of experts within the rural telecommunications planning environment.

A survey and analysis of the salient and current literature was conducted. The main literature sources included recognised journals in the field, such as Systems Research and Behavioral Science, Telecommunications Policy, IEEE Transactions on Communications and others, a wide range of publications by the International Telecommunications Union (ITU), doctoral theses which included case studies, research reports on South African rural telecommunications issues, and relevant South African policy documents. The ITU is, inter alia, responsible for setting standards and making recommendations in the telecommunications industry with respect to equipment, general policy, and planning methodologies. It is a body that has made a great contribution to the provision of telecommunications in developing countries, especially in terms of the research that it has sponsored and the wealth of literature published. Data Research Africa, a research company based in Durban, South Africa, pioneered research into the provision of telecommunications to rural areas in South Africa. However, the bulk of the previous research in rural telecommunications in South Africa tends to focus on the technological aspects only, and therefore South African literature on the planning aspects of rural telecommunications is scarce. In order to obtain accurate knowledge on rural telecommunications planning in South Africa, numerous informal consultations and two formal meetings were held with relevant experts from the public network operator, Telkom SA, with the aim of exploring the planning issues, as reflected in Appendix G.

The information and knowledge obtained from all of these sources were analysed in chapter one and chapter two of this thesis. The contents of these two chapters formed the starting point of what Checkland and Holwell (1998) call the framework of ideas or knowledge (F). The key conclusion that resulted from this analysis led to the conclusion that the RTS is not just a technological system, but a complex system of people and technology interdependent on other systems/subsystems. Therefore the issues involved in the deployment of rural telecommunications infrastructure, if all its stakeholders are to benefit, are not always technological, but are often complex and 'messy' cutting across various aspects of the rural society. The above conclusion finally led to the need for a systems thinking approach to the planning of rural telecommunications infrastructure. This conclusion enhanced the framework of ideas (F) even further in that the need for a systems approach was justified, and in terms of the pattern for a research approach of Checkland and Holwell (1998) one now had to seek for an appropriate systems approach or metamethodology that could use this framework of ideas or knowledge for the attainment of the main goal.

In moving closer towards the goal of this research, the next sub-goal focussed on the investigation and analysis of suitable methodologies and techniques from the field of systems thinking, which could be used to improve the current planning of rural telecommunications infrastructure. In order to achieve this sub-goal it was necessary to delve deeper into the systemic aspects of rural telecommunications as a system, so that one could understand the nature of this system. The most important output of chapter three can be summed up in the statement that the planning for rural telecommunications infrastructure is really planning for an open complex dynamic sociotechnical system, whose emerging properties are benefits to all stakeholders. One may refer to the end of chapter three for further implications of this statement with respect to planning of rural telecommunications infrastructure. The latter part of chapter three provided a conceptual overview of planning with a particular focus on planning in the systems context. Appendix A explored additional aspects related to achieving the second sub-goal through an investigation into various relevant systems methodologies.

The stage was gradually set for defining the product related to the main goal of this research, i.e. the systemic planning framework for rural telecommunications infrastructure. On the basis of the work so far it was possible to formulate a set of seven principles that would guide the development of the framework (Table 4.1). A multimethodological approach informed by critical systems thinking was used to harness the strengths of various methodologies and mix the most appropriate methodologies, methods, and techniques in a complementary manner, to build the planning framework. Within the dominant methodology of Interactive Planning (Ackoff, 1981) various methods and techniques such as elements of critical systems heuristics, stakeholder analysis, rich pictures, interpretive structural modelling and systems engineering were mixed to form a systemic framework that satisfied the requirements of the seven guiding principles. This work is covered in chapter four of the thesis. Implicit in the achievement of the main goal of the research is the theoretical and practical validation of the framework, which was covered in chapters four and five respectively.

A case study was used for the practical verification that the main goal of the research was achieved. The findings from it, following the opinion of the participants in this experimental application of the framework, showed that the framework represents an improvement on current planning practice in rural telecommunications. The Mapumulo case study together with the evaluations of the process and the framework was covered in detail in chapter five.

The first principle of the framework (Table 4.1) relates to the systemic nature of the framework. This was justified in chapters three and four. During the implementation of the framework the value of such a systemic nature was immediately noticeable within the context of the complexity of the problem on hand. This systemic nature of the framework seems to be a precondition for the rest of the principles to be satisfied.

The problem of concern was not so explicit or obvious at the start of the planning exercise in the experimental application of the framework. However, through the learning process in the formulation of the mess phase one was able to depict the system of problems and issues through a rich picture. This was a suitable way of initially coming to terms with the inherent complexity of the intervention. The stakeholder analysis, the subset of boundary questions that was used, and the workshop with the Mapumulo community, provided the much needed perspective of the community. The ends planning, in particular, further assisted in satisfying the principle of empowerment and redress of the community. Whereas demand forecasting in terms of quantitative tele-traffic data is used in current planning approaches, the ends planning helped to deal with uncertainty. The approach was one of creating the future RTS, instead of the 'predict and prepare' approach. The problem of concern to the planners became much clearer in that one was able to discern what the boundaries of the RTS should be in terms of what was possible in the context of realising the emerging properties of the RTS. Finally, Interpretive Structural Modelling was used to cope with the complexity and quantity of elements and the relationships amongst these, in moving the Mapumulo RTS from its current reality to the idealised design.

The results of the evaluation of the workshops and the framework by the Mapumulo stakeholders and the Telkom planners are indications that the practical verification of the framework was successful.

6.2 The Theoretical And Practical Contribution Of This Research

This research was transdisciplinary in nature. One would expect research such as this to fall within the telecommunications engineering environment. Although the area of concern falls within the telecommunications field, knowledge from other disciplines such as systems theory, systems thinking and intervention, complexity, rural development, planning, and operations research were essential in achieving the goal of the research. The following paragraphs highlight the contributions made to two areas.

This research claims to have made a theoretical and practical contribution to the telecommunications sector. Past research in the telecommunications sector is skewed towards technological advancement and measuring the socio-economic impact or the ultimate payoff of telecommunications infrastructure, even in developing countries (refer to section 1.1.2 of this thesis). The general nature of the research in this sector is characterised by a positivist epistemology. While there is nothing wrong with this approach, correlation between issues is not the same as cause and effect (Ackoff, 1999). In this research, emphasis was placed on obtaining a better understanding of the issues involved in rural telecommunications in terms of the systemic relationships between these issues. The theoretical contribution of this research therefore includes the formulation of the systemic framework for planning of rural telecommunications infrastructure. It was based on the systemic analysis and critique of the literature and current practice of telecommunications planning in chapters one and two, the development of the idea of the RTS illustrated in Figure 3.2, and justified on the basis of multimethodology, a critical systems methodology for mixing methods in the same intervention. The contribution is further supported by the theoretical development that led to the RTS being defined as a complex, dynamic sociotechnical system in chapter three. In addition, the framework itself is an epistemological device, and it is therefore envisaged that new knowledge or new insights into rural telecommunications planning practice will be gained as the framework is applied to different rural situations. To the best knowledge of the author these are new theoretical contributions to the discipline of telecommunications.

The framework itself is a practical contribution to the telecommunications sector. The practical benefits of the framework were evident in the experimental application of the framework. It demonstrated how the framework helped to deal with a complex problem situation, such as the provision of rural telecommunications infrastructure for a typical rural community (Mapumulo), and finally arrive at a suitable plan that could be implemented, maintaining the essence of the RTS. In the course of the application of the framework not only the telecommunications planners were empowered to improve their current practices, but the other important stakeholders such as the rural community, had a greater chance of contributing to improvement of their condition as far as it is associated with rural telecommunications infrastructure development. Especially in a developing country such as South Africa, where great emphasis is placed on community development and empowerment, the planning framework includes the necessary methods and techniques to enable the realisation of these objectives.

Secondly, this research claims to make a contribution to the systems thinking. Critical systems thinking was used as a starting point to address a complex problem in telecommunications, i.e. the planning of rural telecommunications infrastructure. The diverse nature of the systemic intervention required the mixing of different methods and multimethodology, a recent development in critical systems thinking (see Mingers and Gill, 1997) was used as a justification for the way in which the framework was put together. The proposed way of mixing of Interactive Planning, Interactive Management/Interpretive Structural Modelling, elements of Critical Systems Heuristics and Soft Systems Methodology, and techniques from other methodologies in the suggested framework is a unique one. Though the general theory of multimethodology as well as the elements of the separate methods applied here are described in the literature, this variation of multimethodology, involving Interactive Planning as the dominant methodology and the proposed mix of methods for the intervention was not reported previously in the literature to the best knowledge of the author. Therefore this mix of approaches is a contribution to the theory and practice of mixing methods and methodologies in a systemic intervention. The application area (planning of rural telecommunications infrastructure) traditionally would have required hard systems approaches. The mix of approaches applied here was guided by the emancipatory ideas of critical systems thinking. Within this broad framework, Interactive Planning was chosen as a dominant systems approach for the intervention. The chosen mix of interpretivist, emancipatory and functionalist techniques contributed to the multiple perspective needs of the planning process. The practical implementation of the framework in the Mapumulo area of KwaZulu Natal showed the viability of this type of multimethodological approach to complex problem solving. It could be applied probably also to other developmental issues. The case study in chapter five highlighted the position that it is better to initially deploy less infrastructure but move in the right direction towards the idealised design, than engage in massive rollout in the wrong direction. The key issue is one of sustainability in development and this means once again making the appropriate boundary judgements. In addition, the framework also demonstrates how one can maintain a balance between appropriate interpretivist techniques that generate knowledge about the problem situation, and techniques that appear to cater for the aspects of the problem, requiring a functionalist approach, within the same intervention.

6.3 Concluding Remarks And Directions For Possible Further Research

Prospects for further research as a result of this project can be formulated in several directions:

- It was not within the scope of this research to engage in the deployment and commissioning of the telecommunications infrastructure, and the evaluation of this infrastructure in the context of the RTS, i.e. to determine the extent of the realisation of the emerging properties of the RTS. The implementation of the infrastructure and services contained in the plan could be formulated as an action research programme in terms of further investigating the development that is triggered.
- This research was concerned with telecommunications infrastructure, which traditionally belongs to the discipline of engineering, more specifically electrical engineering. Another important technological infrastructure that also traditionally falls within the electrical engineering discipline concerns the distribution of electricity. Electrifying rural areas in South Africa is currently a high priority with respect to basic services. It is envisaged that

many of the issues that rural telecommunications face would be relevant to the distribution of power to rural communities. Can a framework, such as the one developed in this research, ameliorate the problems encountered in the distribution of electricity supply to rural communities, is a possible future research question.

- One of the important findings of this research was the need for collaboration with other infrastructure providers and other relevant agencies by the rural telecommunications planners. This opens the way for research into how this could be formalised and how they could be included in the decision-making processes. The proposed Integrated Development Plan (IDP) of South Africa was also mentioned in the case study. It is not clear from existing government documents how the principles of the IDP plan will be effected. Initial readings of the relevant documents indicate that possibly systems thinking can play a significant role in shaping a framework for implementation. This research could serve as a basis for making better informed judgements on the appropriateness of a systems thinking approach for integration of various development efforts.

One of the features of the planning framework for rural telecommunications infrastructure is that it has the potential to generate new knowledge and insights and thus facilitates learning. With respect to the ends planning within the framework it was emphasised that idealised design is not the same as the ideal design. This means that in seeking to reach the ideal design (which by definition would not be reached) further issues would need attention and it is therefore envisaged that more research questions would surface. Further possible implementations of the framework may provide fertile ground for field investigations of various aspects in rural telecommunications development. It is hoped that this thesis provides a step in the improvement of the planning of rural telecommunications infrastructure in the theoretical and practical sense bringing together recent developments in systems practice and telecommunications.

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APPENDIX A

ANALYSIS OF SOME TRENDS IN THE EVOLUTION OF SYSTEMS THINKING METHODOLOGIES THAT ARE RELEVANT TO THIS RESEARCH

The framework for the planning of rural telecommunications infrastructure developed in this thesis is heavily under-pinned by the theories and ideas inherent in the system sciences and in systems thinking. Lane and Jackson (1995) mention that the systems movement as a whole is characterised by a belief in holism, the organisation of knowledge in cognitive systems, and structured frameworks expressing certain intellectual norms that people find useful in understanding the real world. Nevertheless, the field of systems thinking is both broad and diverse, and Lane and Jackson alert one to the dangers of labeling one particular systems methodology such as Systems Dynamics, as systems thinking. This appendix therefore provides a brief overview of the systems movement and then focuses on recent trends in systems thinking, with a more in depth exposition on the relevant systems approaches applicable to the problem of planning of rural telecommunications infrastructure. It is out of the scope of this thesis to engage in an exhaustive account of all systems methodologies. While the author has investigated the breadth and depth of the various documented systems methodologies only those that have potential relevance to the planning framework will be covered in this thesis. This chapter is structured in such a way that one is able to appreciate how the systems movement has evolved and expanded from General Systems Theory to what is generally classified as Hard Systems Thinking, and Soft Systems Thinking, through to Critical Systems Thinking.

A.1 General Systems Theory, Tektology, Cybernetics

The purpose of this section is to provide an overview of the early development of systems theory. Miller (1978) defines General Systems Theory (GST) as a set of related definitions, assumptions, and propositions, which deal with reality as an integrated hierarchy of organisations of matter and energy. In addition GST serves as a meta-theory of holism, which relates and integrates diverse concepts and theories from the different sciences (Laszlo, 1972). Ludwig von Bertalanffy (1968), a biologist who is widely credited with founding GST, first proposed GST in the 1940s in response to his dissatisfaction with the reductionist, closed system approach of some of the early physicists. Such an approach was not conducive for more practical phenomena as found in living organisms.

Von Bertalanffy distinguished between two types of systems. The closed system, which does not interact with its environment, and the open system, which depends on its environment for its survival. Furthermore, open systems are teleological, i.e. they are purposive, adaptive and/or goal-directed (von Bertalanffy, 1968). The open system is capable of self-regulation, adapting to circumstances by changing the structure and processes of their internal components and they have the ability to reach the same final state from different initial conditions and in different ways (Jackson, 1991: 48).

Although von Bertalanffy is widely recognised as the father of GST, one must acknowledge the work of Bogdanov's three volume *Tektology* which was published in Russia between 1912 and 1927, but only became available to the West by Gorelik (1975) much later (Jackson, 2000). According to Tektology everything exists as an organisation, which is constituted by elements and interrelationships between elements.

> "Thus, for tektology, the first basic notions are those about elements and their combinations. Elements are activities and resistances of all possible kinds. Combinations result in three types: organised, disorganised and neutral complexes. They differ in the magnitude of the practical sum of their elements" (Bogdanov, in Gorelik, 1984: 47).

According to Gorelik, this point of view is identical to the systems approach.

Cybernetics was originally defined by Wiener (1948) as the science of communication and control, and grew out of Shannon's information theory (Shannon and Weaver, 1949), which was designed to optimise the transfer of information through communications channels, and the feedback concept used in engineering control systems. Wiener argued that cybernetics dealt with general laws that governed control processes in a system, irrespective of the nature of the system, and soon applied cybernetics to human concerns (1950s). In understanding control in any system the idea of negative feedback was shown to be crucial, especially for the attainment of the goal of that system. In other words, when behaviour in a system is not according to preset expectations, information is transmitted to bring the behaviour back on track. Inherent in this process of control is the communication of information. One may also refer to Ashby (1956) as a seminal text on the foundational developments of cybernetics.

Whereas systems theory focussed more on the structure of systems and their models, cybernetics has focussed more on how systems function in terms of how they control their actions and how they communicate with other systems or with their own elements. However, it is contradictory to understand the structure of a system separate from its function, and therefore cybernetics and general systems theory should be regarded as two facets of a single approach.

Olsen (1982: 23) makes an interesting application of GST to group activity in planning, policy making and problem solving. He refers to Buckley (1968) and states that:

> "The team or group required to solve complex probabilistic problems is a living, dynamic, adaptive system. The participants of the group as well as the group as a whole change with time. Such systems are open internally as well as externally so that interaction between participants may result in significant changes in the nature of the participants themselves, with important consequences for the group as a whole".

In addition, the activities carried out by the participants of the group are affected by their state and relationship to each other at any particular time and within a particular environment (Baumgartner et al, 1976). As a result of this Olsen (1982) concludes that it is very difficult to predict group activity and productivity. In order to improve the situation he provides a framework of information pertaining to group productivity and group maintenance structured along GST that is supposed to assist the designer in the selection and implementation of appropriate design methods and strategies and related group processes.

While systems thinking in general has flourished in many different ways, GST has failed in its applications as originally intended. It was expected that GST would provide a meta-level language and theory in which the problems of different disciplines could be expressed and solved, and by doing this it was envisaged that the unity of science would be promoted. However very little of the outcomes anticipated by the founders of the Society for General Systems Research can be found (Checkland, 1999). A further critique of GST is provided by Midgley (2000: 46-48) regarding its silence on the subject/object dualism, i.e. the observer (subject) of the system is somehow independent or does not influence the observed (object).

Checkland (1981: 125) mentions that the idea of 'systems practice' implies a desire to find out how to use systems concepts in trying to solve problems. He explains that the view of the problem solver as to the way the world is described (i.e. 'natural', 'designed physical', 'designed abstract', or 'human activity' systems) will determine the particular systems approach. The engineering profession has made its contributions to systems practice. Checkland (1981) asserts that the generalisations arising from the practice of engineers constitute an important strand of systems thinking that complements general systems theory. The next section deals with such a strand.

A.2 Hard Systems Thinking

Hard systems thinking is that strand of systems thinking that falls in the category of what Jackson (2000) calls, 'The functionalist systems approach'. Within this perspective, systems appear as objective aspects of reality, independent of the observer. Hard systems thinking is traditionally most allied to the engineering disciplines as it is concerned predominantly with bringing about change and improvements in systems and consequently the design and deployment of tangible solutions or systems. In general whatever systems thinking is currently applied in rural telecommunications, such as the design of the switching of the design network, has a hard systems engineering flavour, being influenced by systems engineering, systems analysis and operations research. The planning framework for rural telecommunications infrastructure developed in this research moves away from the traditional 'hard systems only' approach towards a multimethodological use of methodologies and techniques from both hard and soft systems thinking.

In a nutshell, hard systems thinkers seek to model the real world system of concern with a view to optimising its performance according to predefined ends and objectives (Lane and

Jackson, 1995). Whereas natural scientists carry out their scientific inquiry in the laboratory, the systems model provides the 'experimental laboratory' for the hard systems thinking practitioner who emulates the method of science for the inquiry. Checkland (1981) provides an apt description of the hard systems approach. He states that the hard systems approach presupposes that an important class of real world problems can be addressed on the basis of the following assumption: There is a desired state, S_1, and a present state, S_0, and alternate ways of getting from S_0 to S_1. Problem solving then consists of defining the current state (S_0), the desired state (S_1) and then defining the best way, by the systems person or systems engineer, of getting from S_0 to S_1. The activities that had a major influence on hard systems thinking are systems engineering, systems analysis and Operational Research. All three started at about the same time and subscribe to the problem solving process of hard systems thinking of 'moving from S_0 to S_1' as described by Checkland (1981).

A.2.1 Systems Engineering

Systems engineering is concerned with the planning, design, construction, evaluation, and maintenance of large-scale systems that may involve both machines and human beings (Flagle et al, 1960). It is interesting to note that systems engineering is reputed to have started in the 1940s at the Bell *Telephone* Laboratories in the US. Development of systems engineering epistemology leaves much to be desired, perhaps because the engineering profession attracts action-oriented people who value practical achievement more than anything else. As a result engineers and technologists are impatient with theorising and even after a good design has been realized in practice, they are seldom inclined to think about the way they went about the design. Principles are learnt from experience and grasped intuitively long before they are codified and expounded (Checkland, 1981). However, (Hall, 1962, 1969) who was associated with the Bell laboratories, provides perhaps the most classic writings on systems engineering, and so this section is based on his works. It must be noted however that even Hall's contribution is generalised from previous successful projects rather than from a theoretical foundation.

According to Hall (1969) systems engineering has three broad dimensions: -

- The knowledge and information dimension, which emphasises the need for an integration of specialised knowledge from different disciplines.

- The time dimension, which is related to the chronological phases that are typical of systems work, i.e. from conception through to retirement or modification of the system.
- The logic dimension, which is related to the process carried out in the chronological phases mentioned above.

The knowledge dimension deals with the core issues of the system and this dimension is expanding all the time as new knowledge is gained through research and experience.

Hall further expands the time dimension into seven activity categories:-

- **Program Planning,** in which those activities and projects it wants to pursue in more detail are defined and selected.
- **Project Planning,** in which attention is focussed on specific projects of an overall program with budgetary constraints.
- **System Development,** in which the implementation of the project plan takes place. The products of this activity are detailed specifications, blueprints and bill of quantities.
- **Production,** in which the system elements and the total system are produced and installation plans are designed.
- **Installation,** in which the system is installed and ready for commissioning.
- **Operation,** in which the system is serving its designed purpose
- **Retirement,** in which the system is withdrawn, replaced or modified.

Hall represents the logic dimension of systems engineering as a seven-step problem solving sequence, which is practised within each of the phases in the time dimension mentioned above. The process is iterative and interactive.

- **Problem Definition:** This requires a good understanding of the problem in terms of its structure and behaviour over time such that sufficient knowledge is available to carry out the next steps.
- **Value System Design:** Warfield defines a value system as "A set of interrelated elements including objectives, constraints, evaluation factors, and decision criteria, which provide a basis for decision making" (Warfield, 1976: 181). In value system

design therefore the objectives to be achieved and their interrelationships are clarified.

