SPATIAL ANALYSIS OF DEVELOPMENT POTENTIAL IN SOUTH AFRICA

A STUDY OF THEORY AND METHODS FOR THE SPATIAL ANALYSIS OF URBAN AND REGIONAL SYSTEMS IN THE SOUTH AFRICAN CONTEXT.

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M.U.R.P. THESIS

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CONTENTS

preface

Space in all its aspects is a central concern of planning research. The common sense view of space - determined by height, length and breadth - is giving way to a richer concept. Physical space seems to be merely one aspect of the multi-dimensional framework within which men and women carry out their daily activities. It is becoming possible to visualize social and economic spaces, where distances are measured in unfamiliar terms that have little to do with feet and inches. One begins to sense, very dimly, how one kind of space is warped and transformed as it moves through time - or interacts with another kind of space.

My first contact with these ideas occured during a regional study in the Department of Urban and Regional Planning at U.C.T. The problems of analysing these spaces and describing the structural relationships and interactions between them, prompted me to continue the work of that project in the form of a thesis.

For their assistance while traversing the spaces of planning research, I would like to thank Tony Barac, my supervisor, for his ability to provide inspiration and the urge to work when most needed, and for keeping abreast of the last minute rush; Carol Barac and Hirsh Fish for many helpful discussions; my wife, Linda, for her help in her professional capacity with the bibliographies and her active support throughout the whole process; Pam Roberts for her beautiful typing; Mujahid Gamiet and Yusuf Abrahams for their help with the diagrams; and last but very important, I must thank my colleagues in the second-year class of 1969 for all that happened during the course of the S.G.P.M. Program.

Needless to say, the Author is responsible for all errors and inconsistencies.

Ceri Rhys Jones

Cape Town, October, 1971.

conventions

Terms:

Where necessary for the logic of an argument, a term may be carefully defined, but otherwise the context within which the term occurs should be sufficient to clarify its meaning.

References:

Sources in the text are given in the Harvard System format throughout. These references are grouped in two bibliographis at the end of the text, one of South African material and one of general references. Not all the references in the bibliography of South African material are substantial to the thesis. However, if a particular reference is mentioned in the text, the name of that author is underlined.

The letters S.G.P.M. refer to the 'Spatial Growth Probability Model for the Republic of South Africa' Project 2/1, 1969 of the Department of Urban & Regional Planning, U.C.T.

Notes:

References to notes are given in the text as (N1), (N2) and are grouped at the end of each chapter.

References to appendices are given as (A1), (A2) in the text and are grouped at the end of the main text.

Structure:

A detailed list of contents is given at the head of each chapter and cross referencing between chapter sections is given in terms of this structure.

Once upon a time - or maybe twice, there
was a paradise called Pepperland .....
The principal natural resources of Pepperland
were - and still are - sun..... music.....
laughter.... and love.

(ancient twentieth century myth)

THESIS: objectives, procedure and argument

OBJECTIVES

The object of this thesis is to investigate methods of spatial analysis in relation to urban and regional systems.

This is done to see if it is possible to calculate the effect of investment location decisions on the national socio-economic system.

PROCEDURE

TERMS OF REFERENCE:

1) The thesis is related as closely as possible to the South African situation.
2) Work in South Africa relevant to the thesis is given particular attention.
3) The S.G.P.M. (A1) is taken as a starting point for discussion, and the program for this project can be regarded as the factor which generated the work on this thesis and gave it direction.

METHOD:

Since the thesis takes the form of a dissertation, rather than an analytical or quantitative study, the basic method was to review as much of the relevant literature as possible, and to condense from that ideas and concepts which might prove useful in terms of the objectives. Logical and consistent formulation of argument has been attempted and a positive rather than normative approach adopted throughout. References are given to support the argument though the author accepts full responsibility for weaknesses of logic, and misinterpretation.

STRUCTURE:

The thesis begins with a general discussion of the metatheory, or philosophy of method, of planning. The second chapter deals with the theoretical background germane to the thesis, and also the historical background of the system to which the study is directed. The third chapter deals with more specific matters relating to spatial analysis, and the fourth synthesises some of the ideas in a critical analysis of the S.G.P.M. Chapter five concludes the argument.

The appendices contain a summary of the S.G.P.M. for reference purposes as well as a bibliography of South African material relevant to the work of the thesis and to planning in general.

ARGUMENT

The development of the argument in the thesis does not follow a strictly linear pattern, therefore the main conclusion and ideas are set out here in the form of a series of propositions so that the reader may gain a clear overview of the whole argument in order to appreciate the connections between the parts.