- **Systems Synthesis:** This activity synthesises the objectives produced in the value system design and then possible alternative systems are created. This is predominantly a conceptual exercise.
- **Systems Analysis:** This activity is concerned with understanding the behaviour and characteristics of the alternative systems created in the system synthesis with respect to the objectives.
- **Optimisation of Each Alternative:** This involves the fine-tuning of each of the alternative systems into its most efficient and effective state.
- **Decision Making:** This activity involves the choice of the most promising alternative system and therefore is usually done with the optimisation activity mentioned above.
- **Planning for Action to Implement the Next Phase:** This involves the development of the prototype and the physical realisation of the system beyond prototype including the monitoring and evaluation of the system.

The whole approach places an emphasis on defining a range of unambiguous objectives, usually achieved by means of trade-offs, so that the performance of the system can be determined accurately. It must also be emphasised that the various sequences or steps should not be followed such that each phase is completely carried out before moving on to the next one. Learning takes place as the various stages are carried out and this often calls for a revisit to previous stages.

In a more recent article in the journal 'Systems Engineering', Beckerman (2000) states that "systems engineering as it is practised today is almost exclusively reductionist". She investigates the application of complex systems science to systems engineering and proposes a way to meld the reductionist and holistic strategies for engineering complex systems. The usual practice, according to her, is to subdivide the complex system into individual components,

> "That behaves as if it were a simple system displaying only a few variables, all of which lend themselves to common analytical treatment. The sum of the behaviours of the individual components is assumed to provide the system properties… The consequences of the reductionist approach ripple through the entire development life cycle" (Beckerman, 2000: 97).

She admits that while the reductionist approach has succeeded quite well for the better part of the past fifty years it suffers from a serious fallacy that the summation of the system component behaviours will provide the desired total system behaviour. The unexpected behaviours and results that frequently occur during a 'systems integration' test occur despite thorough and successful testing of all the system components.

Although there is recognition that better ways of defining interactions are needed, the current approaches are limited, as most interactions are currently identified by reducing them to pairwise sets between two components at a time. Whereas in actuality, functionality or purpose emerges from multiple interactions that thread their way through the system. Beckerman proposes a melding process of the reductionist and the holistic by looking at the concept of emergence such as driver comfort in a motor vehicle as a synthesis of all interactions (AC/heat, cruise control, arm rests, seat position, etc.), and not just one component by itself. She suggests some ways of achieving this within a systems engineering framework.

Even more serious are the limitations of systems engineering when applied to large engineering projects where the key purpose of the intervention is to improve the quality of life, such as rural telecommunications and electrification. When applied to management systems, systems engineering was found to be lacking in many respects (Jenkins, 1969), (Checkland, 1981). A general summary of these limitations is provided in section A.2.3 of this thesis. The next section provides an overview of two other approaches that shaped hard systems thinking, Operational Research and systems analysis. Today, classical operational research encompasses systems analysis.

A.2.2 Systems Analysis And Operational Research

Systems analysis and Operational Research (OR) started approximately at the same time in the US and the UK, respectively; under similar circumstances i.e. World War II military applications. Whereas systems engineering comprises a sequence of activities that ultimately lead to the design and deployment of a complex man-made system, systems analysis is the systematic appraisal of the cost and other implications of meeting a defined requirement in various ways (Checkland, 1981: 138). It was a way of tackling complex problems of resource allocations in defence. According to Quade (1963) systems analysis is concerned with analysis to suggest a course of action by systematically examining the costs, effectiveness and risks of alternate policies or strategies - and designing additional ones if those examined are found wanting. (See also Miser and Quade, 1985).

A further description by Quade and Boucher (1968) encapsulates the systems analysis process:

> "One strives to look at the entire problem, as a whole, in context, and to compare alternative choices in the light of their possible outcomes. Three sorts of enquiry are required; any of which can modify the others as the work proceeds. There is a need, first of all, for a systematic investigation of the decision makers' objectives and of the relevant criteria for deciding among the alternatives that promise to achieve these objectives. Next, the alternatives need to be identified, examined for feasibility, and then compared in terms of their effectiveness and costs, taking time and risk into account. Finally an attempt must be made to design better alternatives and select other goals if those previously examined are found wanting."

The essential elements of the systems analysis methodology then are as follows: - (see also Checkland, 1981: 136): -

- Problem formulation that results in objectives that need to be accomplished.
- Identifying alternative techniques or 'systems' by which the objectives may be accomplished.
- The cost or resources required by each technique or 'system'.
- Building models showing the relationships among the objectives, techniques and 'systems', the environment, and the resources.
- Determining criteria relating to objectives and cost or resources for choosing the preferred optimal alternative.

The official definition of Operational Research according to the United Kingdom OR Society reads as:

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

The main methodological resources of Operational Research include various optimisation methods and decision-making methods for multiple criteria problems. The phases involved in an Operational Research approach as described by Jackson (1991: 77) are as follows: -

- Formulating the problem
- Constructing a mathematical model to represent the system under study
- Deriving a solution from the model
- Testing the model and the solutions derived from it
- Establishing controls over the solution
- Implementation of the solution

The early intentions of the Operational Research protagonists that OR should have a systems orientation with interdisciplinary teams using the method of science to solve real world problems, were not realized as OR degenerated into little more than mathematical modelling (Churchman, 1979). And so OR has become a less popular choice for solving real world problems. However it must be noted that the OR societies have seen a substantial move away from the classical OR practice to a practice that deals with the messes in problem situations in more than a scientific or mathematical approach. The salient critical writings on hard systems thinking and in particular Operational Research include (Ackoff, 1977, 1979a, 1979b), (Checkland, 1981, 1983), (Churchman, 1979), (Rosenhead, 1981, 1989) and Friend (1993, 1998).

One important spin-off from the efforts to address the limitations of classical OR, is the emergence of Community Operational Research or Community OR. Midgley (2000: 279) defines Community OR as intervention in the service of community development: working for improvement by dealing with issues that have a perceived negative effect on either the whole of, or sections of, local communities. For an in depth treatment of Community OR one may refer to Midgley (2000),

Checkland (1981) and Jackson (1991) provide a concise but fairly exhaustive treatment of the criticisms levelled against hard systems thinking, and the author believes that more than a summary of this will be out of the scope of this thesis. In chapter one brief mention was made of the limitations of the current methods used in the planning of rural telecommunications infrastructure, based purely on the current practices themselves rather than on the philosophy or paradigm underpinning the practice. What follows is a summarised critical account of hard systems thinking and its inability to fully address the problems associated with planning of rural telecommunications infrastructure.

A.2.3 Further Discussion Of Hard Systems Theory

There are common threads that run across the systems engineering approach, systems analysis and Operational Research that characterise the paradigm of hard systems thinking. In observing Checkland's formulation of moving from S_0 to S_1, the relevant factors, constraints and objectives are established in advance with general consensus among the 'expert' problem solvers whose world view of the problem situation leads to the only representation of the problem (Checkland, 1981). Checkland is correct in saying that engineers usually kick off their work with a prescribed set of 'specifications' and therefore the task becomes one of designing according to specifications. Not all engineering problems are well defined and well structured, though. In fact the argument that very often specifications are influenced by ready-made existing solutions rather than the unique nature of the problem under consideration has merit.

In a situation such as the provision of technology for rural telecommunications in developing countries, which is traditionally in the engineering domain, it is not uncommon to find that technology solutions that proved to be successful elsewhere in developed countries, have influenced the specifications for rural telecommunications technology in underdeveloped countries. Systems engineering, in its classical form is unable to cope with the mess involved in soliciting community needs and obtaining an accommodation of the various viewpoints, and coming up with a consensual set of specifications.

On a similar note, traditional hard systems thinking such as in systems analysis takes as given the definition of a need and then undertakes a systematic analysis of the economic feasibility of meeting the need. In a complex problem like rural telecommunications, which is supposed to stimulate development of rural communities, emphasis on a technocratic one-sided cost benefit analysis is short-sighted. So while the hard systems thinking such as systems engineering may be conducive to certain aspects in the planning of rural telecommunications infrastructure, it is inadequate as a planning framework.

In dealing with socio-technical systems in general, hard systems thinking pays little or no attention to the animated or social subsystems. Yet the raison d'être of engineering a system such as telecommunications or electrical power distribution is (or should be) to provide value to the human being. Instead people are treated as components of a machine to be engineered. Self-determination and the ability of people to control their own destiny are usually ignored. Rather, hard systems thinkers assume the future to be outside the control of the people and thus, according to Ackoff, the opportunity to mobilize people to design their own future is missed.

Implicit in hard systems thinking is the demand for quantification and optimisation With large complex systems, the conceptualisation and building of a model at best will be an approximation and will reflect the bias of the modeller. Of serious concern is the tendency to ignore or distort those factors in the problem situation that are not amenable to quantification. According to Jackson (1991), hard systems thinking seems to treat the model as synonymous with reality. The model becomes the focus of attention and the 'generator of optimum solutions'. However large complex systems are usually dynamic and so the models soon become out-of-date representations resulting in out-of-date solutions. This is certainly the case for the RTS. Although a conceptual model of the RTS was created in chapter three, Figure 3.2, this was purely for the purposes of justifying a systems approach and not for an optimum solution. For a complex, dynamic socio-technical system such as the RTS, one is currently unable to create an acceptably accurate model for the purposes of planning of infrastructure.

Another criticism of hard systems thinking is its subtle tendency to be used to legitimise vested interest. As Jackson (1991) explains, in a situation where choices have to be made regarding different objectives, such as in softer problem situations, there is always the tendency to privilege the objectives (vested interest) of the most powerful stakeholder. Having manipulated the situation hard systems approaches then seek to cover their tracks by encouraging "depoliticization" and "scientization" in the words of Rosenhead (1989). The complex modelling and mathematical techniques create an air of objectivity and so conflict is hidden.

There are two other methodologies that are regarded as being functionalist but, in the opinion of the author, fall on the boundary between hard and soft systems thinking, that are worthy of mention in this section due to their extensive use in practice. Both System Dynamics (SD) and Organisational Cybernetics are founded on the principles of cybernetics. System Dynamics, originally known as 'industrial dynamics' was developed by Forrester (1958, 1961) and uses the principles of cybernetics to evaluate business and other organisational and social contexts. SD regards complexity in a system as a function of its elements and the 'flows' (relationships) among these elements, including the feedback loops. In a nutshell SD emphasises the model structure of the system which supports an interest in its prediction and control, informing any decision-making process regarding the system.

Based on Clemson (1984), Jackson (2000: 156) labels organisational cybernetics as second-order cybernetics. First-order cybernetics is concerned with organised complexity in that it studies matter, energy and information, whereas second-order cybernetics is concerned with relativistic organised complexity in that it also studies the observing system. The most important features of organisational cybernetics are encapsulated in Beer's Viable System Model (Beer, 1979, 1981, 1985). See also Espejo and Harnden (1989). The underlying principle of the VSM is that when a system or organisation is not performing according to expectations, then cybernetic principles are being violated. The VSM is an arrangement of five functional elements that are interconnected through a complex of information and control loops. The model allows, for example, the representation of a company and its divisions in the context of the wider organisation of which it may be a part. Both system dynamics and the VSM are substantially well-established methodologies.

On the basis of the main research goal and the chosen methodology for the research and the planning framework, it was felt that these approaches do not fit the research goal and the chosen methodologies. In pursing additional system methodologies the following sections will discuss soft systems thinking.

A.3 Soft Systems Thinking

Whereas hard systems thinking is appropriate for well-defined technical and organisational problems, soft systems thinking has within its scope a fuller treatment of ill-structured and messy real world problems that cannot be adequately addressed by hard systems approaches. A fundamental drawback of hard systems thinking is its inability to deal with the diverse demands of the human element in a problem situation (Jackson, 1991). Since soft systems thinking evolved from the practice of systems engineering (a hard systems paradigm), it can be expected that the early approaches of soft systems thinking will contain some threads of hard system thinking. A fundamental distinction though is made by Checkland (1983) and later elaborated on in Checkland (1999).

In hard systems thinking the concept 'system' is used as a label for something taken to exist in the world outside of the observers. The assumption is that the world can be taken as a set of interacting systems or subsystems, some of which do not work very well and so can be engineered to work better. The assumptions are quite different in soft systems thinking. The world is taken to be complex, confusing and messy with diverse perspectives, and in coping with it a process of inquiry into it can be organised as a learning system. Thus the concept of system no longer applies to the outside world but instead to the process of learning about the world. It is this shift in systemicity from the world to the process of inquiry into the world that forms the fundamental intellectual distinction between hard systems thinking and soft systems thinking (Checkland, 1999).

Jackson (2000) categorises soft systems thinking as an interpretive systems approach. The primary area of concern in this approach is perceptions, values, beliefs and interests. It accepts that multiple perceptions of reality exist, and one needs to find a way of accommodating this. Methodologies in soft systems thinking seek to understand these perceptions, values, beliefs, and interests so that one could predict and control outcomes. Culture and politics play an important role in the interpretive systems approach.

There are various seminal works that have influenced the soft systems thinking movement. These include contributions by Vickers (1965), Churchman (1971), Warfield (1976), Ackoff (1981), Checkland (1981), and Mason and Mitroff (1981). Warfield however claims that his methodology of IM, which is dependent on ISM, is founded on a method of science to deal with complexity. IM is therefore agnostic towards systems paradigms. Jackson (2000) however, regards IM as an interpretive systems approach. More will be said about this later on in this section. It is beyond the scope of this thesis to engage in a comprehensive treatment of all the above contributions. Instead the thinking of Vickers and Churchman, which pioneered the soft systems thinking movement, will be summarised, and then a deeper treatment of the methodologies relevant to this thesis will be covered.

A.3.1 Social Systems Design

C. West Churchman, a one time ardent protagonist of operations research, based his 'Social Systems Design' on an elucidation of various different philosophical positions and implies that the problem situation must therefore also be viewed from different positions. Churchman's teachings had a strong influence on Mitroff and Linstone (1993) and they mention that Churchman significantly extended the ideas of his mentor, the American philosopher E. A. Singer, to form the philosophical basis for the modern systems approach (p92). In his 'Design of Modern Inquiry Systems' Van Gigch (1988) explains that:

> "According to Churchman (1971), for the Leibenizian (after Leibniz) Inquiring system truth is analytical, that is the truth content of a system is associated entirely with its formal content. Systems can be represented by formal models whose validation rests on their ability to offer theoretical explanations of a phenomenon with a wide canvas. The Lockean (after Locke) Inquiring system represents the method of inquiry that validates truth through consensus and through direct observation and experience. The Kantian (after Kant) Inquiring system combines formulation of a model, which provides a prior knowledge with the empirical validation of evidence of a posterior nature. In a sense the Kantian inquiry system combines some features of Leibenizian with those of the Lockean inquiry system. The Hegelian (after Hegel) inquiring system seeks to obtain the truth by direct confrontation of opposing views. Out of conflict of thesis and antithesis, a more encompassing synthesis will hopefully emerge. Finally in the Singerian (after the philosopher E.A. Singer) inquiring system, laws and facts are not hard and immutable, but approximations that require continual analysis to confirm their validity."

Churchman (1971) proposes a different understanding of objectivity to that found in hard systems thinking. Objectivity is perceived to lie in the model representation of the system and further justified or supported by the 'scientific approach', in hard systems thinking, similar to the philosophy expressed in the Leibnizian inquiring system. And so the results of a system study are said to have a high degree of confidence level. Churchman's view is that successful systems are as much in the mind of the observers of the system as in the system itself, and therefore to claim objectivity based on a single model representation of a system is meaningless.

Informed by the Kantian and Hegelian inquiring system Churchman (1971) holds that one cannot rely on a single dogmatic worldview of the nature of a system. One has to "keep an open mind". He impresses upon those responsible for social systems to be aware of their own limited worldviews. "There are no experts in the systems approach" according to Churchman and therefore social system designers are morally obligated to listen to even the critics of the systems approach. Rather there are many possible worldviews based on various inherent assumptions. These different worldviews must be explored and exposed and in embracing the inherent subjectivity a whole view of the system is obtained.

In comparing the different philosophical positions Churchman (1971) contends that no inquiry system is ever absolute and complete, but by bringing together different worldviews and subjectivities, the restrictive nature of one worldview can be overcome. So objectivity in a sense becomes viewed as a way in which subjectivity is managed and embraced. One way to unearth hidden assumptions and reach an accommodation and appreciation of the different worldviews is through a process of debate as suggested by the Hegelian inquiring system. The truth is sought and obtained by direct confrontation of opposing views and out of conflict of thesis and antithesis a more accommodating synthesis will hopefully emerge.

Finally, based on the Lockean and Singerian inquiry system one should always strive to take on the "whole system" although this may not be practically achievable. However a thorough and comprehensive systems design as an ideal goal forces one to critically assess the comprehensiveness or the lack of, thus far in the design process. The process of seeking accommodation and appreciation is a never-ending process. Nevertheless the debate should converge towards a consensus amongst the stakeholders of a worldview/s so that the required interventions can be carried out.

A.3.2 Appreciative Systems Theory

Appreciative systems theory was developed by Vickers (1965, 1973, 1983), who based his theory on the many years of practical experience that he had. A literature review indicates that Vickers and his appreciative systems theory is not as well known as Churchman and his social systems design, perhaps because Vickers spent most of his working life in the 'non-academic world' and it was only during his retirement that he began to seriously publish as a deep scholar. However his thinking has had a significant influence on soft systems thinking and therefore deserves some attention in this thesis. In particular, the development of Checkland's Soft Systems Methodology, to be discussed later, has been greatly influenced by appreciative systems theory. It is therefore no surprise that Checkland and Casar (1986) and (Checkland (1999) have produced perhaps the most illustrated interpretation of appreciative systems theory in the soft systems thinking movement.

Appreciative systems theory (AST) rejects the goal seeking model of human activity and the cybernetic model whose course is determined from outside the system. Rather Vickers suggests the notion of "appreciation" (Checkland, 1999). Checkland and Casar (1986) published a summative synthesis of an appreciative systems model, based on the whole corpus of Vickers' writings, discussed in Checkland (1999: A50-A53). Figure A.1 illustrates the structure of an appreciative system based on Vickers' "two stranded rope". It depicts the interacting flux of events and ideas unfolding along the time domain. The events and ideas are inseparable, continuously affecting each other. The notion of appreciation stems from our ability to make choices and judgement as human beings. Appreciation is about perceiving some selective reality in the system, then making judgements about it, which contributes to the ideas strand, which then leads to action that becomes part of the events strand. This would seem trivial but for the continual recursive nature of this process, i.e. the flux of events and ideas generates appreciation which itself contributes to the flux and the action that the appreciation leads to also contribute to the flux.

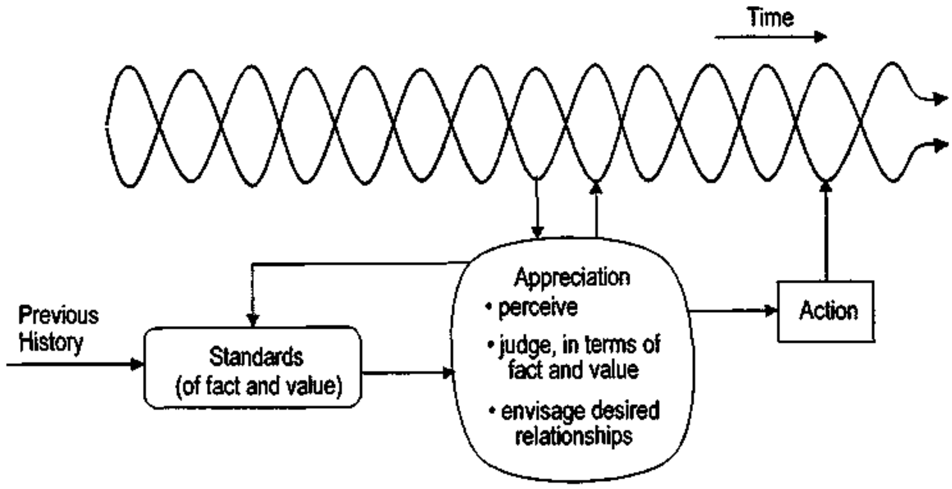


Figure A.1. The structure of an Appreciative System
Adapted from (Checkland and Casar, 1986) & (Checkland, 1999)

Also depicted in Figure A.1 is the influence of standards.

> "The epistemology of judgement making will be one of relationship managing rather than goal seeking, the latter being an occasional special case of the former. And both reality and judgements stem from standards of both fact and value: standards of what *is*, and standards of what is good or bad, acceptable or unacceptable" (Checkland 1999).

These value judgements will inform how to manage the relevant relationships. Vickers' greatest insight according to Checkland (1999) is that there is usually no absolute and ultimate source for the standards by which value judgements are made, i.e. what is good, important or relevant. Rather the previous history of the systems itself provides the current standards and moreover the current operation of the system may modify its current and future operation through its effect on the standards. One must keep in mind that this appreciation process is recursive and dynamic with time.

The major themes that recur in appreciative systems theory, adapted from Checkland (1999) are:

- A rich concept of day-to-day experienced life i.e. the interacting flux of events and ideas unfolding through time.

- A separation of 'reality judgements' and then 'value judgements'.
- The emphasis on managing relationships is a richer concept of human action than the ubiquitous goal-seeking model of human activity.
- The initiating of action stemming from reality and value judgements.
- The notion that standards, judgements and action are a recursive process organised as a systemic epistemology as illustrated in Figure A.1.

Finally, in comparing Churchman's social systems design and Vickers appreciative systems theory one has to conclude that although they make unique contributions to the philosophy of soft systems thinking, they are not dissimilar. The main thrust of social systems design is towards managing subjectivity by responding to the different worldviews of the system, through a process of dialectical debate, converging towards consensus. This is complementary to maintaining relationships through the process of appreciation based on standards of fact and value, which is not absolute but dependent on the previous history of the system. Both epistemologies are systemic.

A.3.3 Strategic Assumption Surfacing And Testing (SAST)

The primary aim of SAST is to foster understanding and appreciation amongst the various participants gathered around a problem situation, with respect to the assumptions and beliefs they hold about the problem situation. Emphasis is placed on problem formulation rather than on problem solving. SAST was designed by Mason and Mitroff (1981) for ill-structured problem contexts (messes) where the lack of consensus on which strategy to follow stifled or delayed needed action. SAST is underpinned by the philosophy of Churchman (1968, 1971) that advocates the need for different worldviews in a situation while at the same time accepting that every worldview is terribly restricted. This position also implies that there are no experts in the systems approach and therefore systems designers should always expose their worldviews to those that differ strongly and in so doing, subjectivity is managed and embraced. A more detailed overview of Churchman's philosophy was given in section A.3.1 of this thesis.

The fundamental tenets of SAST are that adversarial debates on polarised views about messes, by the participants of the intervention, will lead to a higher order synthesis. The methodology of SAST comprises of four sequential stages: -

Group Formation. The aim of this stage is to organise people into groups in such a way that a rich dialectical debate could take place. Therefore people who share the same view should be grouped together so that a particular view could be strongly supported. In addition, as many perceptions or differing opinions about the problem situation as possible should be accommodated. The groups should then be divided according to advocates of the different strategies, people with vested interests, and managers from different functional areas and/or subsystems.

Assumption Surfacing. The aim of assumption surfacing is to uncover and analyse the underlying assumptions upon which the various views on the strategies are based. Three specific techniques are used to assist in this process: Stakeholder analysis, assumption specification, and assumption rating.

In **Stakeholder analysis** each group must identify those persons on whom the success or failure of the strategy or design under concern depends. Stakeholders must include those affected by the strategy or design, those who have an interest in it, people who can affect the adoption, and implementation of it, and those who care about it.

In **Assumption specification** each group constructs a list of assumptions they have made about the individual stakeholders in assuming that their preferred strategy or design will succeed.

In **Assumption rating** two questions are asked about the assumptions made above: How important is the assumption in terms of its role in the success or failure of the strategy or design and how certain is the group that the assumption is justified? The answers are then used to rank the assumptions on a chart as shown in Figure A.2.

Dialectical Debate. In this stage the groups are brought back together and each group then makes a presentation on their strategy or design and the results of the assumption surfacing. Once all the groups have made their presentations a dialectical debate is encouraged. Issues pertaining to those stakeholders who may have been left out, assumptions of stakeholders that may not have been taken into account, assumptions of one group that another might have trouble with, the appropriateness of the assumption rating results, and the discrepancies between the groups in rating certain assumptions, are debated. The groups are asked to retire once more to reconsider and modify their assumptions for as long as progress is being made. When this is complete a final stage of synthesis takes place.

Synthesis. The aim of this stage is to reach a compromise on assumptions. A new list of agreed assumptions is negotiated and new strategies or designs can be derived. If no synthesis could be reached then issues of disagreement are recorded and ways of resolving this is discussed, such as further research.

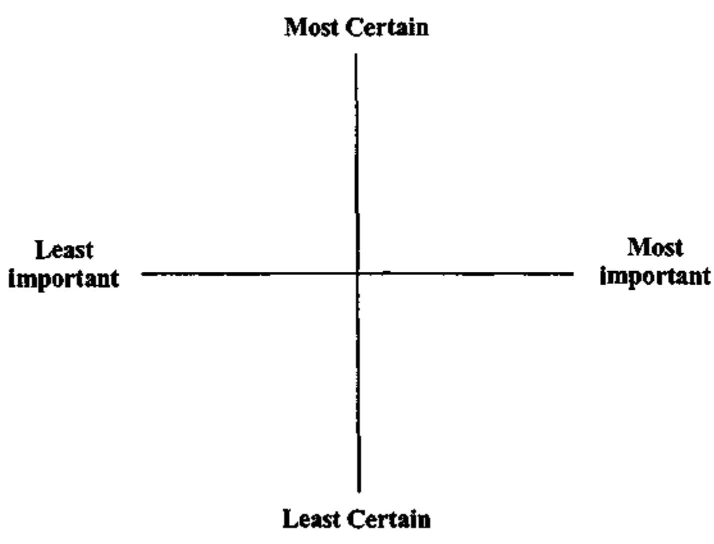


Figure A. 2. An assumption rating chart used in SAST

Flood and Jackson (1991) provide an in-depth critique of SAST with regards to its usefulness to systems practitioners. The successful operation of SAST is dependent on genuine participation being possible. There are and will be situations where genuine participation is not possible. In this case the philosophy of SAST is distorted and so the methodology will be ineffective. The methodology focuses on bringing diverse and opposing views to a point of consensus or accommodation, but hardly any attention is paid to the complex nature of the situation or the complexity of the system. Therefore SAST would provide only a partial solution to a complex situation whose participants hold divergent views. Further, in situations where there are irreconcilable differences (coercive contexts) it will be impossible to achieve the dialectical debate necessary for the proper application of SAST. One must take cognisance then of the fact that SAST is most suited to situations in which the system/subsystem is simple and the participants are able to come to an agreement on the assumptions that underlie the strategy or design.

A.3.4 Unbounded Systems Thinking

SAST and Unbounded Systems Thinking (UST) are built on similar philosophies and their approaches have similar tenets, although the scope of the purpose of UST is much wider. In fact SAST or parts of it, is often used within the UST approach. Therefore the discussion on UST is included here.

UST was developed by Mitroff and Linstone (1993) as an inquiry system (IS) that focussed on achieving multiple perspectives on a problem situation by "sweeping in" other inquiry systems ("ways of knowing"), from different paradigms of thought. In particular the authors mention the Inductive-Consensual IS, which is characterised by an empiricist system i.e. the inference of a general conclusion from a limited set of observations. The Analytic-Deductive inquiry system is mentioned as the second way of knowing. This is characterised by breaking down complex phenomena into its basic components i.e. the reductionist approach. These two inquiry systems are regarded as "old thinking" by the authors.

In the third way of knowing, the Multiple Realities IS, the data facts or observations that one gathers about a problem situation are influenced by the images, theories or models one has of the world. In other words the Multiple Realities IS is an interpretivist IS. A fourth way of knowing according to Mitroff and Linstone is through conflict and is labelled The Dialectic IS. This is a process of debate between two polarised positions on the same data set, or between a thesis and an antithesis, which enables the observer of the confrontation to come to a final decision, such as in a courtroom situation. Both these inquiry systems are meant for complex thinking, according to the authors.

A fifth way of knowing, Unbounded Systems Thinking, is proposed as "New Thinking" (Mitroff and Linstone, 1993). It is argued that each of the above IS have their fundamental deficiencies, but provide unique insights, when applied exclusively to a problem situation. At the core of the "sweeping in" process there is an underlying theory of how all the different branches or mutually dependent pieces of knowledge relate to one another. Therefore in UST there is no dominant perspective from any particular paradigm, rather, it is argued that all inquiry systems are interdependent on one another. The theory is based on the philosophy of Churchman (1971) and Singer (1959) from which could be gleaned the following critical propositions, relevant to UST: "Every science is to be found within every other; every model presupposes every other model; every problem is to be found within every other problem" (Mitroff and Linstone, 1993: 171).

The UST inquiry system centres on the 'Multiple Perspective Concept' and three categories of perspectives are suggested, the T, O, and P perspectives. The T (Technical) perspective subsumes the type of Inductive-Consensual IS and Analytic-Deductive IS. The O (Organisational or societal perspective) and the P (Personal or individual perspective) bring to the surface all the complexity due to the human factor, both as a society and as individuals. Issues such as culture, myths, and history that affect systems are dealt with in the O perspective. Individual worldviews, intuition, and unique patterns of individual behaviour are surfaced in the P perspective.

The underlying philosophy of UST, however, enables the inquiry system to be much broader than just multiple perspectives. This inquiry system also insists on including a broader sense and scope of aesthetics and ethics as vital aspects of a problem situation. For a similar treatment one may refer to Ackoff (1994). Should UST be regarded as soft systems thinking? One of the main purposes of UST, it seems, is to free those wishing to appreciate and formulate a problem situation, from the restrictions of just a functionalist approach (the T perspective). So the approaches used in the formulation of the perspectives range across both the hard and soft paradigms. However all that UST does is to facilitate this range of perspectives irrespective of the nature of the system, and because this is in essence a subjectivist approach, this author regards UST as a soft approach to problem solving. UST has been successfully applied in a number of situations and one may refer to Mitroff and Linstone (1993: 113-150) for some salient case studies.

A.3.5 Checkland's Soft System Methodology

Checkland and his colleagues first published some of the principles of SSM in 1972 (Tsouvalis and Checkland, 1996). SSM evolved from research that investigated the application of hard systems engineering to ill defined, ill structured, messy problems that managers of organisations were facing. However it soon became clear that the declared framework of hard systems engineering used in the action research practice provided at best very little improvement to the messy problem situations encountered and so SSM emerged as a more appropriate alternative. SSM was initially developed as a logically organised intellectual seven-stage methodology to understand and improve real world messy problems. The methodology later evolved to SSM mode 2, which caters for the cultural issues such as the history, the social system and the political system of the group under study. This version of SSM was first published in 1988 (Checkland, 1988a). Subsequent insights and modifications to SSM over the years by various users and critics of the methodology have enriched the practice of SSM.

A.3.5.1 A Description Of The Methodology Of SSM

Figure A.3 shows the original seven-stage systemic process of enquiry of SSM. In principle, the methodology comprises two main activities: the real world activities, and the conceptualisation or systems thinking activities. Stages 1, 2, 5, 6, 7 are characterised by everyday language and concepts and unreflective engagement with the problem situation. Stages 3 and 4 are characterised by systems language so that conscious reflection can be carried out with the real world problem situation (Tsouvalis and Checkland, 1996). SSM encourages the participants to move to and fro between these two activities as this particular process is essential for a deeper understanding of the problem, and to ensure the most appropriate action. Later, Tsouvalis and Checkland (1996) discourage the use of the dividing line between the two worlds. Although SSM is intrinsically a collaborative process the people involved in the real world activity do not necessarily have to be the same people doing the systems thinking. The process is not meant to be followed chronologically from step one to step seven, but rather, one may start a project at any stage, or work with two or more stages simultaneously.

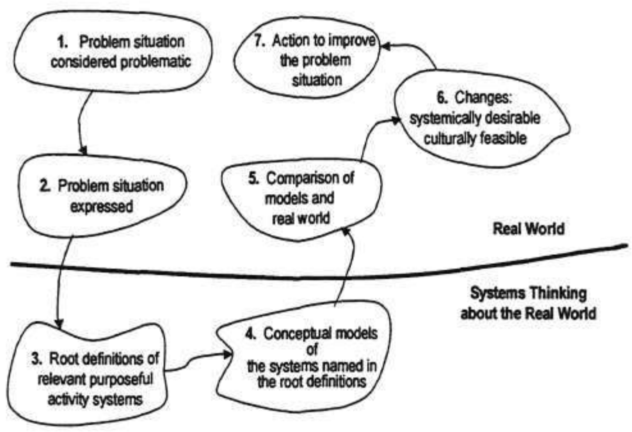


Figure A.3. Seven stage model of SSM (Checkland, 1975, reproduced in Checkland & Scholes, 1990)

Whereas root definitions are descriptions of what the system is and what transformation processes are required for improvement, conceptual models (stage 4) are models of the human activity systems (holons) that will achieve this transformation. In other words "that which needs to be done". Conceptual models are not about current reality but are structured purely according to the root definitions.

After recursively refining the outputs of the comparison stage in relation to the root definitions and conceptual models, discussion about possible changes follows in stage 6. The changes that are discussed must meet the two criteria shown in stage 6, Figure A.3, that is they must be systemically desirable in relation to the deep insights gained from the previous stages and culturally feasible due to the human element. Three kinds of changes are possible; structural and procedural changes such as those within an organisation, and attitudinal changes such as the willingness to change. In rare instances there may be the need for the creation and implementation of a system in order to achieve the agreed outcomes.

From the description of the methodology it is clear that there are some general principles that underpin SSM and these principles have always remained consistent through the evolution of SSM into its current form. The real world consists of problem situations that are well defined and predictable, that are conducive to hard systems thinking, and situations that are ill structured and messy. However well defined problems are often a subset or reside within a context of a social system, and so different human perceptions and interpretations together with changing phenomena call for an approach that subsumes hard systems thinking. SSM is such an approach and because it holds that our interpretations of the world are based on our perceptions or experiences of it there will always be different worldviews towards an ill-structured problem.

Whereas in hard system thinking the problem situation is systemic in structure and may fall within the optimisation paradigm, the enquiry process of SSM constitutes the systemicity, making use of conceptual system models that facilitate the learning. SSM then subscribes to an interpreting and learning paradigm where the outcomes of applying the methodology in a situation need to be defensible and will promote improvement rather than being absolute. Therefore the concept of purposeful 'Human Activity Systems' surviving in a changing environment is the cornerstone of SSM.

The SSM illustrated in Figure A.4 while holding to its foundation principles includes a cultural analysis stream and a less conspicuous dividing line between the two 'worlds', and dispels the false illusion that the various stages must be followed in a certain sequence. Over the years the action research that was carried out using SSM in real life situations saw the importance for an understanding of the cultural, political and historical factors and the relationships among them, for these influenced the action to be taken. Although stages 1 and 2 in the original form of SSM would have catered for this enquiry the cultural issues could be misconstrued to be less significant. Therefore the original logic based stream is now integrated with a cultural stream that emphasises the cultural enquiry explicitly as an on-going process to, and as important as, the logic based stream.

In examining Figure A.4 one would notice that the dividing line between the real world activities and the systems thinking world has now become implicit. This line was initially necessary for the novice users of SSM so that the conscious application of systems thinking was made explicit. However the outcomes of the systems thinking world are considered to be of heuristic value and the dividing line may give the false impression that there are two different worlds. The learning paradigm of SSM implies that knowledge will be generated during the application of SSM in a problem situation. Tsouvalis and Checkland (1996) give an account of the knowledge articulated in an SSM study. In brief the knowledge articulated in SSM is generally expressed as experience based knowledge, so the whole heuristic process in SSM, rather than below the line heuristic activities are vital for the generation of knowledge.

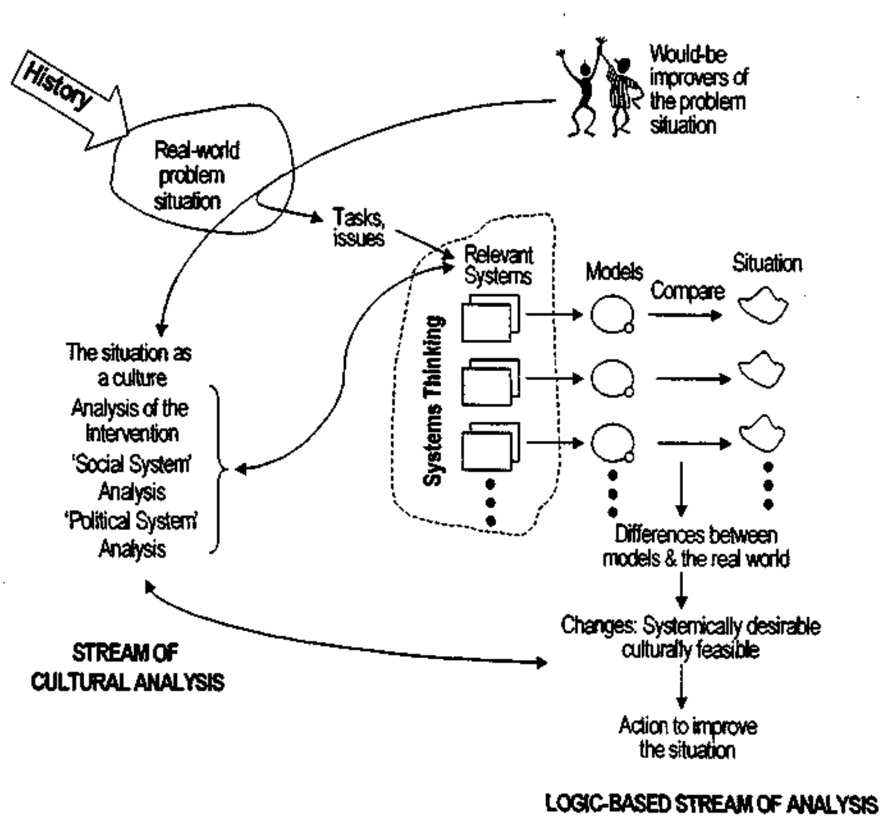


Figure A.4. The 'Two-strands model' of SSM (After Checkland & Scholes, 1990)

As a user gains more experience with SSM the methodology becomes internalised becoming part and parcel of one's thinking about problem situations. All the user needs is to be aware of the fundamental ideas of the methodology and the improvisation will happen according to the dictates of the problem situation. The root definitions, conceptual models, cultural and logical streams will be a matter of almost instinct to the SSM-user assisting her/him in making sense of the emerging experience. It is this mature mode of SSM that allows SSM to be versatile in terms of its applications. Checkland (1999), in his 30 year retrospective on SSM regards four intellectual breakthroughs as crucial to the success of SSM practice: The concept of 'human activity systems', the use of models as epistemological devices rather than a representation of reality, the use of models to stimulate debate and learning rather than for the purposes of design, and the application of SSM in the information systems domain.

A.3.5.2 Some Of The Techniques Used In SSM: Rich Pictures, CATWOE Analysis, Root Definitions And Conceptual Models

A rich picture is an ideal way of expressing one's own understanding and interpretation of the perceived complex problem situation under investigation. This depiction of the problem situation, which is never really complete, allows for parallel analyses while not losing track of any of the issues. This is extremely difficult with linear prose. There are no prescribed rules as such for rich pictures and therefore it is unlikely that two such pictures (by different persons) of the set task will evolve in an identical manner. This is of course desirable when one considers that the mutual understanding and appreciation of the problem situation is an expected significant achievement of stage 1 and 2.

The rich picture is not a systems description but in general will indicate the interconnections and relationships, processes and structure of the various issues. For example, a rich picture may depict the primary stakeholders of a RTS in a particular area, their interrelationships, and their concerns about the lack of telecommunications (See also Monk and Howard, 1998).

The root definitions that are used to inform the conceptual models are of two different kinds (Checkland and Wilson, 1980). Primary Task root definitions express a holon whose

system boundaries might coincide with the existing boundaries of the organisation. The transformation of telephone services to rural areas into economic development for the rural community will be a primary task root definition. Issue Based root definitions do not express holons that coincide with existing functions of the network operator. For example the network operator may not institutionalise the resolution of conflict between two rural communities as to who gets telephone services first. The crux of any root definition is the explicit root transformation process that is meant to bring about some predefined output. Checkland and Scholes, (1990) caution the user of SSM about the pitfalls to be avoided when expressing the transformation process. Firstly, the entity to be transformed must not be confused with the resources needed to bring about this transformation. Secondly, the action (verbs) should not be used as inputs and outputs. The transformation process deals with changing entities, for example telephone services into economic development.
In order to avoid the pitfalls and confusion associated with root definitions Smyth and Checkland (1976) formulated the mnemonic CATWOE to assist in producing clear well formulated root definitions where: -

Customers are the victims or beneficiaries of the transformation (**T**),

Actors are those who would do T,

Transformation process that converts the input to output,

Weltanschauung or the worldview, which makes this transformation meaningful in context,

Owners who could stop the transformation, and

Environmental constraints are elements outside the system which it takes as given.

For any purposeful Human activity system there will always be different interpretations depending on the different worldviews and so there will be a number of different transformations by which the activity system can be expressed. In exercising CATWOE the pairing of the transformation process (T) and the worldview (W) is of crucial importance. Using the intellectual apparatus of CATWOE ensures that the thinking is multilevel, covering at least the system level (what), subsystem (how), and the wider system vis á vis the owners (why).

The success in the comparison stage in terms of how things should be done in the real world depends on how well the conceptual model is assembled. Checkland and Tsouvalis (1997) mention five criteria that should be used to ensure the best possible model: effectiveness (is the transformation process the right thing to be doing taking into account the long term aims?); efficacy (do the means selected, work?); efficiency (is the transformation process being done with minimum resources?) (Forbes and Checkland, 1987: 8); ethicality (is the transformation process a moral thing to do?); and elegance (is the transformation process aesthetically pleasing?) (Checkland and Scholes, 1990: 288).

A.3.5.3 Some Criticisms Of SSM

There have been some criticisms levelled against SSM especially in the early years of its development, notably Thomas and Locket (1979), Jackson (1982,1983), Burrell (1983) and Mingers (1984). A concise discussion of these criticisms is found in Flood and Jackson (1991) and Jackson (2000), and therefore only the main points will be mentioned here, rather than an in-depth discussion.