1) CHAPTER ONE: Metatheory: The role of method in Planning is investigated. To start with the proposition is put forward that Planning is concerned with the investigation of the behaviour and control of urban and regional systems, and that it is a research oriented discipline first and problem-solving discipline second. The value of the Planner rests in his capacity to criticise and evaluate alternative policies, rather than to make policy itself.

In this respect scientific method is discussed and it is proposed that there is no reason why the hypothetico-deductive method could not be used in Planning.

Following this discussion on method the use of system concepts is discussed, with particular attention to a general definition of the idea. A 'system' is held to be an arrangement of parts in a dimensional domain, such that the connections between parts can be explained only with reference to the whole.

Models are then discussed, and their use in scientific research is illustrated. It is suggested that models are essential in the research of complex behavioural systems.

It is postulated that through the use of models as research tools, and the system view of phenomena, planning can take its place among the sciences, and its action-oriented tradition falls away. The solution of problems becomes a benefit of continuing research rather than an end in itself.

2) PLANNING, POLICY & CONTROL: The last proposition is investigated with reference to some of the thinking in this country, and the place of the planner vis-a-vis the decision-maker is investigated. The purpose

of this discussion is to show that planning must be neutral in decision-making so that policies can be evaluated. Bluntly put - planning must disengage itself from politics, so that it can get involved in politics as a part of the research process. It is postulated that political systems and ideas are as much a subject of research and analysis as any other behavioural phenomena, and furthermore a reasoned evaluation of these issues is essential in South Africa.

CHAPTER 2:

1-3: The historical development of Regional Science, Geography and Economics is reviewed and the following trends and weaknesses isolated:

1) Regional science is an eclectic, integrative discipline. Much of the work is brought together in a general theory developed by Isard. The significance of Isard's latest work is the attention being paid to political and social factors, which has been overlooked in Regional science until recently.

2) Geography is traced through its descriptive, classical and regional stages and the present quantitative and analytical stage. The use of models and concern for the analysis of spatial distribution of phenomena is stressed.

3) Economics is criticised for its lack of attention to extra-market activities that influence the allocation of resources. The general application of the Western 'Protestant ethic' of much economic theory is questioned, as well as the strong behavioural assumption of the theories.

4-5) The historical review of South Africa is included to show that there are certain determinants in the development of the country which can be ignored in research only at risk to the value of results. These determinants are the socio-political forces, i.e. inter- and intra-group conflict, politico-economic concepts - the control of the economy by extra-market forces; the powerful environmental factors of land and climate. The urbanising forces in an industrialising country whose major natural resources are minerals which require capital-intensive extractive processes are also examined.

6) The urbanisation of South Africa is considered further, and its structure is picked out as a spine of centres or the high inland plateau paralleled by a series of seaports on the east coast. This system is an artificial device in no case related to major transport routes or abundant water. The structure is heavily dependent on a transport network for its survival.

CHAPTER 3:

1) Spatial analysis: It is postulated that urban/regional phenomena exist in several types of spaces, of which actual space is only one variety, but these spaces can all be analysed in terms of nodes, networks and surfaces. The concept of differentiation is introduced in terms of horizontal movement and vertical movement (hierarchy). Time and distance are discussed as determinants of these movement patterns. The kinds of data relating to these systems are discussed and concepts of energy and information are mentioned briefly. The relevance of these ideas in terms of the system view expressed in Ch. 1 must be stressed.

2) Regions are viewed both as areas of land in actual space and as conceptual devices, the two concepts having specific purposes at different stages of the research process. Some aspects of regional definition are discussed, and type of regions outlined with reference back to the node, net and surface ideas of section 1. The point of absolute and relative location again emphasises the two concepts of a region as a real thing or a mental construct.

   Two examples of regional definition and spatial analysis are quoted, by Berry, and Board et al. The latter is a South African study of particular importance.

3) The growth and development aspects of the thesis and the S.G.P.M. are mentioned and the usefulness of these concepts in measurement is queried. A work on these aspects is criticised and some of the pitfalls pointed out in Chapter 2, are outlined.

CHAPTER 4:

1) The foregoing ideas are synthesised by taking the S.G.P.M. and analysing it to see if it could be improved, or if it would need to be replaced by a more powerful model to achieve the goals set in the program.

The proposals made for its improvement and also for its replacement depend on the context of the criticism (detailed or general) and the results expected of the model. In both cases the general concepts of the thesis indicate specific directions for the research. Three proposals are suggested: a short, medium and long term project which are discussed in turn. Notes to this chapter develop further a few points of method that are considered relevant.