The first criticism concerns the nature of the interpretive theory that characterises SSM. It is argued that problem situations in organisations are not only related to the conflicting worldviews of the individual actors, for which an accommodation is sought in SSM, but are also due to the neglect of cybernetic laws within an organisation, which are not taken seriously by SSM. The next criticism centres on a theme of consensus versus conflict. It is argued that SSM is based on a consensus worldview, which pays little attention to real conflict and coercion. The possibility that individuals or groups may have differences of real interest cannot be conceptualised within the logic of SSM, except through the cultural analysis, which does not fully cater for emancipatory interests. Further, in hierarchical settings within an organisation, genuine participative debates, on which SSM depends, is severely constrained due to the power imbalances in such organisations. It is quite possible therefore that the results obtained by SSM for a particular problem situation, would favour the powerful. Although the two-strand version of SSM recognises power, the methodology is not explicit about its neutrality in situations where it is not possible to have unconstrained debate. It must be noted that SSM has been practised mostly in managerial situations in which the participants would share common interests, and in which power would play a lesser role.

A.3.6 Ackoff's Interactive Planning

In section 3.5.4 of this thesis mention was made of the four orientations of planning as advocated by Russell Ackoff. These orientations were categorised into "reactivism", "preactivism", "inactivism" and "interactivism". Interactive Planning (IP) is a methodology advocated by Russell Ackoff in order to operationalise the process of achieving the objectives enunciated in interactivism. In a nutshell IP consists of "the design of a desirable future and the selection or intervention of ways of bringing it about as closely as possible" (Ackoff, 1999: 106).

Russell Ackoff, one of the founders of the operations research movement in the United States of America, broke out of the traditional operations research mould of 'optimisation' and 'objectivity', which characterised the Machine Age, to embrace the Systems Age. The thinking of the Machine Age according to Ackoff (1974, 1981, and 1999) consists of two ideas about the nature of the world: Reductionism and Mechanism. Problems are understood through the reductionist method of analysis and all phenomena are explained using one mechanistic relation of 'cause-effect'. Relying solely on a reductionist and mechanistic method of analysis leads to a deterministic worldview in which teleological concepts such as free will, purposeful behaviour and goals are meaningless. The worldview that the Machine Age yields is not discarded but rather is incorporated as a special case within the Systems Age.

In the Systems Age the concepts of reductionism, mechanism and the analytical mode of thought is supplemented by the concept of expansionism, teleology and a synthetic (systems thinking) mode of thought. Expansionism according to Ackoff is a doctrine that maintains that while the real world i.e. objects and events and all experiences of them consist of parts, these parts belong to a larger whole. The focus of attention in understanding and real world problem solving is on the whole with its interrelated parts, rather than on the parts themselves. It is these very principles that characterise the Systems Age (or systems thinking) that influenced Ackoff's view on human organisations or social groups.

Organisations are viewed as "purposeful systems that contain purposeful parts, with different roles or functions, and that are themselves parts of larger purposeful systems" (Ackoff 1999: 319). And therefore there are at least three wholes that have inherent value in themselves which must be considered in organisational problems: The effectiveness with which the organisation serves its own purposes, *the self-control problem*; the effectiveness with which the system serves the purposes of its parts i.e. the welfare of the organisation members, *the humanisation problem*; and the relationship of the organisation to the larger community of which it is a part, *the environmentalization problem*. Accepting this systems perspective of organisations calls for a different approach to decision making, especially in relation to objectivity.

Because the structure and parameters of messes continuously change, especially in turbulent environments, and because optimal solutions are not sustainable under such circumstances, there is a need for decision-making systems that can learn and adapt effectively. Inherent in expansionistic approaches to the organisation is the requirement that the multiple purposes of the different interacting wholes will lead to multiple perspectives from the different stakeholders. Therefore Ackoff rejects the idea of an objective value- free decision-making process and instead recommends that organisations strive for a "value-full" perspective that adequately reflects stakeholder diversity (Sinn, 1998). The implications of this is that all those who can be affected by the outcome of a decision should either be involved in it or their interests should be well represented. In addition Ackoff advocates that an account should be taken of aesthetic value which he calls stylistic preferences and progress towards ideals, in decision making. This is in keeping with Ackoff's idea of development as discussed in section 2.4 of this thesis.

Finally, in terms of the principles of expansionism and the synthetic mode of thought, problem situations must not be viewed as isolated problems but rather as a system of problems called messes. Messes require holistic treatment that necessitates interaction with a variety of disciplines. To facilitate development, the organisational stakeholders can learn how to establish a value-full perspective of the mess and thereby confront it. Ackoff advocates a synthesising planning paradigm to cater for all of these issues and Interactive

Planning is precisely the methodology for such a paradigm. Interactive Planning has been successfully used in a variety of contexts including regional planning in South Africa (Strumpfer, 1997), planning hospital organisation (Lartindrake and Curran, 1996), business (Barstow, 1990), city planning (Ozbekhan, 1997) and assisting community groups (Magidson, 1992).

A.3.6.1 Operating Principles Of Interactive Planning

The modus operandi of IP depends on three operating principles: The participative principle, the principle of continuity and the holistic principle.

The Participative Principle

In IP, emphasis and importance is shifted away from the actual plan (product) to the planning process itself, because the principal benefit in IP derives from engaging in the process. The participative principle facilitates the kind of development that Ackoff advocates which is two-dimensional. Through participation not only can members of the organisation develop and serve the organisation more effectively, but organisational development as a whole is enhanced. So the 'self-control problem' and the 'humanisation problem' is given due consideration.

The participative principle has two important implications for planning. The first one stems from the concept of development i.e. an increase in one's desire, and ability to satisfy one's own desire and that of others. No one can plan effectively for someone else. It is better to plan for one's self than be planned for by others for this promotes development. The second implication raises a question about the role of 'expert planners' and external or internal planning units. The role should be to provide encouragement and facilitation for the planning of others by themselves.

The Principle Of Continuity

The principle of continuity suggests that planning does not come to an end for it is a process that is under constant review. Events, expectations and initial assumptions change with time and so the planning needs to cater for this dynamism. Another reason for continuous planning is that the values that are being pursued very often change as one gets closer to them. Finally if the principal benefit of planning is derived from participating in it then it should not discontinue.

The Holistic Principle

The holistic principle is intended to address the deficiencies experienced with the top-down or bottom-up sequential planning. It advocates that the more parts of a system that plan simultaneously and interdependently the better. Systems are hierarchical in nature and so the holistic principle addresses different dimensions of an organisation. The holistic principle is therefore made up of the principle of co-ordination and the principle of integration. In order to ensure effective planning, all units at the same level should be planned for simultaneously and interdependently (principle of co-ordination), and also planning should be carried out interdependently at all levels (principle of integration).

The rationale for this, according to Ackoff, is that very often a threat or opportunity that appears in one unit may be addressed in another unit or in several of them simultaneously. This is in keeping with the view that problems should be addressed simultaneously and co-operatively from as many different points of view as possible. In addition, conflict often arises between levels of an organisation and between units at the same level, as a result of a lack of awareness or poor communication of the impact of one level or unit on another. The holistic principle is one way of managing this conflict.

A.3.6.2 The Five Phases Of Interactive Planning

This section provides an overview of the five phases of IP and those details that are relevant to this thesis. For an in-depth treatment of the processes involved in the various phases one may refer to Ackoff (1981). Although the discussion of IP by Ackoff revolves around the corporation, this section will attempt to keep the discussion as general as possible with applications to the organisation as a system. The five phases of IP are made up of: 'Formulation of the Mess', 'Ends Planning', 'Means Planning', 'Resource Planning', and 'Implementation and Control'. Of important note is the caution that the five phases are not meant to be followed in any particular order. They are interdependent aspects of a systemic process and moreover the process should never be completed implying a continual revisit to the various phases. Figure A.5 illustrates the five phases of an interactive planning cycle with their associated products.

Formulating The Mess

The first phase of IP consists of formulating the mess that the organisation is in. The mess consists of the future that the organisation is bound to experience based on two false assumptions. First it is assumed that the organisation will continue to behave, as it currently does i.e. no changes in current plans, policies and practices. Second, it is assumed that the environment will not change or, if it does it will change as expected. Every system has the potential to deteriorate and self-destruct and therefore one of the purposes of mess formulation is to identify these threats and to deal with them. The product or output of the mess formulation stage is a reference scenario that clearly depicts the future that the organisation or system is heading towards.

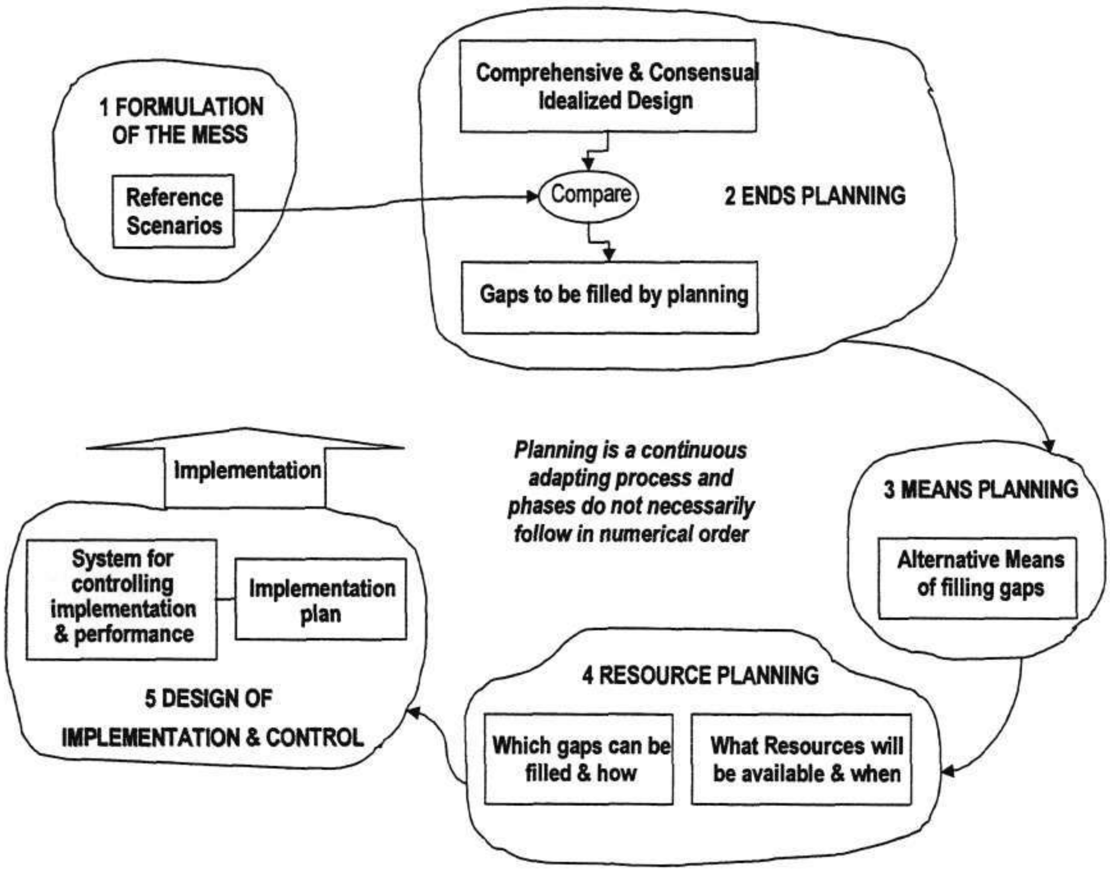


Figure A.5. An Interactive Planning cycle (After Ackoff, 1981)

Ackoff recommends that the participants begin the mess formulation stage with a systems analysis. A systems analysis should result in a "comprehensive and cohesive description of the current state of the corporation and its environment, how the corporation operates, who and what it affects and is affected by, and how." (Ackoff, 1981: 80). An obstruction analysis that follows brings to surface those constraints, both environmental and internal, that obstruct organisational development. Ackoff asserts that the principal obstructions to corporate development are usually self-imposed and usually consist of discrepancies between what one thinks or hopes one does and what one does in reality. The next task that the participants engage in is the preparation of reference projections that are extrapolations of past performances of a system into the future, assuming no significant changes in the behaviour of the system or its environment. These projections will normally reveal the impossibilities of the system that assists in understanding the mess. Finally the outputs of the systems analysis, obstruction analysis and reference projections are synthesised into a reference scenario that reveals the mess of the system. In other words it should reveal that if the system and its environment continue to behave as they are then the system would not meet its objectives.

Ends Planning

This phase of IP consists of designing a desired future, called idealized design, and extracting from the comparison between the reference scenario and the idealized design the gaps that need to be filled and those ends that the rest of the planning process needs to pursue. Ends are desired outcomes of action and are of three types: Goals that are expected to be obtained within the period covered by the plan, Objectives which are obtained after the planning period but towards which progress is made during the period planned for, and ideals that are unattainable but towards which progress is possible. The gaps that need to be filled should be classified as goals, objectives and ideals.

Idealized design or redesign of a system is a way in which the stakeholders of that system can prepare a vision of or conceptualise what they would like the system to be like right now assuming that this was possible. However there are two constraints on the idealized design: The design must be technologically feasible and operationally viable within the current environment of the system being planned for. In addition, because of the continual changes and uncertainties in the real world, the idealized design must be capable of rapid learning and adaptation.

Idealized design lies at the very core of IP and in general consists of three steps, selecting a mission, specifying the desired properties of the system and designing the system. The benefits include the following: -

- The facilitation of participation which produces development.
- The opportunity to incorporate the aesthetic values of the system stakeholders into the planning process.
- The consensus generated among the participants and the subsequent commitment that is made towards the realisation of that design.
- The creativity and innovation that is stimulated.
- The idealized design process clarifies those parts of the design that are pragmatic to implement.

Once again the benefits derived from idealized design lie not only in the implementation of the plans that finally emerge but also in the learning and creativity experienced through the process. Finally it must be emphasised that the product of an idealized design is not an ideal system. It is always capable of being improved and improving itself and therefore Ackoff refers to it as the most ideal seeking system which its designers can conceive of (Ackoff, 1981: 107).

Means Planning

The product obtained from comparing the final comprehensive and consensual idealized design with the reference scenario is a set of prioritised goals, objectives and ideals. In the means planning phase the ways of approximating the desired future are selected or created. In a sense means planning consists of two fundamental activities: The formulation of alternatives and the evaluation of these alternatives as the means. The different types of means may include courses of action, procedures and processes, practices such as timely reports, projects, or programs. In addition the relevant policies need to be selected or designed. The problems associated with the discrepancies between the reference scenarios and the idealized design may be treated in one of three ways according to Ackoff.

Problems may be resolved to produce a satisfactory outcome, solved to produce an optimal outcome, or dissolved, which significantly reduces the problem. Each treatment is largely based on experience and judgement, experiment and science or redesign of the system, respectively.

Once a set of alternatives has been formulated, the next main activity in means planning is choosing the most appropriate alternatives. Ackoff insists that before a choice is made the alternative means must be evaluated, either through experimentation or through modelling, depending on the resources and other legal or ethical impediments. Because participants have to make decisions about specific actions they tend to disagree more during the means planning stage. Experimentation and modelling also helps to resolve this.

Resource Planning

This phase of planning involves determining the amount and kind of each type of resource required by the means plan, how much of each will be available, what the gaps are between requirements and availability, and how they are to be filled (Ackoff, 1981: 231). In most corporations resource planning is highly developed because very often it is the only aspect of planning, the main focus of attention being the financial aspects. At least four types of resources should be taken into account: inputs, which include materials, supplies, energy, and services; facilities and equipment; personnel; and finances. It is interesting to note that Ackoff recommends the use of traditional operations research techniques such as mathematical procedures for resource planning.

Design Of Implementation And Control

This last phase of IP is certainly not the final. In fact this phase can be regarded as "planning for planning" (Sinn, 1998: 441). Design of implementation and control is concerned with implementing and controlling the decisions made in the prior phases and their subsequent performance. Participants design a feedback system and the information that is obtained, together with the continual monitoring of the environment of the system, provide the necessary ingredients for continuous planning and improvement towards the ideals agreed to in the ends planning. Finally it must be mentioned that "IP is a system of activities, hence it is more than the sum of its parts; it is the product of their interactions" (Ackoff, 1981:240). Therefore to engage only in certain phases of IP as planning is missing the mark.

A.3.6.3 Some Criticisms Of Interactive Planning

Sinn (1998) provides a comparison of interactive planning and SSM, in terms of their underlying theory, problem solving techniques, and outcomes. Although there are considerable differences, both the methodologies are dominated by the principles of the interpretive systems approach. Furthermore, Flood and Jackson (1991) mention that in complex systems where the participants have diverse interests and viewpoints but an accommodation among them is possible, interactive planning and SSM are well suited. It is not surprising that most of the criticisms levelled against SSM also apply to interactive planning. One may refer to Chesterton et al. (1975), Rosenhead (1984), Bryer (1979), Jackson (1982, 1983), and Mingers (1984) for an in depth critique of interactive planning.

A.3.7 Warfield's Interpretive Structural Modelling And Interactive Management

The process of Interpretive Structural Modelling (ISM) was designed by Warfield (1976) as a participatory, interdisciplinary learning process in an attempt to deal with the problem of managing complexity. Warfield recognises that a common ingredient of societal problems is the complexity they entail and the consequences of that complexity. All societal systems involve human planning, oversight, and steering, and are thus dependent upon the quality of human thought. In section 3.4.1 and 3.4.2 of this thesis a brief discussion on Warfield's theory on complexity was presented. The 'Structure-Based School of Thought', which was developed by Warfield and his colleagues, contends that complexity finds its locus in the human mind and is often distributed among the minds of several actors, rather than the system under investigation. Therefore the organisation of complexity is the foundation upon which that complexity can find resolution. ISM, which emphasises the significance of structural thinking, as the primary intellectual mode required in dealing with large complex systems, is an attempt to facilitate that resolution. (Warfield, 1996a, 1999); (Staley, 1995).

Although sufficient conditions for coping with complexity are not known, necessary conditions can be identified and one such condition according to Warfield is the reduction of cognitive burden by the use of aids in structuring complexity. In a system that consists of many parts and relations it is difficult to perceive and understand the structure of the system. The bounded rationality of the human mind implies that the span of absolute judgement and the span of immediate memory of humans is about seven items. This precludes the simultaneous consideration of many elements and relations by the human mind alone (Miller, 1956); (Simon, 1974).

The development of systems structure is inherently an iterative process and Warfield proposes a formal approach in the use of the machine (computer) and mathematics in a user-friendly environment to speed up the development of the structure and to overcome the barriers due to the limitations of the human being. A formal approach as compared to an intuitive approach to the structuring methodology is communicable in detail and conducive to evaluation. When analysing a system, or in trying to understand the interrelationships within the system, it is difficult to simultaneously cope with the "tyranny of quantity". This tyranny according to Warfield must be imposed on the machine so that the participants can do the creative and productive thinking and concentrate on the challenging aspects of the issues.

ISM is a learning approach to decision-making through group interaction. The process accommodates human perceptions with the most essential function being organisational. ISM does not add any contextual information and so the value added is purely structural. Graphics and words are employed in carefully defined patterns called structural models to portray the structure of a complex issue or a system. These structural models are formally constructed according to the rules and techniques that are founded in substantive theory, one of the core theories being the theory of relations. Intent structures, DELTA charts, preference structures and decision trees that are themselves founded in various branches of mathematics, are used in ISM. Warfield claims that the use of graphical methods based on theory of relations is in direct line of scientific thought that has been evolving for over 2000 years. In particular he mentions the works of Aristotle, Euler (1736) (graph theory), Boole and de Morgan (1847) (Logic), de Morgan and C. S. Peirce (1892) (relation theory), Caley (1858) (matrices) and Birkoff (1948) (lattice theory), (all cited in Warfield, 1982: 156)

Structural modelling uses a representation system that is comparatively well defined and perhaps the following statement by Warfield provides the most significant rationale for structuring complex issues into a representation system:

> "By progressively engaging new concepts and perceptions of the object system and translating these into a representation system that allows for various kinds of modularization of that system, it is possible to construct on paper a perception that is considerably more encompassing, definite, and utilitarian than that held in the mind at any one time. Thereby, the efficiency of rotation of concepts through the mind, in the effort to construct a more apt perception, may be increased through the effective presentation of the collective perceptions embedded in the representation system" (Warfield, 1976: 200).

In a nutshell ISM is a process that clarifies and transforms ill-structured mental models about the system under study into a clear interrelated structured set of system elements, which may include the needs, constraints and objectives. The operational process of ISM is carried out in two phases (see also Ryan, 1998):

- A creative process in which the group observes the complex issue and generates a list of possible elements of the complex issue. An appropriate contextual relation is then selected.
- A computer aided process for structuring the elements into a model of the underlying system that leads to the complexity. The group responds to computer-posed inquiries concerning element interaction. The responses required are usually 'yes' or 'no'. The computed displays the generated map. The map is then iterated and edited for group satisfaction with the structure.

The following types of structure may be generated depending on the type of relationships:

- Intent structures which indicate the relationships between intentions, objectives, goals, purposes, etc.
- Priority structures which structure the elements in order of priority.
- Attribute enhancement structures that show the relationships between a set of factors, problems or opportunities.
- Process structures that sequence the parts of activities.
- Mathematically dependent structures which structure relationships between quantifiable parts.