CHAPTER 5:

Conclusions - these could be read in conjunction with this summary to provide a clearer overview of the thesis before the main text is read.

An attempt has been made to work from the general to the particular, building up a set of concepts as the work proceeds. At each stage, however, conclusions are arrived at which could stand in their own right. In this respect the thesis could be regarded as a mosaic of similar arguments rather than a linear argument and may appear a little disjointed. It is hoped that the summary and conclusion will mitigate this to some extent.

CHAPTER ONE: introduction

1. METATHEORY - general. 1.1 The study of urban and regional systems. 1.2 Planning - pure and applied. 1.3 Systems. 1.4 Causal research and systems thinking. 1.5 Wholes and Aggregates. 1.6 Attributes of parts. 1.7 General. 1.8 Open Systems. 1.9 Complex open systems. 1.10 Definition of the concept 'model'. 1.11 Types of models. 1.12 Experimental models in planning. 1.13 Problem-orientation, simulation and experiments. 1.14 Conclusion.

2. PLANNING, CONTROL AND POLICY - general. 2.1 Politics, economics and freedom. 2.2 Towards a non-normative approach to politics.

3. NOTES - 1 to 13.

1. METATHEORY

The purpose of the discussion in Chapter 4 will be to outline a few specific methods which could be applied to a solution of the problems generated by a project such as the building of a spatial growth probability model. Because of this it is necessary to investigate the role of method in Planning as a general concept in order to provide a framework within which this discussion fits so that the value of, and even the necessity for these methods can be assessed. In addition to this the function of Planning as a discipline is discussed in order to provide a framework for the following section which deals with the relevance of Planning in South Africa.

To begin with, consider Planning as a discipline which identifies and evaluates the solution to a problem. In order to buy cigarettes at the corner shop, one may evaluate the relative costs and benefits of walking, running, taking the car or staying at home, depending on one's need for fresh air, exercise, time or the availability of funds. This definition is of little significance at the individual level, where the application of a rational method is not urgently required because the mistakes an individual makes usually affect himself more than others. A much larger group of individuals - a city, province or state, which has organised itself into institutions and hierarchies, begins to need Planning of a higher order. Over time, a specialist discipline will begin to crystallise out of the decision-making structures that affect and effect societies. The element that causes this crystallization is the need for critical evaluation of differing action policies. The military need someone to evaluate strategies of missile deployment; the monopolist wants to know which advertising campaign will work best to sell a new product, the Government wants to know how to curb the New Left without too much fuss.

A dichotomy begins to appear here in the break between decision and action on the one hand and evaluation and criticism on the other. Because Planning has grown out of the decision processes of kings and business men it is often difficult to distinguish between the decision and the plan. The heritage of 'design and construct' planners in the Wood and Nash tradition and the Utopian ideas of Owen and his contemporaries still leaves Planning with the tendency to confuse the technical and the ideological (Benevoto, 1963).

It is just this distinction between technique and ideology that serves to define and establish Planning as an independent discipline, and moreover leads to a description of the nature of that discipline. It is this distinction that Popper (1961, pp 64-70) discusses under the heading of Piecemeal vs. Utopian engineering. The divergent methods and nature of these two types of engineer are defined by Popper as follows:

1. He (the piecemeal engineer) may have ideas of a 'society-as-a-whole', its direction, welfare, and so on, but,

2. he does not try to redesign 'society-as-a-whole'.

3. He tries to achieve ends by incremental changes, learning by errors, comparing expected and achieved results.

This form of piecemeal thinking is set against the Utopian who:

1. attempts the renovation of society-as-a-whole in terms of a blueprint, and

2. attempts a complete control of society, state and history in order to mould the forces affecting society-as-a-whole.

Inevitably the latter approach comes to depend on 'the expedience of piecemeal improvisation...' more characteristic of centralised or collectivist Planning' (Popper, 1961, p68) (N1). Even here though the difference between decision-maker and planner is not explicit, although it is much easier to conceive a healthier relationship between the two under piecemeal planning than Utopian Planning.

The point of making this distinction is that there is a well documented method of thought and research which can support the activities of the piecemeal engineer, but the Utopian has little to fall back on except propaganda, polemics, and sometimes naked force. The piecemeal engineer can approach his problem without prejudice towards any

particular solution, but the Utopian has a preconceived idea about the kind and scope of Planning to be done. Thus the Utopian cannot allow human frailty to interfere with his plans, and must mould not only Man but Men. Thus there is little possibility of testing the efficiency of his scheme, because those who do not like it are said to be unfit for it, or not yet sufficiently persuaded.

It is obviously still possible to conceive of the piecemeal engineer being engaged in both the decisions side of Planning and its evaluation side in certain circumstances (the manager of a factory, for instance) but the evolution of Planning as a specialist discipline mentioned above leads to the conclusion that a planner is one who criticises and evaluates the effects of decisions and policies usually drawn up by others, and that he does this not in terms of some overriding doctrine or blueprint, but according to the best and most reliable means and measures available to him at the time The fact that a Planner may well be engaged in the formulation of goals with the decision makers, and in the carrying out of plans with the administration should not obscure the fact that even in these situations (which can be considered special cases) he can still operate as a critic using reliable and testable methods for his evaluation.

The Planner as defined here could still be involved in anything from ICBMs to books. Is there a discipline of Planning which is identifiable not only by method but by area of concern? In terms of the definition one might expect to meet an engineer or a librarian who has become involved in the planning aspects of his profession, but can there be a group of people who are professional Planners, but who may,in certain circumstances specialise in the economic, social or physical aspects of Planning?

It seems that the growing concern with the day to day management of human affairs, the relation of men to their environment, and the responsible allocation and distribution of wealth and resources in the sciences, in business and government has certainly spurred the development of a particular kind of person with a particular frame of mind who is involved in these problems for their own sake, rather than as a side effect or extension of their existing discipline. Although it is possible to trace the image of the Planner to its origins in middle-class Utopianism, and the 'professional advisers of the rich and powerful' (McLoughlin, 1969, p.311), there has come to exist very recently a body of knowledge, and a group of people called Planning and Planners. This discipline is still ill-defined and its edges blur into related disciplines to a degree that sometimes camouflages its real content. However, it is clear that as the individual social sciences have tackled more and more

complex issues in their fields, and as business and government attempt to deal with social and economic problems of greater scale and complexity, and as architects and urban designers try to provide solutions to these problems there has grown a specific need for an integrative force that can make some sense out of the apparent chaos. (N2).

Thus a picture emerges - admittedly vague - of a discipline firmly rooted in the behavioural sciences with strong inputs from the liberal professions committed not only to the study of man and his environment, but also to the ways in which man controls that environment and the other men who happen to be in it.

This ancestry has led to confusion within the discipline itself about its relation to other disciplines, its standing as science or art, and even its contextual objectives; what does a Planner have to do to plan, and what does he plan. As McLoughlin (1969) points out, other generalised disciplines are accepted because their field of concern is defined and recognisable. The human body is the unquestioned field of General Medicine, the modern firm is the accepted field of Management Science. What are the systems that Planning is concerned with? More often than not planners will not be able to give a strict answer. If a generalist is not some kind of superman who knows how to do everyone's job, but a specialist in a 'higher order system in the given context' (McLoughlin, 1969, p.306) then a definition of these systems provides a framework for defining the discipline of Planning as well as for illustrating the interfaces between other skills. (N3). Therefore if the man-environment issue referred to above is seen in the context of urban and regional systems it is possible to define a Planner as one who <u>studies</u> urban and regional systems and <u>advises</u> on the control and management of these systems.

1.1 <u>THE STUDY OF URBAN AND REGIONAL SYSTEMS</u> (N4)

In a previous paper by the author (Jones, 1970) it was assumed that scientific method was substantial to the study of urban and regional systems. No justification was given explicitly for that assumption in the paper, and subsequent discussion has revealed that this is still a disputable subject. For reasons which are not difficult to find there is some resistance to the idea that Planning is a science, dependent for its continuation and development on the application of scientific reasoning in its approach to problems and solutions.

One reason is the evolution of Planning out of the behavioural sciences which themselves are hesitant to acknowledge methods of science as the backbone of viable research. Another is the heritage of environmentalist thinking (of which many architect-planners are guilty) which postulates simplistic physical solutions to socio-economic problems. This attitude relates closely to the Utopian tradition mentioned earlier. By far the most important reason appears to be the lack of understanding of the nature of science as illustrated by what scientists do - or scientific method. A great deal of the argument of this thesis rests on the assumption that Planning is a science, dependent on scientific method; therefore it is necessary to spend some time here on an explanation of what this means.

Medawar (1969, p.59) speaks of the scientific method as 'a potentiation of common sense exercised with a specially firm determination not to persist in error if any exertion of hand or mind can deliver us from it. Like other exploratory processes, it can be resolved into a dialogue between fact and fancy, the actual and the possible; between what could be true and what is in fact the case. The purpose of scientific enquiry is not to compile an inventory of factual information, nor to build up a totalitarian world picture of natural Laws in which every event that is not compulsory is forbidden. We should think of it rather as a logically articulated structure of justifiable beliefs about nature. It begins as a story about a Possible World - a story which we invent and criticize and modify as we go along, so that it ends by being, as nearly as we can make it, a story about real life.' This unfrightening picture is based on the hypothetico-deductive method of reasoning that involves the interaction of imaginative and critical thought, where the generative act is the formation of a hypothesis (or an opinion) which is then subjected to criticism by experimentation. Although the act of hypothesis formation is non-logical (as opposed to illogical) the act of criticism or experiment makes use of logical processes to test the logical consequences of belief. (N5).