The ISM process can be used as a building block for other idea generation and management processes. In fact the ISM process itself is always a part of a more embracing process, in particular Interactive Management (IM). IM was conceived as a system of managing complexity and was developed at the University of Virginia in 1980 by Warfield and his colleagues, to serve as one of those embracing processes. IM is a computer assisted group activity that supports the development and interpretation of structural models of complex situations. It is steered by the rigorous process of ISM into deep learning about the complex situation at hand, which then provides a legitimate and defensible basis for a systematic resolution of the complex problem, which then leads to the design of improved systems. IM is claimed to be based on a new science (Warfield and Cárdenas, 1994) called the "Science of Generic Design" developed by Warfield (1994). The underlying approach taken in the practice of IM is rooted in the integrated knowledge of human behaviour, philosophy, and technology.

Warfield offers four universal priors to science as the human being, language, reasoning through relationships and archival representations, and he asserts that without each of these there can be no science (Warfield, 1994: 16). He characterises each of these in terms of their significance to science. Of particular interest is his characterisation of reasoning through relationships, which is based on the philosophy of Peirce. Warfield's work is in part based on the four types of inference, identified originally by Peirce, which is illustrated below in Figure A.6.

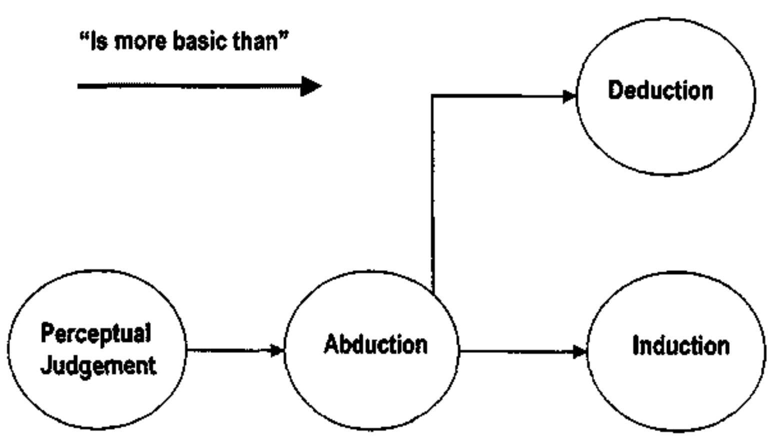


Figure A.6. Types of inference according to Peirce (after Warfield, 1994)

Perceptual judgement is the most basic form of inference and is usually regarded as subjective in nature. It is inference that is immediately formed when a mental transformation takes place as a result of sensory perceptions. Perceptual judgement is least susceptible to analysis. Abduction is a mental process whereby plausible hypothesis and conjectures are generated to explain unexpected situations where the outcomes have not yet been established. Deduction is the process of formal reasoning that starts with certain given assumptions about a situation and finally predicts the practical consequences of the hypothesis articulated. Induction is the process of inference of a conclusion resulting from observations or experimental work that is used to validate any hypothesis. Peirce's theory on inference is a fundamental part of the philosophy that Warfield developed to support his process of inquiry.

Figure A.7 shows a scale of belief that is also applicable to Warfield's philosophy, again based on work of Peirce. Inference is the vehicle for moving human belief from one end of the scale to the next (Warfield, 1994: 53). Here is the interpretation of the elements of Figure A.7 given in Warfield (1994). Real inquiry is stimulated by a dissonance and a doubt as a result of a destabilised belief (disbelief). Neutrality offers no basis for decision making. Next in the enquiry is inclination towards belief and then finally belief, which can be seen as leading to habitual behaviour. According to Warfield (1994), Peirce viewed deduction as syllogistic and therefore it merely rearranged existing knowledge, rather than producing new knowledge. Abduction and Induction on the other hand are seen as ampliative inferences, producing new knowledge. This is the philosophical context that informs the methodology of IM.

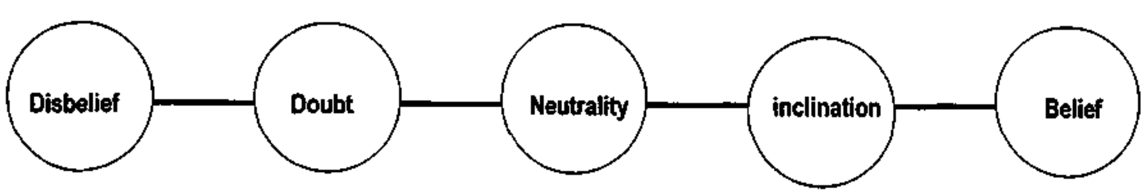


Figure A.7. A scale of belief (Warfield, 1994)

Figure A.8 provides a self-explanatory overview of the process and products involved in IM. The process consists of three main phases: the development of the problem situation definition, generation of alternative designs and finally the choice of design (Warfield and Cárdenas, 1994).

The process described in Figure A.8 has five distinct success levels: -

- Learning - what is involved in approaching the problem.
- Learning about the issue itself.
- Achieving a good definition of the issue
- Finding good alternative design for resolving the issue.
- Arriving at a good action choice to resolve the issue

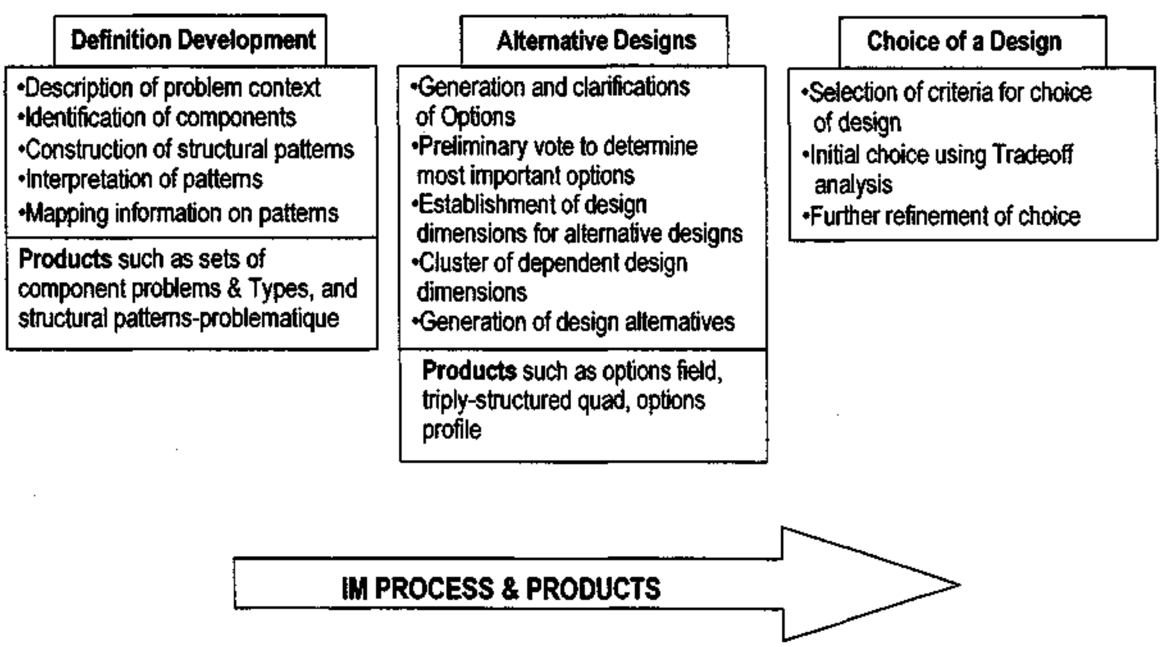


Figure A.8. Overview of the process and products of IM

ISM/IM has been successfully applied to a range of complex situations such as city planning, transportation management, General Management issues, Higher Education Program Planning, Project Design, Problem definition, Energy and Environmental conservation, Engineering design and production, and social issues. (Warfield, 1982); Saxena *et al.*, 1992, Hawthorne and Sage, 1975; Jedlicka and Mayer, 1980). One may also refer to the annotated bibliography on ISM and IM obtainable from The Institute for Advanced Study in the Integrative Sciences, George Mason University, Fairfax, Virginia, USA. Web site: http://www.gmu.edu/departments/t-iasis.

A.3.7.1 Some Criticisms of ISM/IM

ISM/IM is a well-developed (in terms of theory and practice) methodology spanning some 20 years, with hundreds of applications (Warfield and Cárdenas, 1994). It is therefore surprising that the author could not find any criticisms on ISM/IM in the formal research literature such as those in which Warfield published his work over the years. Jackson (2000) provides a very brief sketch of possible weaknesses in the details of the approach of the methodology. The need to work in small groups, usually eight to twelve, is limiting. The mandatory use of computer assistance could be time-consuming and an IM session could turn out to be mechanical if too much emphasis is placed on the computer software. Perhaps the strongest point that Jackson (2000) makes is the limitations of the structural logic to cope with the messes in social issues. The author shares this view and shall now expand on this.

Jackson (2000) categorises IM as an interpretive systems approach and Cárdenas (2000) provides an account of the characteristics of IM that makes it conducive to a soft systems approach classification. However while IM is a 'consensus' seeking methodology in terms of the structure of the system or problem under investigation, the crux of the methodology is a *systematic* representation of the issues according to functionalist logic. Although learning as an important part of the process is emphasised, the salient features of the interpretive systems approach are stifled by some of the methods and techniques, such as the relational logic. Hence IM can be characterised as a harder approach than SSM. How IM deals with situations in which there are vested interests, conflict and power such as may be found in a rural telecommunications planning situations is not addressed by the methodology.

The use of computer software in soft systems approaches as part and parcel of the inquiry is a controversial issue. Computer software is based on science that works well under bounded conditions, and therefore is not well suited to situations that are prone to uncertainty and unpredictability. However, it must be noted that Warfield's primary aim in IM is dealing with the complexity of the situation (see for example Warfield, 1999). His writings seem to indicate that he is agnostic to hard systems or soft systems approaches. In fact IM has been used in both hard systems, such as the extreme case of the design of a mechanical drive train, and in situations that required softer approaches, such as strategic planning in an academic department. In general, complex societal problems will require more than one approach (see Mitroff and Linstone, 1993), and so IM could be a most appropriate methodology as part of a larger systems intervention

A.4 Critical Systems Thinking

The two main themes that dominated the studies into systemic interventions prior to the 1990s were design and debate (Flood and Romm, 1996). Designs focussed on how systems are best co-ordinated and controlled for example cybernetics, system dynamics and systems engineering, as discussed earlier in this chapter. Debate concentrated on addressing divergent viewpoints about a problem situation with the intention of facilitating an accommodation of these viewpoints through a systemic process, such as Soft Systems Methodology. However in the 1980s, according to Jackson (1994) limitations in the different strands of system thinking began to surface and there was a failure to think through the relation between the various approaches. Critical Systems Thinking (CST) was developed as a strand of systems thinking to address this failure. The seminal contributions to CST include contributions by Ulrich (1983), Jackson (1991), Flood and Jackson (1991), and Jackson (1994). Its main task was to evaluate the strengths and weaknesses of the various systems approaches and to think through the relations between the different methodologies.

CST is best understood by looking at the fundamental commitments that it is said to embrace. Flood and Jackson (1991a) mention three of these commitments:

- **Critical Awareness** includes understanding the strengths and weaknesses and the theoretical underpinnings of the available system approaches and their methodologies. It also includes a close examination of the assumptions and values that may influence the design of particular systems or that may be prevalent in existing systems. Also the context of application of the system methodologies must be understood with the intention of determining the consequences of action (Flood, 1990).

- **Emancipation** includes ensuring that intervention is focussed on improvement or the maximum development of potential (Midgley, 1996). Where the exercise of power prevents proper use of systems intervention new methodologies should be formulated to tackle these situations.
- **Methodological pluralism** advocates the use of a variety of methodologies in a theoretically coherent manner with a full understanding of the strengths and weaknesses of the methodologies in relation to the problem situation. Jackson (1994) states that methodological pluralism calls for a metamethodology, which respects all other commitments of CST, which will operationalise pluralism.

Jackson (1991a) mentions the original five commitments as critical awareness, social awareness, human emancipation, complementarism at the methodological level, and complementarism at the theoretical level. However Midgley (1996) argues that methodologies embody theoretical assumptions and so theoretical pluralism is implicit in methodological pluralism. Also the social consequences (social awareness) of applying different systems methodologies is inextricably linked to the commitment of emancipation. Therefore the original five commitments may be embodied in the three highlighted above.

CST is underpinned by the philosophical thought of Habermas (1972). In particular his epistemological "theory of knowledge-constitutive interests" identifies three types of interests that motivate the inquiry of knowledge: a technical cognitive interest, a practical interest in achieving mutual understanding, and a human emancipatory interest. An exegesis of Habermas' philosophy is not within the scope of this thesis. Instead the following explanation by Jackson (1991) will suffice.

> "According to Habermas, human beings possess two fundamental cognitive interests that direct their attempts to acquire knowledge: a *technical* interest and a *practical* interest. The two interests are 'quasi-transcendental' because they necessarily derive from the sociocultural form of life of the human species, which depend on 'work and interaction'. Work enables human beings to achieve goals

> and to bring about material well-being. Its success depends upon achieving technical mastery over the environment of action. The importance of work for the human species directs knowledge toward a technical interest in the prediction and control of natural and social systems. Interaction requires human beings to secure and expand the possibilities for intersubjective understanding among those involved in social systems. Disagreement between different individuals and groups can be just as much a threat to the reproduction of the sociocultural form of life as a failure to predict and control natural and social processes. The importance of interaction leads the human species to have a practical interest in the progress of mutual understanding.
>
> While work and interaction have, for Habermas, pre-eminent anthropological status, the analysis of power and the way it is exercised are equally important, he argues, if we are to understand past and present social arrangements. The exercise of power in the social process can prevent the open and free discussion necessary for the success of work and interaction. Human beings have, therefore, a third cognitive interest: an emancipatory interest in freeing themselves from constraints imposed by power relations and in learning, through a process of genuine participatory democracy, to control their own destinies" (Jackson, 1991: 12).

Without an acceptance of methodological pluralism it is hardly likely that the technical interest, the practical interest and the emancipatory interest will be satisfied in a systemic intervention. In a methodological pluralistic approach, for example, hard systems thinking such as systems engineering and cybernetic systems serve the technical interest to predict and control the environment. Soft Systems Thinking such as Interactive Planning and Soft Systems Methodology serve the practical interest in achieving mutual understanding. A methodology such as Critical System Heuristics (to be discussed later in this section) can serve the emancipatory interest to free oneself from oppressive power relations. Jackson (1991a) relates human emancipation to maximising the development of human potential and therefore argues that all three interrelated human interests need to be addressed to achieve emancipation. It should be noted that the commitment to critical awareness supports methodological pluralism in terms of the critical thinking about and the critical use of methodology, and also supports emancipation through the surfacing of power relations. The question that now remains is how does one operationalise CST in the real world?

A.4.1 Total Systems Intervention

Total Systems Intervention (TSI), which was originally presented, in Flood and Jackson

(1991) is a metamethodology framework that evolved within the critical systems thinking movement. It offered systems practitioners a guide to choose between different methodologies among different paradigms (hard, soft, etc.) for a particular intervention in a theoretically informed manner. TSI primarily views problem solving as a process of intervention that supports learning about and managing complex interacting issues. Its original form, labelled TSI version one by Midgley (1997), employed metaphors, creative thinking and the knowledge and elucidation gained from the process of reflection and critique to create its 'total systems interventions' approach.

The framework in TSI version one consists of a three-phase process similar to that illustrated in Figure A.9, which evolved much later. Similar to the 'formulation of the mess' in Interactive Planning and the expression of rich pictures in Soft Systems Methodology, TSI begins with the perception of the mess. However, TSI adds a further dimension of creativity and choice to the implementation strategy for analysing and dealing with the perceived mess (Wilby, 1996).

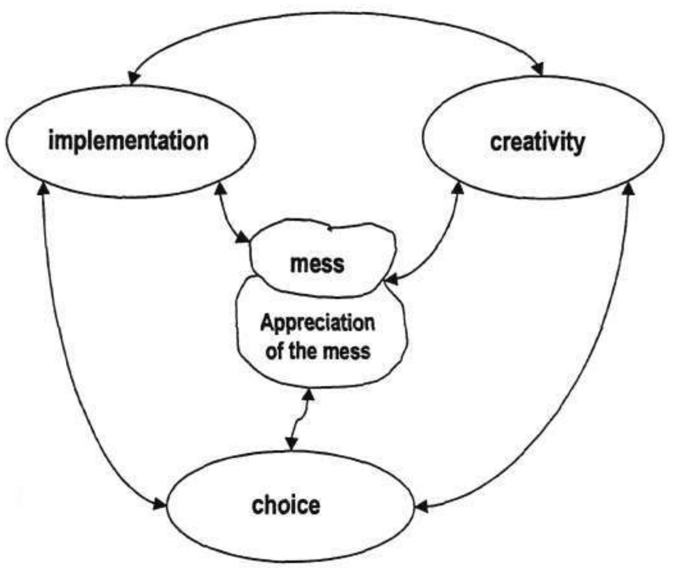


Figure A.9. Three-phase process of TSI (Flood 1995)

In TSI version one the creativity phase uses metaphors of organisation, e.g. the brain metaphor or the machine metaphor (Morgan, 1986), to stimulate creative thinking in order to surface the issues inherent in the perceived mess. The product of the creativity phase should be (a) key metaphor(s) that aptly describe the mess. The choice phase is about choosing the most appropriate methodologies, informed by the metaphors and the system of systems methodology (Flood and Jackson, 1991: 42), for tackling the mess (also mentioned in chapter five of this thesis). The implementation phase employs the chosen methodologies to deal with the issues surfaced in the creativity and choice phase. It must be noted that although TSI was said to 'begin with the creativity phase' the structure and process of TSI version one is iterative and effectively does not have a particular start and finish. It is important to note that it is the *methodologies* that are mixed and not *methods* in TSI version one.

As a result of a postmodern critique of TSI version one, structural and processual changes were made in a new version (Flood, 1995). In addition a deeper consciousness through which these changes could be better understood was catered for (see Flood and Romm, 1996). This is known as TSI version two or Local Systemic Intervention (LSI)

In LSI the basic structure of TSI version one (three phases) is expanded to include three modes: the critical review mode, the problem-solving mode, and the critical reflection mode, which all involve the three phases of creativity, choice and implementation but in a recursive manner. However, both the creativity phase and the choice phase have been significantly transformed (Midgley, 1997). In the creativity phase the metaphorical analysis makes room for people to create their own metaphors. In addition the use of creativity-enhancing techniques and space and time for thinking creatively is emphasised. In the choice phase the system of systems methodologies was discarded. Rather, Flood (1996) proposes four key organisational dimensions or domains that practitioners are interested in: organisational processes, organisational structure, organisational culture, and organisational politics. The task now becomes one of aligning methods with domains. All this is done within the three modes.

The centre of critique (in terms of creativity-choice-implementation) for each mode is different. For the critical review mode the centre is the possible methodologies and methods that may be incorporated in the problem-solving mode. For the problem-solving mode the centre of critique is the mess appreciation. For the critical reflection mode the centre of critique is the product of the problem-solving mode. Each mode in turn encourages creative thinking about the centre of critique, choice from the centre of critique, and implementation of that choice (Flood, 1996). It is important to note that LSI promotes the mixing of methodologies and methods so long as the principles of the methodologies are adhered to. Some of the criticisms levelled against TSI version one and two are covered in chapter five of this thesis.

A.4.2 Critical Systems Heuristics

Critical Systems Heuristics (CSH) was developed by Ulrich (1983, 1996, and 1998). Ulrich is highly critical of the "monopoly of knowledge and power" inherent in the expert and technocratic driven social planning. He asserts that including ordinary people in the intervention process and giving them a voice is not good enough. The voices must be made "competent". He proposes an ideal, which advocates that "citizens become *citizen-planners* and planners should see themselves as *planner-citizens*". CSH addresses the whole issue of the commitment to emancipation as advocated by Jackson (1991) in critical systems thinking. However Ulrich prefers the term 'improvement' which deals with the issues of ethics, conflict and choice. There is no simple positive answer to the question: "How can we justify the value implications, let alone the 'rationality', of any proposal for 'improvement' in the face of conflicting needs and interests?" according to Ulrich (1996: 9). CSH provides a clear and generic critical path to address the issues arising out of this question. It uses the systems idea to explore a critical path that is not expert driven and holds emancipatory potential for ordinary citizens.

CSH is founded on the philosophy of Habermas' Theory of Communicative Action (Habermas, 1984, 1987) and Kant's Critical Philosophy (Kant, 1784), and so theory and practice are interconnected and well balanced. A key feature being that CSH neither seeks a total theoretical solution to the problem of securing rational action nor a "consensus theoretic" approach. The purpose or aim of CSH then is to develop a critical consciousness in people about the improvement that is needed and that is possible and then to empower people with self-reflective and argumentative skills, which translates the critical consciousness into a meaningful and effective participation in the planning process. It is important and relevant to the planning framework developed in this thesis to note that CSH is not a self-contained planning methodology but is intended to complement other approaches.

The core concept in CSH is the notion of Boundary Judgements and how this relates to promoting improvement. According to Ulrich all plans for improvement depend on assumptions about what facts and values are to be considered and what is to be left out. In other words determining the system of concern or the "context of application". Ulrich calls these boundary judgements or justification break-offs because they define the boundaries of the planning effort and the point at which justification ends. Ulrich (1996: 17) regards this as the *"fundamental critical kernel of systems thinking"*. In a pragmatic situation such as planning for improvement holism without boundary judgements leads to endless options for understanding improvement.