Thus as Medawar points out (1969, p.2ff) the layman's concept of the scientist as an innovator (creative) and also a questioner of received beliefs (a skeptic) - two apparently inconciliable roles - is correct and is reconciled in terms of the hypotherico-deductive system of reasoning.

Although this brief discussion in no way covers the full range of argument it serves to show that science is not the esoteric system of thought and practice that many seem to think it is, that there are in fact very few fields of study which do not implicitly use this method in one form or another, and there is nothing to lose, rather a great deal to gain, by

admitting freely that since this is the case, there may as well be a more explicit use of the methods in the approach to Planning problems. It is possible for Planners (and a great many other social scientists) to drop their humanist/vitalist defences and settle down to study their respective fields in a scientific way. It is not the intention here to rally all behavioural scientists to the call of a particular methodology; the intention is merely to illustrate that it requires not great intellectual strain to consider planning as a science (N6). The effect of this is to give to the discipline a basic structure which allows some consistency of approach to problems and provides a basis for the criticism, review and repair of ideas according to a logical system.

1.2 PLANNING - PURE AND APPLIED

For the purposes of the argument no difference is recognised between 'pure' and 'applied' science, or pure and applied research. The emphasis on one or the other varies with fashion and the urgencies of problems of the time (Bernal, 1969). It could be argued that because of the nature of the problems with which Planning deals, it must be considered an applied science; it can equally well be argued that this is irrelevant, in that it makes no difference to the methods which the Planner uses to attack his problems. However at the root of the pure versus applied controversy is hidden the awkward question of ethics - of a scientist's personal and political motivations in a given situation. There is an intuitive feeling that the 'pure' scientist finds it easier to remove himself from the day-to-day tug of war that applied scientists may find themselves involved in, with the solution of practical problems.

The problem of involvement and bias is worth considering briefly since it has some bearing on the argument in section 1.4 where the social relevance of Planning is discussed in relation to South Africa.

There is no cut-and-dried formula which can protect the scientist from the pressures of the community in which he lives and works. His own ideas and biases, the politics of his employers and the kind of problem on which he works all contribute to these pressures. Eventually all that can be said about the reliability of a scientist's work is that it depends entirely on his personal commitment to the strict application of logical criticism to his results. This applies as much in science as in any of the liberal professions. A lawyer can become a shark, a doctor a quack, and a scientist a charlatan, in spite of professional codes, ethical constructs and fine methods. The point of the code or method,

is not to constrict the individual, but to provide a basis for comparison - a datum - against which the behaviour or product can be judged. In this case a commonly accepted way of solving problems can serve as common language for criticism, and a constant check on the activities or practitioners of the discipline within the community of members of that discipline and related fields of study. Planning at this stage of development seems to have no general concensus of opinion or method of this kind except in some of its more developed aspects such as Regional Science and the closely related sections of other disciplines like Urban Geography.

The critical function of the Planning discipline in both research and in the solution or particular problems is of primary importance. In research it is an on-going process where no theory or concept is ever taken for granted but continually worried and worked until those theories yield better explanations and more reliable predictions. In problem solving the evaluation aspect is not merely an aspect of research method, but an aspect of the planner's relationship to his discipline and more important to the society of which he is a part. If commitment to a particular point of view, or bias in favour of a particular set of decisions influences his judgement then he can no longer call himself a scientist, or a professional, and his proposals must stand suspect. More than this, it means that the Planner's role is not 'to plan'. This seems a rather surprising idea, and apparently completely impractical, but it is worth looking at. Even McLoughlin is not clear on this (1969, p.297 et seq.). In the background of his discussion on the systems approach to Planning one can still sense a single Plan; albeit thoroughly understood, well integrated and workable: the brainchild of systems planners. There are still vestiges of the nineteenth century concept of the Architect-Planner, subtly revised and updated, but still subject to the same criticism as the Utopians described earlier. The division between Planner and Decision-Maker is not made clear. The Planner does not make the decisions - the most he can do is to advise on the best decisions to make in the circumstances and to point out the consequences of a wrong decision, but it is not his responsibility to make those decisions. Following the same argument it is not the purpose of Planning to arrive at a final, circumscribed, single Plan. The discipline is directed at the research of urban and regional systems, and identifying ways of controlling these systems in the most economical,efficient and human ways available at the time

Government officials, managers, politicians, and generals plan. These are the decision-makers who decide to re-locate populations, establish growth points, develop harbours and military bases. It is their job to set up enabling legislation and the policy action necessary to convert a

'plan' into reality. The planner is an adviser who uses his discipline to criticise and evaluate these decisions to the best of his ability and in as logical and scientific a way as possible. In practice it may be very difficult to distinguish between the two, but it is a principle which forms the core of Planning and one which a planner ignores at great peril to his impartiality and balance of judgement in a field where such balance can directly affect not only return on investment, but more importantly human lives, over what is usually more than the short term.

1.3 SYSTEMS:

A discussion of the metatheory of planning would not be complete without mention of the growing attention being paid to systems as a concept. If 'systems thinking' is taken to be a habit of mind that enables one to judge things in terms of structure rather than in terms of quantity (Boulding, 1956) than its implications could be significant. In an early essay on systems, Angyal (1941) defined this difference between quantity and structure are carefully developed logical argument. There is at present a great deal of lip service paid to the idea of 'system' without a sound understanding of what the concept really implies. This may be due to the fact that the concept originated in the field of biology with a strict logical consistency. However, the concept has obviously had important applications in other fields and through the popularisation of scientists like Bertalanffy, has reached a very wide public as a general intuitive idea. This is not to be sneered at, but in some respects a return to the source can improve the understanding of this rather vague and over-used concept.

The sections that follow are taken from chapter eight of Angyal's book 'Foundations of the science of personality' (Angyal, 1941).

1) RELATIONSHIPS AND CONNECTIONS:

*A relationship requires two and only two members (relata) for the establishment of a relationship. Pairs of relations can aggregate into complex relationships.

*A system may be composed of an unspecified number of components, and it is not necessary to specify the relationships between components (if it is actually possible to do this) to describe the system.

This restriction of the meaning of the term 'relation' may seem strange, but its common usage can also be taken to denote compoint relations e.g. group A (a,b,c,d,e,) in relation to group B (f,g,h,i,j,) or causal chains a-b-c-d-e (i.e. a-b, b-c, c-d, etc.)

*Connections which are difficult to resolve into 2-term relations display system-connectedness.

*'System' in common usage also differs from the definition above, in that it is used to describe aggregates of elements and the relations between those elements. In a system, the type of connection between components is very different from that in aggregates, therefore 'system' here is taken to be synonymous with 'whole', and 'components' are abstracted, leaving only the organization. Thus for purposes of discussion systems are regarded as organizations of wholes.

*For two objects to be related they must have the same characteristic (e.g. colour, weight, size) in other words, relationships are based on identity.

*Components of a system are described by means of their position within the system; i.e. an object is not part of a system due to an inherent quality, but because of its 'positional value in the system'.

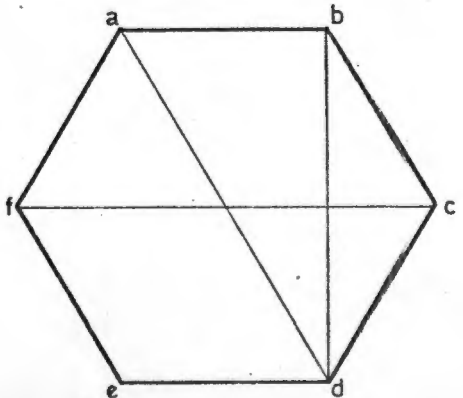
2) DIMENSIONAL DOMAINS:

*Relationships between objects and arrangements of objects in systems presupposes the separation of objects in space (a dimensional domain). Although this is a necessary condition for both relationships and systems, the <u>function</u> of the domain is different in both cases.

*The purpose of a dimensional domain serves merely to <u>separate</u> relata, but the domain itself does not form part of the relationship. The weight or size of two objects can be compared without paying attention to the space between them.

*In the case of a system, however, the dimensional domain not only separates the parts but <u>participates in the formation of the system</u>. A system is a distribution of the members in a dimensional domain.

*Connection between relata is direct, the connection goes from a to b without being affected by the intervening space. In a system, connections between parts can only be described in terms of the whole; for example, the connection between the six points a b c d e f in the diagram below can only be adequately described with reference to the whole diagram.



System components are not taken separately, but are viewed in terms of a 'superordinate, more inclusive factor' the system in which and by which they are connected.