In order to empower the practitioners of CSH with some methodological rigor Ulrich proffers a conceptual framework that hinges on a set of twelve boundary judgements related to the sources of human intentionality that determine the meaning of improvement. An implicit belief in the planning framework developed in this thesis is that ultimately and fundamentally it is the people that are most important with respect to the plan - more important than the technology, time space issues, and material social issues. A similar belief is expressed in CSH: "It is people on whom the meaning of improvement depends first of all, for they posses the sense of purposefulness, the power, knowledge and sense of responsibility that together determine *what ought to count as improvement*" (Ulrich, 1996: 20). Figure A.10 gives an overview of the way in which the twelve boundary judgements are categorised in relation to human intentionality.

The twelve boundary questions are arranged in four groups of three questions each. The first question in each group is related to a social role e.g. who ought to be the plan's client? The second question relates to role specific concerns e.g. what ought to be the plan's purpose? The third to the problem of dealing with the conflicting concerns that are part of social reality e.g. what ought to be the underlying measure of improvement? (Ulrich, 1996: 24-31).

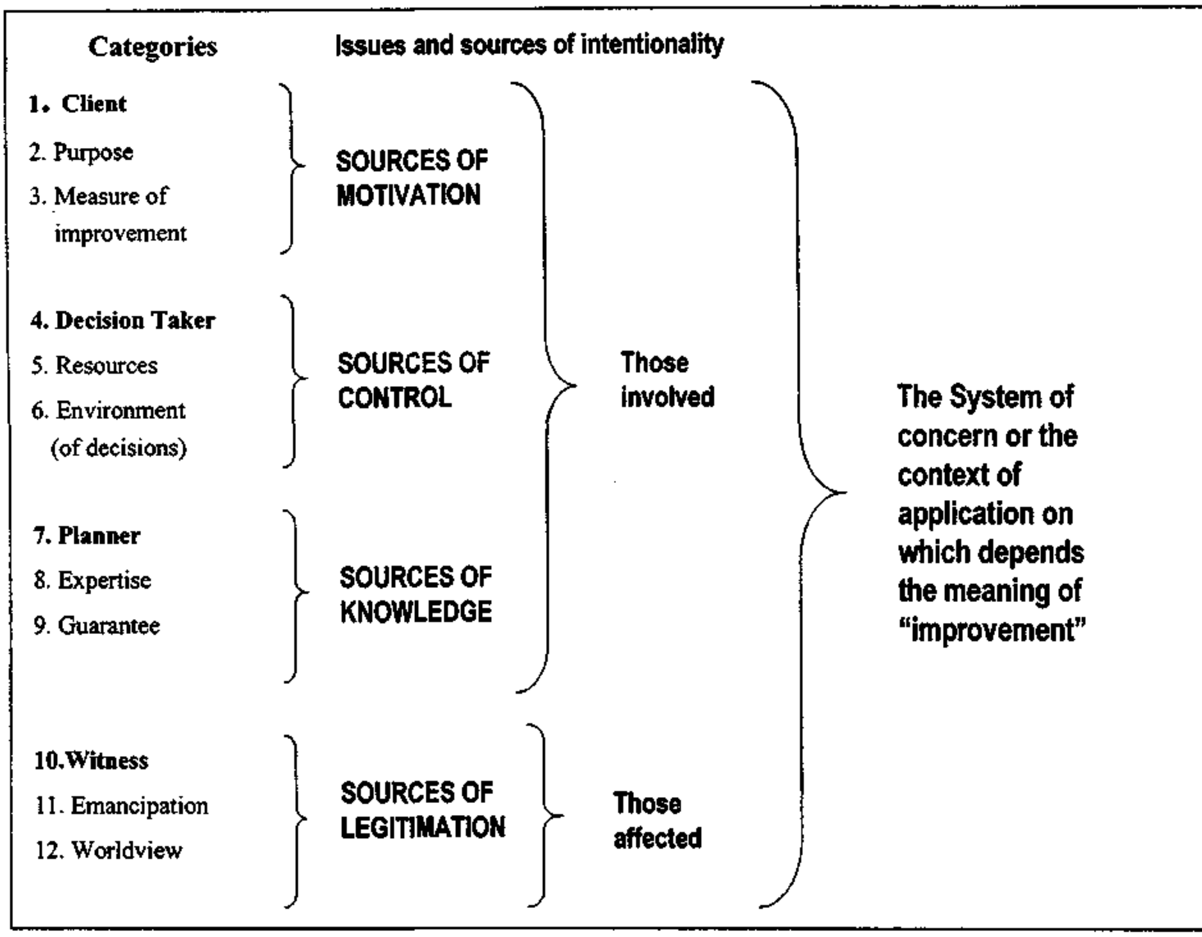


Figure A.10. An overview of critically heuristic categories (Ulrich 1983: 258)

A salient feature in applying the boundary questions is the use of the 'ought' mode and the 'is' mode to the set of generic questions, for example, who ought to be the decision maker compared to who is the decision maker. This is similar in concept to analysing what should be the vision and how this fits in with current reality. It is this mode of questioning that unlocks the critical power and drives the processes of unfolding a plan's normative and empirical content.

This appendix dealt with the major systems approaches that characterise the systems movement. The purpose of this exercise was to provide a substantial account of these systems approaches and their applicable methodologies with the intention of finding the most suitable approach or combination of approaches for the development of the planning framework for rural telecommunications infrastructure. Therefore it was necessary to engage in those aspects of the various approaches covered. It must be stressed that while the author studied a far wider range of methodologies during the research, only those with potential application and necessary for the elucidation of the framework were covered.

APPENDIX B: 'FORMULATION OF THE MESS' WORKSHOP

Table B1: Details of participants in the 'Formulation of the mess' workshop held on the 12th July 2001 at the Telkom SA centre for learning in Durban. The author facilitated the workshop.

PARTICIPANT	POSITION IN TELKOM SA SECTION	EMAIL ADDRESS
GROUP ONE		
Mr. A. Hoffmann	Area Manager: Technology engineering	Hoffmaal@telkom.co.za
Mr. M. Paes	Senior Engineer: Technology Engineering	Paesmj@telkom.co.za
Mr. R. Ramparsad	Engineering Operations: Regional Network Engineering	Ramparr@telkom.co.za
Ms M. L. Giles	Senior Planner: Regional Integrated Network Planning	Gilesml@telkom.co.za
GROUP TWO		
Mr. M. C.Thurlby	Senior Planner: Regional Integrated Network Planning	Thurlbm@telkom.co.za
Mr. D. van den Berg	Technologist: Microwave and radio engineering	Vdbergds@telkom.co.za
Mr. B. S. Gumede	Specialist: Technology Engineering	Gumedes@telkom.co.za
GROUP THREE		
Mr. S. Dancer	Senior Planner: Regional Integrated Network Planning	Dancersa@telkom.co.za
Mr. L. Nayager	Specialist: Technology Engineering	Nayagel@telkom.co.za
Mr. P. H. Mlotshwa	Engineer: Technology Engineering	Mlotshph@telkom.co.za
Mr E. Smith	Area Manager: Regional Integrated Network Planning	Smithe4@telkom.co.za

Table B2: Results of the Stakeholder Analysis for the Mapumulo area. The data shown are as per the original transcripts, without any significant editing. The author adds texts in italics.

Group one

Standard stakeholders	**Fiduciary stakeholders**	**Silent stakeholders**
• Farmers • Trading Stores – Spar – Bottle Store – Vendors • Scholars • Hospital • Fuel Station • Pensioners • Taxi (Transportation) • Residences • Consumers • Property owners • Unemployed (e.g. "kids")	• Government • Police • Health • Education • SAPOS *(South African Post Offices)* • Tribal Auth*orities* • Tribal Chiefs • Hospital • Sugar Industry • ESKOM *(power generator and distributor)*/Utilities • Banks	• Tourism • Animals/ECO System • Water • Roads/Rail • Sport/Recreation

Group Two

Standard stakeholders	**Fiduciary stakeholders**	**Silent stakeholders**
• Business – Commercial & Government • Police • Education • Vendors • Hospital • Emergency Services • Farmers • Households • Sugar Farmers • Chiefs • High income businesses	• Associations: Sugar Cane, Taxi/Bus, Residential (neighbourhood watch), Chief hierarchy. • Governments	• Large commercial expansion • Increase in schools

Group Three

Standard stakeholders	Fiduciary stakeholders	Silent stakeholders
• Corporate business (Major business in Town) • Local Business/farming/ small business • Schools – Education Department • Clinics/Hospitals • Churches • Security Services (Police) • Town Governments (local authorities)/governance • Public (households) • Distant relatives	• Traditional leader • Local authority/District Municipality • Dept. Health • Consultants – Environments – Infrastructure • Church groups/youth groups	• *HIV* AIDS • Migration Workers • Scholars • Political Changes • Technology evolution • Demographics • Economic growth/decline

PPT B1: Black and white copy of the preliminary power point presentation delivered at the 'formulation of the mess workshop'

Telkom Workshop, 12 July 2001
CFL, Durban, South Africa

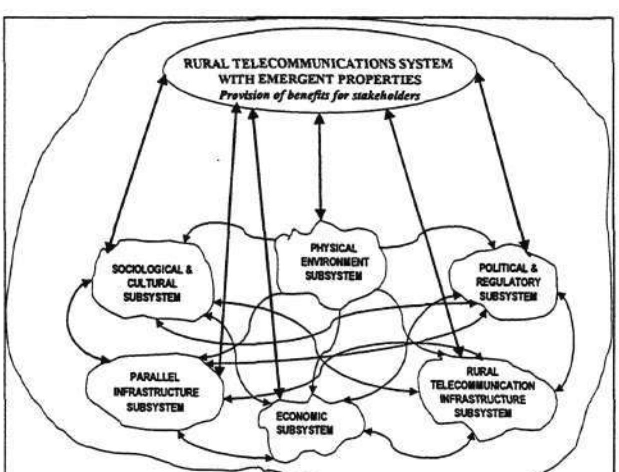
Implementation of a Systemic Planning & Design Framework for Rural Telecommunications Infrastructure

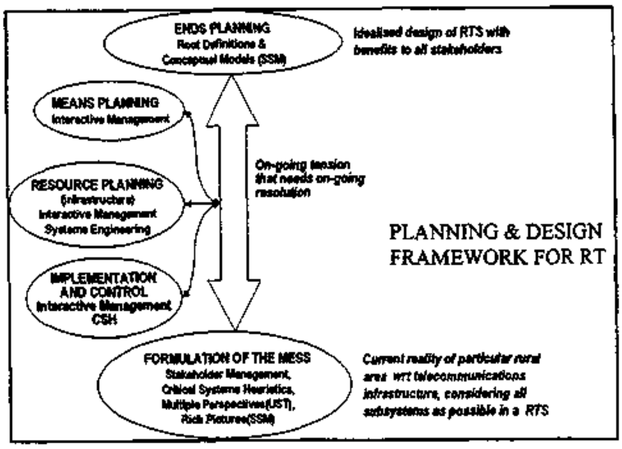
By

Theo Andrew

Agenda

- 10 minute orientation and background
- 10 minute general overview of the framework
- 2 hour Practical Case Study of Formulation of the Mess
  - Background of rural area under consideration
  - stakeholder analysis/ CSH
  - TOP perspectives
  - Rich Pictures





Stakeholder Management

- ■ Standard Stakeholders
  - ◆ All those would be affected by
  - ◆ all those that could possibly affect
- ■ Fiduciary Stakeholders
  - ◆ can and may act on behalf of clients
- ■ Silent Stakeholders
  - ◆ could be affected but do not exist at the moment or unable to voice their concerns

Critically-Heuristic Boundary Questions to support Stakeholder Management

■ **"Ought" mode**

- Who ought to be the plan's client? That is, whose interests ought to be served?
- Who ought to be the decision-maker/s? That is, who ought to be in a position to change the plan's measure of improvement?
- Who ought to be involved as planner/s? That is, who ought to be considered competent to participate in the design of the plan?
- Who ought to be witness to the interests of those affected but not involved? That is, who should argue the case of those who cannot speak for themselves but maybe concerned.

Critically-Heuristic Boundary Questions to support Stakeholder Management

- "Is Mode"
  - Who is the plan's client? That is, whose interests does it actually serve?
  - Who is the decision-maker/s? That is, who is in a position to change the plan's measure of improvement?
  - Who is involved as planner? That is, who is considered competent to participate in the design of the plan?
  - Who is witness to the interests of those affected but not involved? That is, who argues the case of those who cannot speak for themselves but may be concerned.

Multiple Perspectives on Problem Situation (TOP)

What is Objectivity?

- Technical
  - hard issues such as technology, environment, those that can be quantifiable
- Organisational
  - Telkom, Govt., rural community
- Personal
  - your perspectives - ethics - Society

Rich Pictures (Checkland)

- Pictures are a better means for recording relationships and connections than linear prose
- RP is an approach which subjective interpretation and understanding of messy situations is achievable
- Rich Pictures facilitate multiple perspectives and learning.

Guidelines for drawing Rich Pictures

- Elements of structure
  - physical aspects and components e.g. buildings and equipment, departmental divisions
- Elements of progress
  - aspects of a situation that undergo change or are in a state of flux
- Relationship between structure & process and between processes
- The RP is basically never finished

Some Common Mistakes when Drawing Rich Pictures

- A rich picture is not a system description. Do not impose a system structure on it
- Each item pictured need not be connected to more or one other items.
- Beware of RP looking like flowcharts
- Beware of linear sequential drawing

Figure B1, A map of KwaZulu Natal showing the relative location of the Mapumulo area. (Courtesy, KwaZulu Natal tourism)

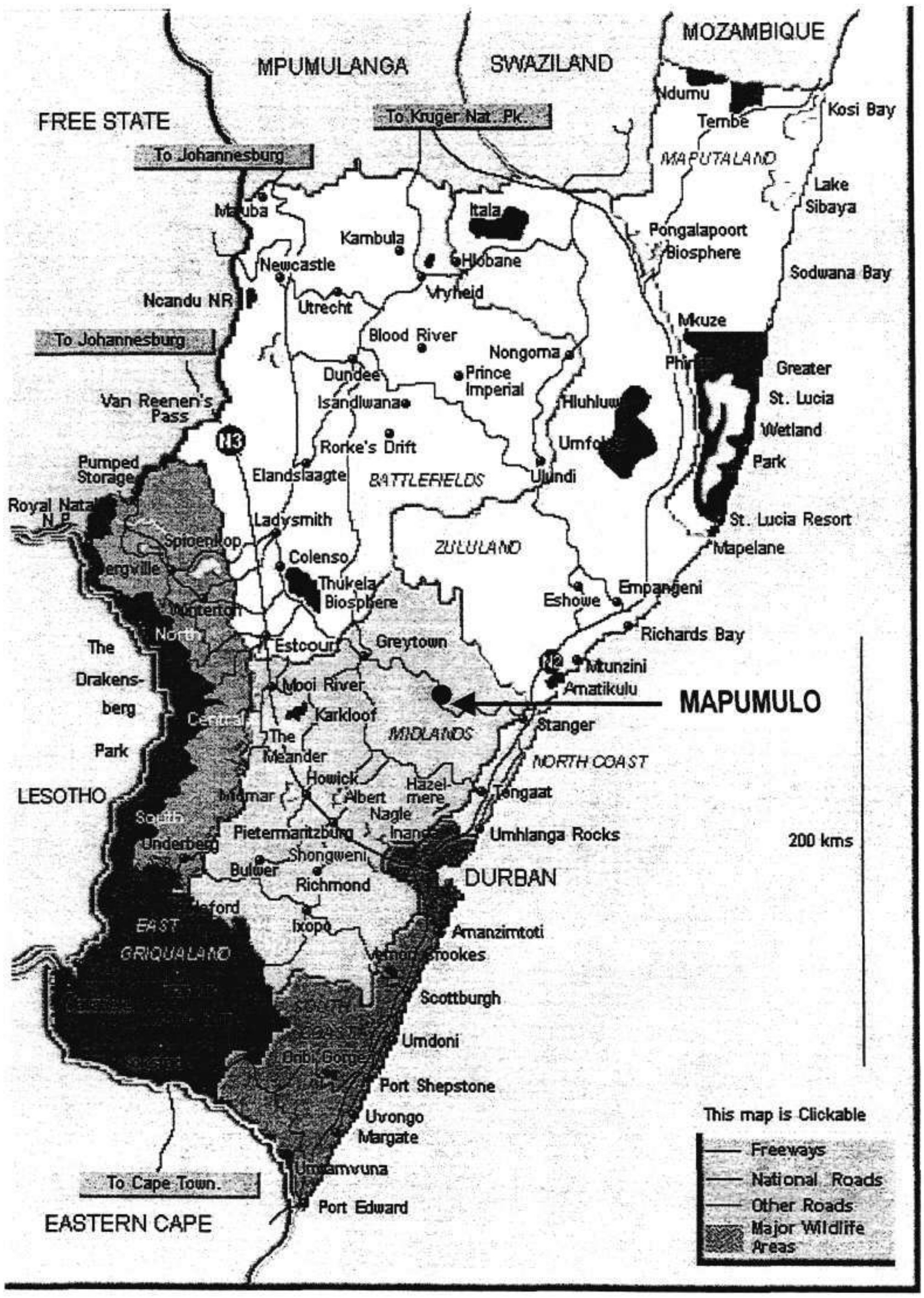
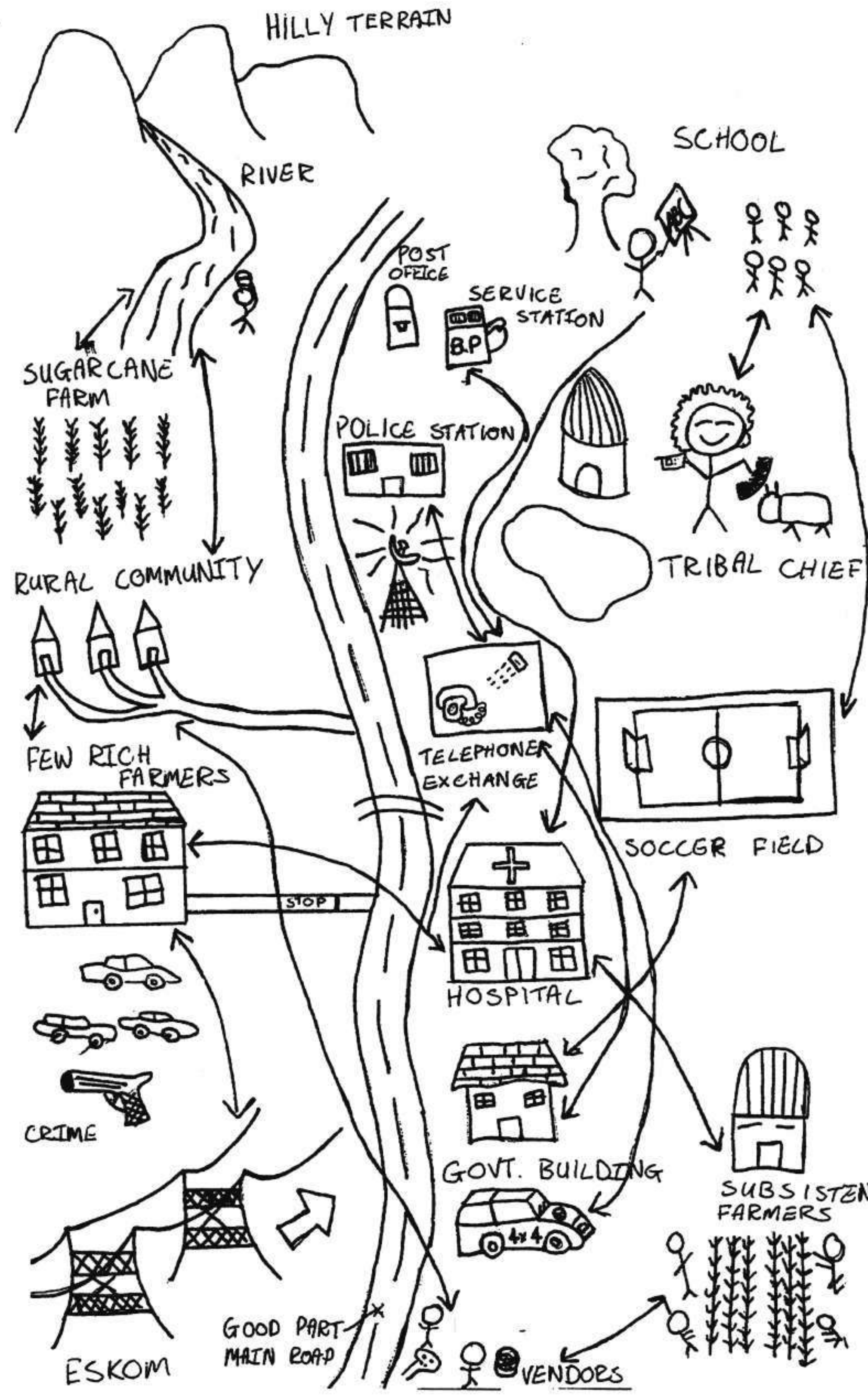


Figure B2, A rich picture developed by the Telkom Planners depicting the range of issues or the mess that the planners have to deal with in providing telecommunications infrastructure to the Mapumulo area



Reproduction by Ryan Andrew

APPENDIX C: 'ENDS PLANNING/IDEALISED DESIGN' WORKSHOP

Table C1: Details of participants in the 'Ends planning/idealised design' workshop held on the 17th September 2001 at the Telkom SA centre for learning in Durban. The author facilitated the workshop.