1.4 CAUSAL RESEARCH AND SYSTEMS THINKING

'In causal research the task is to single out from a multiplicity of data pairs of facts between which there is a necessary connection. In systems thinking the task is not to find direct relations between members, but to find the superordinate system in which they are connected, or to define, the positional value of members relative to the superordinate system.'

As a corollary to this it is possible to say that relationships may be deduced from systems, but not vice-versa. Thus it seems that 'system' is the more general logical genus, and 'relations' could be considered as a special case of a simplified system 'adequate only for the logical presentation of very simple specialised constellations'.

1.5 WHOLES AND AGGREGATES

Angyal takes issue with a facile definition of system which one often hears; 'The whole is greater than the sum of its parts.' His argument is that in summations of objects the parts still function because of their inherent qualities (an anonymous crowd of people). When parts constitute a whole (system) however, the parts are not connected by means of their inherent qualities but by means of their position in the system (members of a social organization, a rugby team). The formation of whole does not depend on and is not additional to the summation of parts, but is something of a different order. 'In aggregates it is significant that parts are added, in a system it is significant that parts are arranged.'

Parts in wholes are different from parts of aggregates. In an aggregate the parts still retain their inherent identity (a pocket of oranges is made up of individual oranges which do not change their nature by being put into a pocket). When parts are used in a system, however, the parts are arranged in a system, and the system cannot be understood by looking at the parts, but is an independent framework in which the parts are placed (an orange tells us very little about an orange tree).

1.6 ATTRIBUTES OF PARTS

Although a strong distinction has been made between inherent characteristics of parts of a system and their positional values, each system does demand some functional characteristics of its components. For example, the members of a rugby team could not very well be oranges. Angyal postulates that the greater the degree of organization of the whole, the more will the inherent characteristics of components act as co-determinants of their positional values (N7).

1.7 At this stage in the development of the concept, systems were regarded as static things. As work in the field of biology progressed, however, the importance of the systems idea was realised and attempts were made to relate living organisms and their characteristics to systems concepts. Bertalanffy (1950, 1951, 1956, 1962) has worked towards and continually refined these ideas. It must be remembered, however, that the system concept grew out of Gestalt psychology and the needs of research biologists, and there are always hidden pitfalls in the extrapolation of concepts from one region of science into another. However, it has been shown (Berry, 1963, McLoughlin, 1969, Fair, 1970, March et al, 1971) that a systems, or at least structuralist, approach to Planning problems, is valid and in fact urgently necessary.

1.8 OPEN SYSTEMS (N8)

Because open systems are so important, it is worthwhile to list some of their main characteristics in some detail:

1) Energy throughputs:

Energy is imported into, processed by and exported from, the system within which negative entropic forces dominate.

Essentially open systems maintain the 'negentropic' tendencies by importation of energy into the system. The second law of thermodynamics is obeyed in that the system-environment relationship is entropic. However, within the system entropy decreases.

2) Energy flow is cyclic:

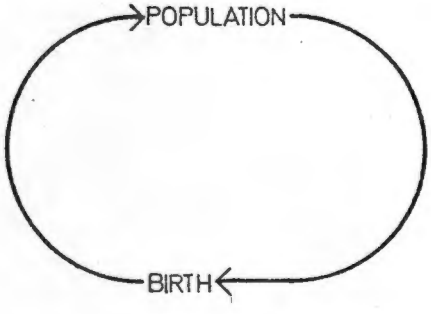
The product exported into the environment furnishes the sources of energy for the repetition of the cycle of activities.

3) Energy is transformed into information:

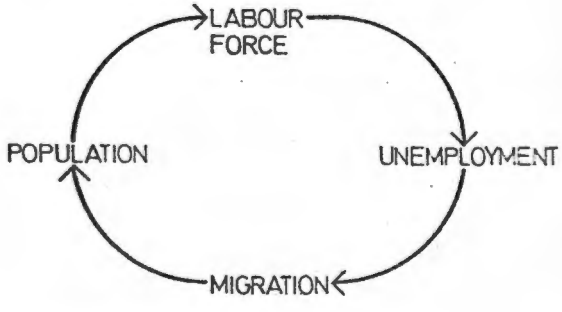
The distinction between energy and information in a system is not easy to make. Many highly developed social structures depend more on information inputs than strictly energic inputs to maintain negentropic forces.

4) There is a tendency towards equilibrium, either dynamic or static:

A system strives to maintain a state of equilibrium. In order to do this it depends on the importation of more energy than is needed for the maintenance of a simply steady state, since energic reserves are needed to cope with emergency situations. Two basic systemic structures are identifiable which serve to achieve this end; positive and negative feedback loops. A positive feedback loop involves relationships that feed on themselves, for example the Population-birth cycle is a feedback loop that is self-amplifying on a continuing basis.