PARTICIPANT	POSITION IN TELKOM SA SECTION	EMAIL ADDRESS
GROUP ONE		
Mr. S. Mkhize	Area Manager Access Network Engineering	Mkhizess@telkom.co.za
Mr. M. Paes	Senior Engineer Technology Engineering	Paesmj@telkom.co.za
Mr. E. Ndunakazi	Junior Manager Technology Engineering	Ndunakez@telkom.co.za
GROUP TWO		
Mr. E. Smith	Area Manager Regional Network Integrated Planning	Smithe4@telkom.co.za
Mr. P. Gumede	Engineer Technology Engineering	Gumedenp@telkom.co.za
Mr. L. Nayager	Specialist Technology Engineering	Nayagel@telkom.co.za
GROUP THREE		
Mr. H. Leonard	Manager Access Network Planning	Leonarhe@telkom.co.za
Mr. D. van den Berg	Technologist Technology Engineering	Vdbergds@telkom.co.za
Ms. N. Gumede	Engineer Technology Engineering	Gumedenm@telkom.co.za
GROUP FOUR		
Mr. A. Roets	Area Manager: Technology Construction	Roetsa@telkom.co.za
Mr. C. Wahlberg	Junior Manager: Technology Engineering.	Wahlbecw@telkom.co.za
Mr. A. Hoffman	Area Manager: Technology Engineering	Hoffmaal@telkom.co.za

Table C2: Results of the <u>Constrained Idealised design</u> for the Mapumulo area done by each of the four groups. The data shown are as per the original transcripts, without any significant editing. The author adds texts in Italics.

Group one

What systems pertaining to the RTS would you like to see at Mapumulo?	**What core RTI would support these systems?**
• Health care - Plain Old Telephone Service (pots), pay phones • Security - pots • Education - pots, pay phones • Banking - pots, IT/Internet • Services- pots • General Population & GSM - pots, pay phones *Some of the broad categories of constraints mentioned were* politics, power, cost, knowledge, infrastructure	• Wireless (solar), copper • Copper distribution

Group Two

What systems pertaining to the RTS would you like to see at Mapumulo?	**What core RTI would support these systems?**
• Pots - town area (limited solar deployment) • Video surveillance (security) • Video/tele-medicine (health) • Tele - conferencing (tribal chief) • Distance Learning (education) • Fast Internet access • Tele-banking	• Fibre systems • Radio/wireless systems • Copper

Group Three

What systems pertaining to the RTS would you like to see at Mapumulo?	**What core RTI would support these systems?**
• Tele-medicine (town and rural) • Distance learning (rural) • Pots (rural and town)	• Fibre/copper • Radio (limited) • VSAT: radio

Group Four

What systems pertaining to the RTS would you like to see at Mapumulo?	**What core RTI would support these systems?**
• Tele-medicine/video conferencing • Voice communications (fixed & mobile) Internet • Emergency services (radio) • Security (police, military, and private) • Private data network (GOVNET) • Distance Learning/education • Banking systems • Broadcasting (audio/video) • Paging • Telemetry	• Switch (accommodation, power, aircon) + data POP. • Core transport (fibre and microwave) • Distribution primary - fibre, copper, microwave. • Distribution secondary - wireless local loop (WLL), copper, point to point or multipoint, mobile, satellite. *Power was mentioned as an important consideration in secondary distribution.* • Content Server • Broadcast Transmitter/coverage

Table C3: Results of the <u>Unconstrained Idealised design</u> for the Mapumulo area done by each of the four groups. The data shown are as per the original transcripts, without any significant editing. The author adds texts in italics.

Group one

What systems pertaining to the RTS would you like to see at Mapumulo?	What core RTI would support these systems?
• Health care - POTS, tele-medicine, paging, radio, IT/Internet, pay phone. • Security - Radio, POTS. • Education - POTS, tele-education, IT/Internet, pay phone. • Banking - POTS, IT/Internet. • Services (Govt., police, post office, electricity) - POTS, IT/Internet, radio. • General population & GSM - POTS (affordable), POTS (general), IT/Internet (general), pay phones. • Broadcasting.	• Copper (internal), wireless point to point, fixed cellular point, PABX, wireless - paging radio. • Wireless (point to multipoint), fixed cellular. • Copper, fixed wireless, DECT/RURTEL. • Copper, fixed wireless. • Copper, fixed wireless (DECT, GSM). • Fixed wireless (DECT, GSM point to point).

Group Two

What systems pertaining to the RTS would you like to see at Mapumulo?	What core RTI would support these systems?
This is what this group would like to see in the Mapumulo area • Electric power available. • POTS widespread. • Wide video surveillance. • Water reticulation to all schools and hospital. • Improved roads or access. • *It was believed that* "Now widespread constrained facilities can be provided". *Mention was made of the* Integrated Development Plan (IDP) by district municipalities.	Not mentioned.

Group Three

What systems pertaining to the RTS would you like to see at Mapumulo?	**What core RTI would support these systems?**
• Tele-medicine • Distance learning • Banking • Library, linked to • Video on demand (information system). • Video surveillance e.g. fire warning. • Broadcasting (voice and video) • POTS services • GSM	• Fibre - DWDM • Copper - xDSL • Radio - DECT, TDMA, satellite, microwave.

Group Four

What systems pertaining to the RTS would you like to see at Mapumulo?	**What core RTI would support these systems?**
• Tele-medicine • Voice (fixed/mobile) • Internet • Emergency services • Security • Virtual Private Networks (VPN) • Distance Education • Full banking services • Broadcast (audio/video) • Paging • Telemetry • Content production (audio/video) • Flexible billing - Customised packages such as prepaid system for high bandwidth.	• Switch/ATM POP, DSLAM • Core - Fibre/DWDM, Ring redundant • Sharing with other utilities • Primary distribution - Fibre to the curb, microwave to the curb, copper/xDSL • Secondary distribution – copper/xDSL, fixed mobile, mobile, … • Content server - distance learning, entertainment. • Broadcast transmitter.

PPT C1: Black and white copy of the power point presentation delivered at the 'Ends planning/idealised design' workshop.

Telkom Workshop 2, 17 Sept 2001
CFL, Durban, South Africa

Implementation of a Systemic Planning & Design Framework for Rural Telecommunications Infrastructure

By

Theo Andrew

Agenda

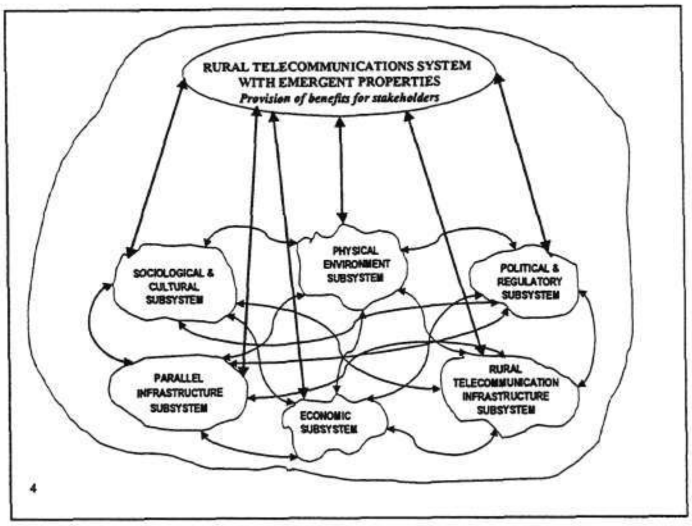
- Review of the process (20 min)
  - the systems engineering approach
  - RTS
  - Framework
  - Formulation of the mess - Rich Pictures
- Ends Planning (2 hours)
  - Some theoretical aspects
  - practical workshop
- Wrap up & Lunch

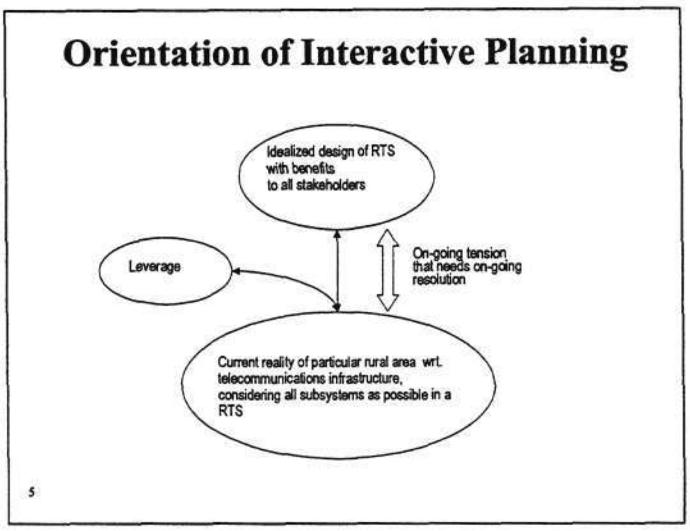
2

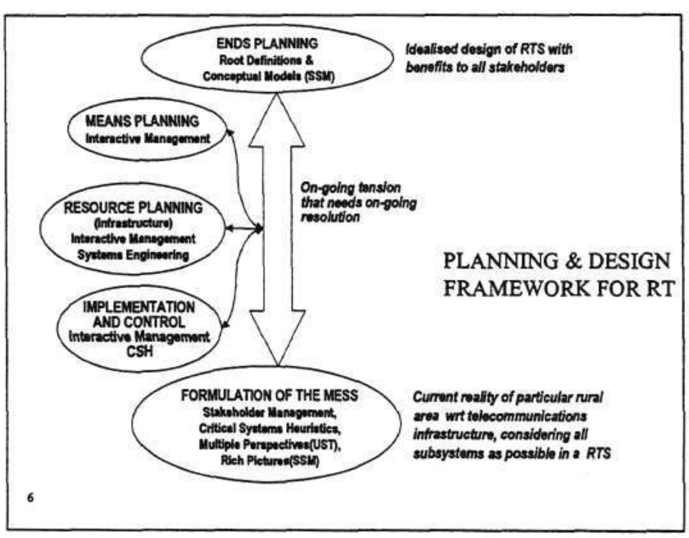
Overview of current practice in planning & design of RTI

- The hard paradigm of systems engineering
  - The knowledge and information dimension
  - The time dimension
  - The logic dimension
- The Time Dimesion
  - Program planning, project planning, system development, production, installation, retirement
- The Logic Dimension
  - Problem formulation, value system design, systems synthesis, systems analyses, optimisation of alternative,
  - decision making, planning for action to implement

3


RURAL TELECOMMUNICATIONS SYSTEM
WITH EMERGENT PROPERTIES
Provision of benefits for stakeholders
SOCIOLOGICAL & CULTURAL SUBSYSTEM
PHYSICAL ENVIRONMENT SUBSYSTEM
POLITICAL & REGULATORY SUBSYSTEM
PARALLEL INFRASTRUCTURE SUBSYSTEM
RURAL TELECOMMUNICATION INFRASTRUCTURE SUBSYSTEM
ECONOMIC SUBSYSTEM
4


Orientation of Interactive Planning
Idealized design of RTS with benefits to all stakeholders
Leverage
On-going tension that needs on-going resolution
Current reality of particular rural area wrt. telecommunications infrastructure, considering all subsystems as possible in a RTS
5


ENDS PLANNING
Root Definitions & Conceptual Models (SSM)
Idealised design of RTS with benefits to all stakeholders
MEANS PLANNING
Interactive Management
RESOURCE PLANNING
(Infrastructure)
Interactive Management
Systems Engineering
On-going tension that needs on-going resolution
PLANNING & DESIGN FRAMEWORK FOR RT
IMPLEMENTATION AND CONTROL
Interactive Management
CSH
FORMULATION OF THE MESS
Stakeholder Management,
Critical Systems Heuristics,
Multiple Perspectives(UST),
Rich Pictures(SSM)
Current reality of particular rural area wrt telecommunications infrastructure, considering all subsystems as possible in a RTS
6

Formulation of the Mess Review

- Discusion on the Stakeholder Analysis and Rich Picture
  - Does it adequately capture the issues and complexity
  - What changes need to be made

7

Ends Planning/Idealised Design

- A vision of the ideal rural telecommunications system for the Mapumulo area that will provide all the benefits for all the stakeholders wrt the services that are possible through the RTI - Right Now
- Conceptual design of appropriate telecom infrastructure to achieve this *(practicality is not required of an idealised design)*

8

Constrained Idealised Design

- The idealised design is constrained by the containing system, ie. The external environment of the RTS does not change.
- In other words there is no need to forecast the future environment. What system would you like to ideally have <u>right now</u>, if you could, within the constraints of the external environment

9

Step 1: Constrained Idealised Design

- What systems pertaining to the RTS would you like to see at Mapumulo?
  - Must be technological feasible
  - Must be operationally viable, ie must be able to survive or be sustainable in the current environment
  - must be adaptable to change
- What RTI will support these systems? Do not mention specific equipment
- Remember maximum benefits to all stakeholders as possible.

10

Unconstrained Idealised Design

- The idealised design is not constrained by the containing system
- The designers are permitted to change any of the containing systems - only in ways that would affect the performance of the system to be designed.
- *Most of the obstacles between current reality and idealised vision does not lie in the environment*

Step 2: Unconstrained Idealised Design

- What systems pertaining to the RTS would you like to see at Mapumulo assuming that you could change the containing system?
- What RTI is needed to support this idealised design? Do not mention specific equipment
- Remember maximum benefits to all stakeholders as possible.

12

Step 3: comparison between constrained and unconstrained Design

- What are the key differences between the constrained and unconstained design for the Mapumulo area?
- What are some of the obstacles to achieving the unconstrained design?

13

Step 4: Current way of planning

- What would the infrastructure look like if it was designed in the usual way? What criteria would be used? And how would you do the design?

14

APPENDIX D: RURAL TELECOMMUNICATIONS PLANNING WORKSHOP HELD WITH MAPUMULO COMMUNITY REPRESENTATIVES

Table D1: Details of the community representatives that participated in the planning workshop held on the 7th November 2001 at Mapumulo. The author conducted the workshop.

PARTICIPANT	AFFILIATION WITHIN MAPUMULO
Mr. M. K. Zungu	Mapumulo Municipality
Mr. E.V. Mhlongo	Deputy Mayor Mapumulo Municipality
Captain O. T. Masikane	South African Police Services Mapumulo
Mr. M. C. Majola	Department of Welfare Mapumulo
Mr. F. Z. Ndlovu	Department of Environmental Health, Mapumulo
Mr. T. A. Ncobela	Department of Justice Mapumulo
Mr. V. Mthethwa	Regulatory and Government Relations, Telkom SA
Mr. J. W. Mthembu	Isulethu Organisation Mapumulo
Mr. V. M. Khoza	Ward 03 Councillor Mapumulo Municipality
Miss. H. T. Myeza	Mapumulo Youth Organisation Sonke Youth Club
Mrs. D. S. Sicini	Ward 09 Councillor Mapumulo Municipality
Mr. T. B. Fihlela	Department of Correctional Services, Mapumulo
Mr. L. B. Dumakude	Agriculture Mapumulo
Miss. N. R. Hadebe	Department of Sport and Recreation
Mrs. B. D. Mkhwanazi	Ward 10 Councillor Mapumulo Municipality
Mr. W. Khumalo	King Shaka District Council
Mr. B. Ntuli	Chairperson of the Regional Transport Forum
Mr. D. J. Zubane	Ward 11 Councillor Mapumulo

Table D2: Results of the Stakeholder Analysis undertaken by the Mapumulo community representatives during the planning workshop for telecommunications, held on 7th November 2001. The author adds texts in italics.

Traditional Leaders: Amakhosi, Izinduna, Izinduna's Councillors, Ward Councillors
Community Leaders: Ward Councillors, Development Committees, Business, Churches
Government Departments Local Authority, District Councils, South African Police Services, etc
Community *Grass roots level*
Other Service Providers *Such as: Eskom, Telkom, and GSM Providers*
Farmers *Includes the subsistence and professional farmers*
Churches *Includes the Kwa Siza Bantu Mission*
Business Owners *Usually SMME*
Non Governmental Organisations and **Community based Organisations**

DOC D1, Agenda for the planning workshop for telecommunications, held on 7th November 2001 at Mapumulo

TELECOMMUNICATION PLANNING WORKSHOP FOR THE MAPUMULO RURAL AREA

DATE: **Wednesday, 7th November 2001**

VENUE: **Ilembe Offices of Regional Council, Mapumulo**

AGENDA

SESSION 1

1.1 Welcome and Introduction of Team Members (Theo Andrew, Nips Nepal and Lucky Badula). Lucky would help with English – Zulu interpretation.

1.2 Background to the research project. Mention the workshops with Telkom.

1.3 Our objectives for the workshop.

1.4 Brief Overview of the Planning Framework.

SESSION 2 (4 groups of 5)

Stakeholder analysis

2.1 Each group discusses and lists those people or organisations they think are stakeholders of the rural telecommunications system.

2.2 Answer the four ought mode questions

2.3 Plenary discussion.

SESSION 3 (Plenary)

3.1 What are the developmental issues in the Mapumulo area?

3.2 How do they see Telecommunications and development?

3.3 What is their response to theft and affordability?

3.4 Comment on Telkom's Rich Picture.

SESSION 4 (Plenary)

4.1 Undertake a constrained design. What do they think should have been done in the area thus far, regarding systems that need telecommunications infrastructure support?

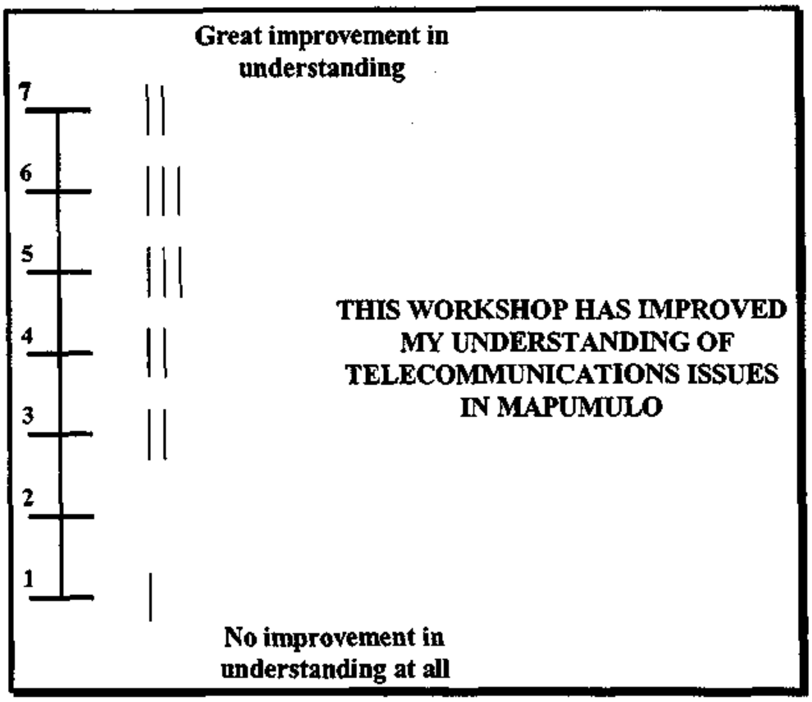
4.2 Undertake an unconstrained design. Assuming infinite resources, what systems would they like to see in the area.

4.3 COMPARE THIS WITH WHAT TELKOM DID.

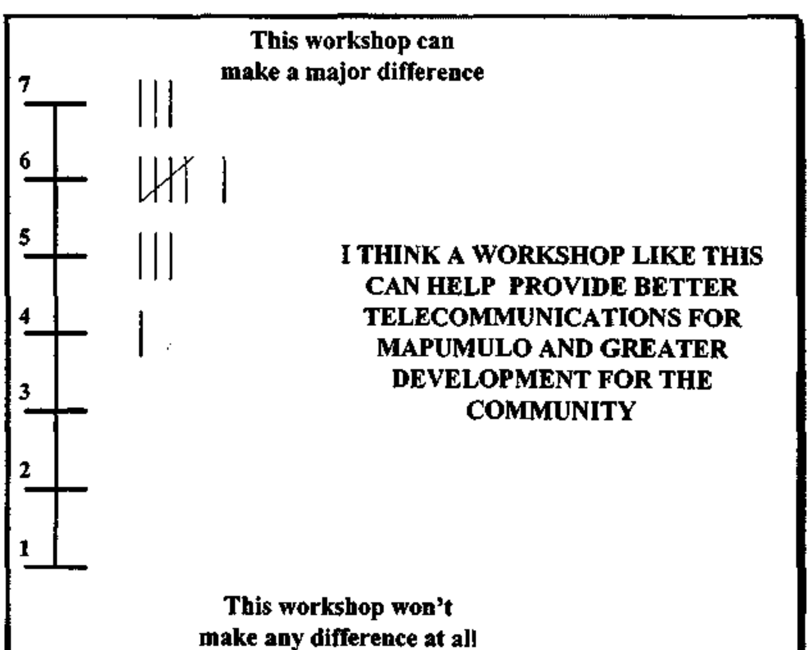
SESSION 5

EVALUATION OF WORKSHOP

Graph D1, Evaluation of the workshop with respect to the understanding of telecommunication issues in Mapumulo by the participants. The individual ratings by the participants are tallied as shown.



Graph D2, Evaluation of the workshop with respect to the improvement of telecommunications infrastructure and development for Mapumulo. The individual ratings by the participants are tallied as shown.



APPENDIX E: TRIAL IMPLEMENTATION OF THE LEVERAGE PHASE OF THE PLANNING FRAMEWORK FOR THE MAPUMULO AREA

Table E1: Details of the Telkom planners that participated in the 'leverage phase' planning workshop held on the 5th December 2001 at the M L Sultan Technikon in Durban. The author conducted the workshop.

PARTICIPANT	AFFILIATION WITHIN MAPUMULO
Mr. E. Smith	Area Manager: Regional Integrated Network Planning
Mr. A. L. Hoffmann	Area Manager: Technology Engineering
Ms. M. L. Giles	Senior Planner: Regional Integrated Network Planning
Mr. S. Mansoor	Senior Planner: Regional Integrated Network Planning
Mr. B. Dickason	Specialist Planner: Regional Integrated Network Planning
Mr. M. C. Thurlby	Specialist Planner: Regional Integrated Network Planning
Mr. M. J. Paes	Senior Engineer: Technology Engineering

DOC E1, Agenda for the 'leverage phase' planning workshop held on the 5th December 2001 at the M L Sultan Technikon in Durban

TRIAL IMPLEMENTATION OF THE LEVERAGE PHASE OF THE RURAL TELECOMMUNICTIONS PLANNING FRAMEWORK FOR THE MAPUMULO RURAL AREA

DATE: **Wednesday, 5th December 2001**

VENUE: **M L Sultan Technikon**

AGENDA

SESSION 1

1.1 Brief review of the planning framework

1.2 Overview of the last 3 workshops and the important issues that emerged.

- 1.2.1 The rich picture
- 1.2.2 The idealised design undertaken by the Telkom Planers
- 1.2.3 The contribution of the Mapumulo stakeholders to the idealised design

SESSION 2

2.1 Comment on the mission statement "The deployment of telecommunications infrastructure to the Mapumulo area to support the human activity systems, such as the health, education and security, that were identified by the stakeholders for the sustained development of the community"

2.2 Comment on the composite idealised design developed thus far (to be handed out, DOC D2).

SESSION 3

ISM SESSION

3.1 Comparison of current reality i.e. to the idealised design. What means are requires to get from the current reality to the idealised design? USE OF ISM

SESSION 4

Evaluation of the planning framework by the Telkom planners

DOC E2, Hand out of relevant information on the idealised design required for the leverage phase of the planning framework

IDEALISED DESIGN FOR THE MAPUMULO AREA

The development of the planning framework was based on the concept of the rural telecommunications system (RTS) whose emerging properties were defined as benefits to all stakeholders. This means that stakeholders such as the network operator (the owners of the network), the community and all those that are part of the RTS will benefit. This emerging property is in a sense ideal if one considers the ultimate case as all stakeholders benefiting according their expectations. The realisation of the ultimate idealised design, the ideal design, will lead to the realisation of the ideal emerging property. So one can say that in general the properties of the ultimate ideal design of the RTS would be the ideal emerging properties of the RTS, i.e. benefits to all stakeholders according to their expectations.

In reflecting on the essential features of an idealised design Ackoff (1981, 1999) suggests three necessary aspects that must be considered.

- Anything is possible except science fiction
- The design must be capable of surviving if it were brought into existence (sustainability)
- The design must be capable of rapid and effective learning and adaptation. This is due to:-
  - → The lack of objective basis for making decisions – the design is experimental.
  - → The design must be continuously evaluated
  - → The design incorporates assumptions about the future - these assumptions must be monitored and modifications must be made if necessary.

There are three basic stages in the method: -

- Select a mission
- Specify the desired properties of the design
- Idealised design of the system

Mission Statement

The mission statement usually applies to organisations and so might seem out of place in this context. However, we have defined the purpose of the Mapumulo rural telecommunications system to be the development of that community. In the context of this background then, a typical mission for those that will do the planning of telecommunications infrastructure for Mapumulo could be: -

> "The deployment of telecommunications infrastructure to the Mapumulo area to support the human activity systems, such as the health, education and security, that were identified by the stakeholders for the sustained development of the community"

Note: the benefits to the network operator are by no means ignored. The argument is that sustained development will ensure that the operator will receive their return on investment. Telkom has already experienced great losses on investment in infrastructure rollout where there was no development.

The Idealised Design

The concept of idealised design is a new experience for many of the participants. Therefore it will be more useful to consider the properties of the design with respect to the benefits to stakeholders in the context of the issues that were raised by the stakeholders. One way to do this is to review the input (set) by the Telkom planners and those (set) by the Mapumulo community. Seek to bring about an accommodation between the two sets and consider how we can move from the current reality that is expressed in the rich picture to the idealised design. In other words what means and resources can we leverage to move towards the idealised design? Interpretive Structural Modelling will be used for this exercise.

Note: Very often the means planning is an end in itself. This is true for this particular situation where many of the systems that were identified for the ends planning are means in themselves and vice versa. For example the need for telemedicine in the ends planning could also be a subsystem as part of the means planning.

Review of the Ends Planning Workshops

Workshop with Telkom (section 6.4)

Table 6.4, Summary of systems pertaining to the RTS, resulting from the unconstrained design that participants would like to see in the Mapumulo area.

Health Care Tele-medicine, video conferencing, POTS, IT / Internet, paging, radio
Security (police, military, and private) POTS, video surveillance, radio
Education POTS, payphones, distance learning, tele-education, IT / Internet
Banking POTS, IT / Internet,
Services (Government, police, post office, emergency services) POTS, IT / Internet, radio
Enhanced Services Broadcasting (audio / video) over telecommunications network
General population GSM, POTS, IT / Internet, payphones
Information Systems such as GOVNET Private data networks, paging, and telemetry
Electric power available to all
Wide video surveillance For example for Fire warnings in the sugar cane farms.
Water reticulation to all schools and hospital

Improved roads or access
Library linked to video on demand
Flexible billing Customised packages such as prepaid system for high bandwidth.

Workshop with the Mapumulo Community Stakeholders (section 6.5)

The following are some of the most important issues that were raised: -

1. The participants did not consider the interests of Telkom during the stakeholder analysis. They perceive telecommunications service as a developmental right like any other service such as roads and water.
2. The participants only considered the silent stakeholders after prompting by the facilitator.
3. The need for integrated development in Mapumulo. The other infrastructure providers should be part of the decision-makers on rural telecommunications for Mapumulo.
4. The need for a bottoms approach within the community – direct consultation with community and traditional leaders.
5. Unreliable communications network
6. Parts of community where there is no infrastructure at all.
7. Lack of understanding of the role of telecommunications in development. More than basic services are seen as a luxury.
8. Theft of equipment is a problem, but not done by people from the community.
9. The question of affordability is linked to development.
10. Some conflicting issues in the Rich Picture point to the need for more accurate information or more collaboration.
11. Education and Health were regarded as equally important and should be given a high priority.
12. Security was an issue but a toll free system to report crime without delay is needed.
13. Need for community policing forum – as a starter all the ward councillors should be connected.

Means Planning using ISM

IN THE CONTEXT OF THE MISSION STATEMENT AND THE KEY PROPERTY OF THE IDEAL SYSTEM BEING 'BENEFITS TO ALL STAKEHOLDERS WHAT ARE THE MEANS THAT IS NEEDED TO MOVE MAPUMULO FROM ITS CURRENT RURAL TELECOMMUNICATIONS SYSTEM TO ITS IDEALISED DESIGN, WITH RESPECT TO TELECOMMUNICATIONS INFRASTRUCTURE?

DOC E3, List of means suggested by the seven Telkom Planners for Moving towards the Idealised Design during the ISM session, cut and pasted from the ISM software file.

Means Planning: Element / Means List

Triggering Question:

"In the context of the mission statement and the key property of the ideal system being 'benefits to all stakeholders', what are the means that is needed to move Mapumulo from its current rural telecommunications system to its idealised design, with respect to telecommunications infrastructure?"

1. Provision of broadband services for the Health Sector (1)
2. Provision of video surveillance and radio for security services (2)
3. Provision of broadband services with distance learning for the education sector (3)
4. Broadband services for banking and e-commerce (4)
5. Provision of POTS and IP services for the general public (5)
6. Information systems for as GOVNET (6)
7. Investigate the availability of electric power (7)
8. Provision of communications or system for fire warning (8)
9. Investigate the availability and quality of roads (9)
10. Link the library to larger information content (10)
11. Devise a flexible billing system such as a prepaid billing system (11)
12. Provide education about Telkom as a network provider (12)
13. Ensure that the silent stakeholders such as the physically handicapped are catered for (13)
14. Devise a system for including other service providers in the decision making process (14)
15. Attend to unreliable telecommunications networks (15)
16. Provide education to the community and their leaders about the role of telecommunications in development (16)
17. Find an innovative way of addressing theft of equipment (17)
18. Provide more payphones (18)
19. Provide toll free services for emergencies such as crime reporting (19)
20. Internet banking (20)
21. Access to Internet services (21)

DOC E4, Category set of the means elements suggested in DOC E3 generated by the ISM Process, cut and pasted from the ISM software file

Categorising Relationship: "Are element A and element B in the same category"?

-----Category Set ------

A. Digital services
(1) (3) (4) (5) (6) (10) (20) (21)
B. Security and surveillance
(2) (8) (17) (19)
D. Parallel infrastructure
(7) (9) (14)
E. Billing system
(11)
F. Community relations
(12) (16)
G. Social responsibility
(13)
H. Universal service
(15) (18)

-----Category Set with text -----

A. Digital services
*Provision of broadband services for the Health Sector (1)
*Provision of broadband services with distance learning for the education sector (3)
*Broadband services for banking and e-commerce (4)
*Provision of POTS and IP services for the general public (5)
*Information systems for as GOVNET (6)
*Link the library to larger information content (10)
*Internet banking (20)
*Access to Internet services (21)
B. Security and surveillance
*Provision of video surveillance and radio for security services (2)
*Provision of communications or system for fire warning (8)
*Find an innovative way of addressing theft of equipment (17)
*Provide toll free services for emergencies such as crime reporting (19)
D. Parallel infrastructure
*Investigate the availability of electric power (7)
*Investigate the availability and quality of roads (9)
*Devise a system for including other service providers in the decision making process (14)
E. Billing system
*Devise a flexible billing system such as a prepaid billing system (11)
F. Community relations
*Provide education about Telkom as a network provider (12)
*Provide education to the community and their leaders about the role of telecommunications in development (16)
G. Social responsibility
*Ensure that the silent stakeholders such as the physically handicapped are catered for (13)
H. Universal service
*Attend to unreliable telecommunications networks (15)
*Provide more payphones (18)

DOC E5, Categorising of Individual Elements / Means mentioned in DOC E3 that led to the Individual Category Sets shown in DOC E4 generated by the ISM Process, cut and pasted from the ISM software file

Categorising Relationship: "Are element A and element B in the same category"?

2 C 1
2 C 1
2 C 1 NO
3 C 1 YES
4 C 1 NO
4 C 2 NO
5 C 1 YES
6 C 1 YES
7 C 1 NO
7 C 2 NO
7 C 4 NO
8 C 1 NO
8 C 2 YES
9 C 1 NO
9 C 2 NO
9 C 4 NO
9 C 7 YES
10 C 1 YES
11 C 1 NO
11 C 2 NO
11 C 4 NO
11 C 7 NO
12 C 1 NO
12 C 2 NO
12 C 4
12 C 1 NO
12 C 7 NO
12 C 11 NO
13 C 1 NO
13 C 2 NO
13 C 4 NO
13 C 7 NO
13 C 11 NO
13 C 12 NO
14 C 1 NO
14 C 2 NO
14 C 4 NO
14 C 7
14 C 1 NO
14 C 9 YES
15 C 1 NO
15 C 2 NO
15 C 4 NO
15 C 7 NO
15 C 11
15 C 1 NO
15 C 12 NO
15 C 13 NO
16 C 1 NO
16 C 2 NO
16 C 4 NO
16 C 7 NO
16 C 11 NO
16 C 12 YES
17 C 1 NO
17 C 2 YES
18 C 1 NO
18 C 2 NO
18 C 4 NO
18 C 7 NO
18 C 11 NO
18 C 12 NO
18 C 13 NO
18 C 15 YES
19 C 1 NO
19 C 2 YES
20 C 1 NO
20 C 2 NO
20 C 4 YES
21 C 1 YES

DOC E6, A Priority Structure Stage Set of the means elements suggested in DOC E3 generated by the ISM Process, cut and pasted from the ISM software file

Structuring Relationship: "Is element A more important than element B"?

Stage Element Numbers

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1 (11)

2 (12)

3 (15)

4 (1)<->(2) (5) (7)

5 (3)

6 (9)<->(14) (19)

7 (4)

8 (6) (10)<->(18)

9 (8) (13) (16)

10 (17)

11 (21)

12 (20)

----------Minimum Graphic Branch (es)------------

The arrow '-->' should be interpreted as 'more important than'.

Stage 1
(11)--> (12)

Stage 2
(12)--> (15)

Stage 3
(15)--> (1) (5) (7)

Stage 4
(2)--> (9) (19)
(5)--> (3)

(7)--> (9)

Stage 5
(3)--> (9) (19)

Stage 6
(14)--> (4)
(19)--> (13)

Stage 7
(4)--> (6) (10)

Stage 8
(6)--> (8) (13)
(18)--> (8) (16)

Stage 9
(8)--> (21)
(13)--> (17)
(16)--> (17)

Stage 10
(17)--> (21)

Stage 11
(21)--> (20)

Stage 12
(20)

Stage Set with Element Statements

Stage 1.
Devise a flexible billing system such as a prepaid billing system (11)

Stage 2.
Provide education about Telkom as a network provider (12)

Stage 3.
Attend to unreliable telecommunications networks (15)

Stage 4.
Provision of broadband services for the Health Sector (1)
Provision of video surveillance and radio for security services (2)
Provision of POTS and IP services for the general public (5)
Investigate the availability of electric power (7)

Stage 5.
Provision of broadband services with distance learning for the education sector (3)

Stage 6.

Investigate the availability and quality of roads (9)
Devise a system for including other service providers in the decision making process (14)
Provide toll free services for emergencies such as crime reporting (19)

Stage 7.

Broadband services for banking and e-commerce (4)

Stage 8.

Information systems such as GOVNET (6)
Link the library to larger information content (10)
Provide more payphones (18)

Stage 9.

Provision of communications or system for fire warning (8)
Ensure that the silent stakeholders such as the physically handicapped are catered for (13)
Provide education to the community and their leaders about the role of telecommunications in development (16)

Stage 10.

Find an innovative way of addressing theft of equipment (17)

Stage 11.

Access to Internet services (21)

Stage 12.

Internet banking (20)

DOC E7, Structuring of Individual Elements / Means mentioned in DOC E3 that led to the Priority Structure Stage Set shown in DOC E6 generated by the ISM Process, cut and pasted from the ISM software file

Structuring Relationship: "Is element A more important than element B"?

1 R 2? YES
2 R 1? YES
1 R 3? NO
3 R 1? NO
1 R 4? YES
4 R 1? NO
3 R 4? YES
4 R 5? NO
5 R 4? YES
1 R 5? NO
5 R 1? NO
3 R 5? NO
5 R 3? YES
4 R 6? YES
6 R 4? NO
6 R 7? NO
4 R 7? NO
7 R 6? YES
7 R 4? YES
1 R 7? NO
3 R 7? NO
7 R 1? NO
7 R 3? NO
5 R 7? NO
6 R 8? YES
8 R 6? NO
8 R 9? NO
6 R 9? NO
4 R 9? NO
9 R 8? YES
9 R 6? YES
9 R 4? YES
1 R 9? YES
3 R 9? YES
7 R 9? NO
8 R 10? (Redo)
8 R 10? (Undo)
7 R 9? YES
8 R 10? NO
6 R 10? NO
4 R 10? YES
10 R 8? YES
10 R 6? NO
8 R 11? NO
6 R 11? NO
10 R 11? NO
4 R 11? NO
9 R 11? NO
11 R 8? YES
11 R 6? YES
11 R 10? YES
11 R 4? YES
11 R 9? YES
1 R 11? YES
3 R 11? (Undo)
1 R 11? NO
3 R 11? NO
11 R 1? YES
11 R 3? YES
11 R 5? YES
11 R 7? YES
8 R 12? NO
6 R 12? NO
10 R 12? NO
4 R 12? NO
9 R 12? NO
12 R 8? YES
12 R 6? YES
12 R 10? YES
12 R 4? YES
12 R 9? YES
11 R 12? YES
12 R 1? YES
12 R 3? YES
12 R 5? YES
12 R 7? YES
12 R 11? NO
8 R 13? NO
6 R 13? YES
13 R 8? NO
10 R 13? NO
8 R 14? NO
13 R 14? NO
6 R 14? NO
10 R 14? NO
4 R 14? NO
9 R 14? YES
14 R 8? YES
14 R 13? YES
14 R 6? YES
14 R 10? YES
14 R 4? YES
14 R 9? (Undo)
14 R 4? YES
14 R 9? YES
8 R 15? NO
13 R 15? NO
6 R 15? NO
10 R 15? NO
4 R 15? NO
9 R 15? NO
15 R 8? NO
11 R 15? (Undo)
15 R 8? YES
15 R 13? (Stop)
15 R 13? YES
15 R 6? YES
15 R 10? YES
15 R 4? YES
15 R 9? YES
11 R 15? YES
12 R 15? YES
15 R 1? YES
15 R 3? YES
15 R 5? YES
15 R 7? YES
15 R 12? (Stop)
12 R 15?
12 R 15? NO
8 R 16? (Stop)
8 R 16? NO
13 R 16? NO
6 R 16? (Stop)
6 R 16? NO
10 R 16? YES
16 R 8? NO
8 R 17? NO
13 R 17? YES
16 R 17? YES
17 R 18? NO
8 R 18? NO
13 R 18? NO

16 R 18? NO
6 R 18? NO
10 R 18? YES
18 R 17? YES
18 R 8? YES
18 R 16? YES
18 R 10? YES
17 R 19? NO
8 R 19? NO
16 R 19? NO

10 R 19? NO
13 R 19? NO
6 R 19? NO
4 R 19? NO
9 R 19? NO
19 R 17? YES
19 R 8? NO
1 R 19? YES
3 R 19? YES
7 R 19? NO

19 R 13? YES
19 R 16? NO
17 R 20? YES
8 R 20? YES
20 R 21? NO
17 R 21? YES
21 R 20? YES
8 R 21? YES

APPENDIX F: Questionnaire for the evaluation of the Rural Telecommunications Planning Framework / Workshops held with Telkom SA Planners

PLEASE CIRCLE THE NUMBER THAT BEST REPRESENTS YOUR OPINION

1. Did the workshop/s widen your knowledge of the issues involved in rural telecommunications planning?

Totally confused			Moderate understanding			Great understanding
1	2	3	4	5	6	7

2. Did you find the techniques/methods used in the framework, such as rich pictures and the idealised design easy to understand?

Extremely difficult			Moderately acceptable			Extremely easy
1	2	3	4	5	6	7

3. How did you find the techniques/methods used in the framework, such as rich pictures and idealised design with respect to their power in highlighting or exposing relevant issues?

Total waist of time			Made no difference			Extremely powerful
1	2	3	4	5	6	7

4. **If the conditions were appropriate for the use of such a systemic planning framework i.e. if Telkom put in place the necessary conditions and resources for the use of the framework, do you think it could improve the current planning process with respect to better results?**

It will have a negative impact			Would not make any difference			Great improvement
1	**2**	**3**	**4**	**5**	**6**	**7**

5. **How easy will it be to adapt or merge the planning framework with some of the current processes that you use in planning rural telecommunications infrastructure?**

Impossible			Moderately easy			Extremely easy
1	**2**	**3**	**4**	**5**	**6**	**7**

6. **With respect to planning rural telecommunications in South Africa with the primary intention of triggering development in that area, how would you rate the planning framework compared to the current approaches in planning?**

The current planning methods will ensure greater development			There will be no difference between the planning framework and the current methods			The planning framework has a greater chance than current practice of triggering development
1	**2**	**3**	**4**	**5**	**6**	**7**

Your opinions are greatly appreciated!

Table F1, Tabulation of Scores of the Evaluation of the Rural Telecommunications Planning Framework / Workshops held with Telkom SA Planners

PARTICIPANTS (P)

QUESTIONS (Q)	P1	P2	P3	P4	P5	P6	P7
Q1	6	6	6	6	6	5	5
Q2	7	6	5	4	6	6	5
Q3	7	5	6	5	7	6	5
Q4	7	6	7	5	7	7	5
Q5	7	3	3	3	7	5	6
Q6	5	5	7	6	7	7	5

APPENDIXG: PLAN OF THE INTERVIEWS WITH TELKOM'S AREA PLANNERS AND SUPPORT DEPARTMENTS - both urban and rural, HELD IN MARCH 2000

1. What is your definition of rural telecommunications?

2. What benefits are expected from a rural telecommunications infrastructure?

3. Who or what section determines which area in particular will receive priority for infrastructure development?

4. What are the driving factors for the choice in question 3?

5. If this assignment was in an urban area or an informal settlement in the metropolitan will the factors be any different?

6. What is the composition of the planning/design team, within your area, in terms of their background and expertise?

7. What planning tools or methodologies are available for rural telecommunications infrastructure planning and what is the architecture or principle modus operandi of such a system?

8. In the planning/design of a particular infrastructure what consideration is given to: -

8.1 Technological issues
8.2 Economic issues
8.3 Political issues.
8.4 Regulatory issues
8.5 Social issues
8.6 Cultural Issues

9. With respect to optimization, which of the above issues will it apply to and how does Telkom see optimization?

10. What kind of consultation takes place and with whom, during the planning and design phase?

11. What mechanisms are there to monitor the success or failure of the newly deployed telecommunication infrastructure?