A POSITIVE FEEDBACK LOOP



A NEGATIVE FEEDBACK LOOP

Negative feedback loops intervene to regulate this kind of relation. This more common type of feedback loop acts in the direction of opposing any initial change in one of its linkages. It is a self-correcting device, though in reality time lags in the interaction of the components of the loop affect its efficiency.

A negative feedback loop can also be termed a goal-seeking device.

5) Differentiation and elaboration:

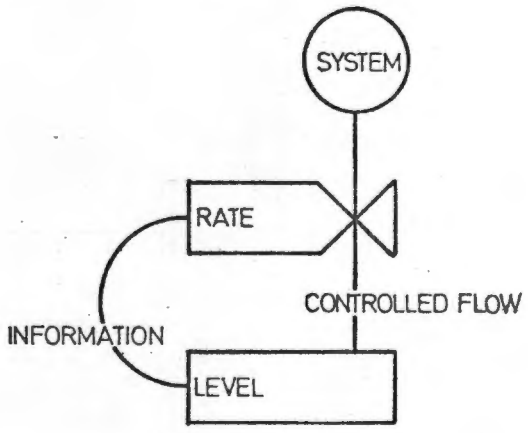
Taking the above example, two kinds of feedback loops within the system, given adequate food, etc., will lead to an increase in population. This factor in the controlling negative loop will cause migration, unemployment which may call into being new kinds of controlling loops to maintain the equilibrium of the overall system.

6) Systems display the principal of equifinality:

Equifinality suggests that a system moves towards the same final state from differing initial conditions by a variety of paths. However, as open systems develop regulatory mechanisms to control their operation the likelihood of Equifinality is reduced.

1.9 COMPLEX OPEN SYSTEMS:

From the above it is possible to recognise the large, complex systems with which planning is concerned. A complex system can be defined as a system having many system states (controlled by negative feedback loops) which determine goals and behaviour and many positive loops which determine growth. These loops are moreover dispersed in space and time rendering the analysis of cause-effect relationships extremely difficult, if not impossible. (N9) Within a system there is a series of states (or levels) and flows (or rates) which are closely linked to the two classes of feedback loops.



This principle is illustrated in the diagram above. It is precisely the identification of these rates and levels and the flows of information between them that provides the key to the analysis of any complex system. It is at this point also that the use of models becomes important in the analytic process.

1.10 DEFINITION OF THE CONCEPT MODEL

Models have been used in scientific research since the time that such research became a way of questioning and predicting the workings of the real world. They are part of the hypothetico-deductive system of reasoning and within this context can be considered as a way of reasoning about the real world by means of translations in space and time (Chorley & Haggett, 1961). Models are introduced into the research process as a bridge between observation and theory. The theoretical predicates are also considered predicates of the model, which furnishes lawful relationships between the two interpretations. Models, therefore, become systems in their own right and the prototype will always be a general system (Apostel, 1961).

Models display certain characteristics which need to be recognised if they are to be correctly used. These are:

1) SELECTIVITY:

Models are constructed in order to simplify some aspect of the real world to enable it to be more clearly understood. This implies a selective attitude to information in which extraneous 'noise' or irrelevant signals are omitted to yield a clearer picture of the area under study. There is an inverse relationship between the selectivity of a model and its accuracy. A highly selective model may be generally applicable but inaccurate, and a detailed or non-selective model may be accurate but yield little information of general applicability.

2) STRUCTURE:

The model mirrors the basic structure of the system being modelled, in this way the essential connections or patterns within the prototype system are made explicit and understandable.

3) SUGGESTIVENESS:

This characteristic implies that models contain suggestions for their own extension and further that the model leads to speculation, formation of hypotheses and eventually predictions. From this it will appear that selection and suggestion are directly related.

4) APPROXIMATION:

This characteristic is similar in nature to 1. in that the model should be a simplification (therefore an approximation) of reality in order to assist manipulation and understanding.

In other words, a model should be simple to manipulate and understand by those who would use it; representative enough in the total range of implications it may have, yet complex enough to closely represent the system under study (Chorafas, 1965).

5) ANALOGUE:

Conclusions must be able to be deduced from the model and re-applied to the real world. Analogue is used purposely in preference to the more grammatically correct analogy since it implies greater precision.

6) RE-APPLICABILITY:

This characteristic has two senses, one similar to 5. above and secondly that that model should ideally have wider significance than a unique abstraction of a prototype system, and be applicable to all prototypes of a similar nature.

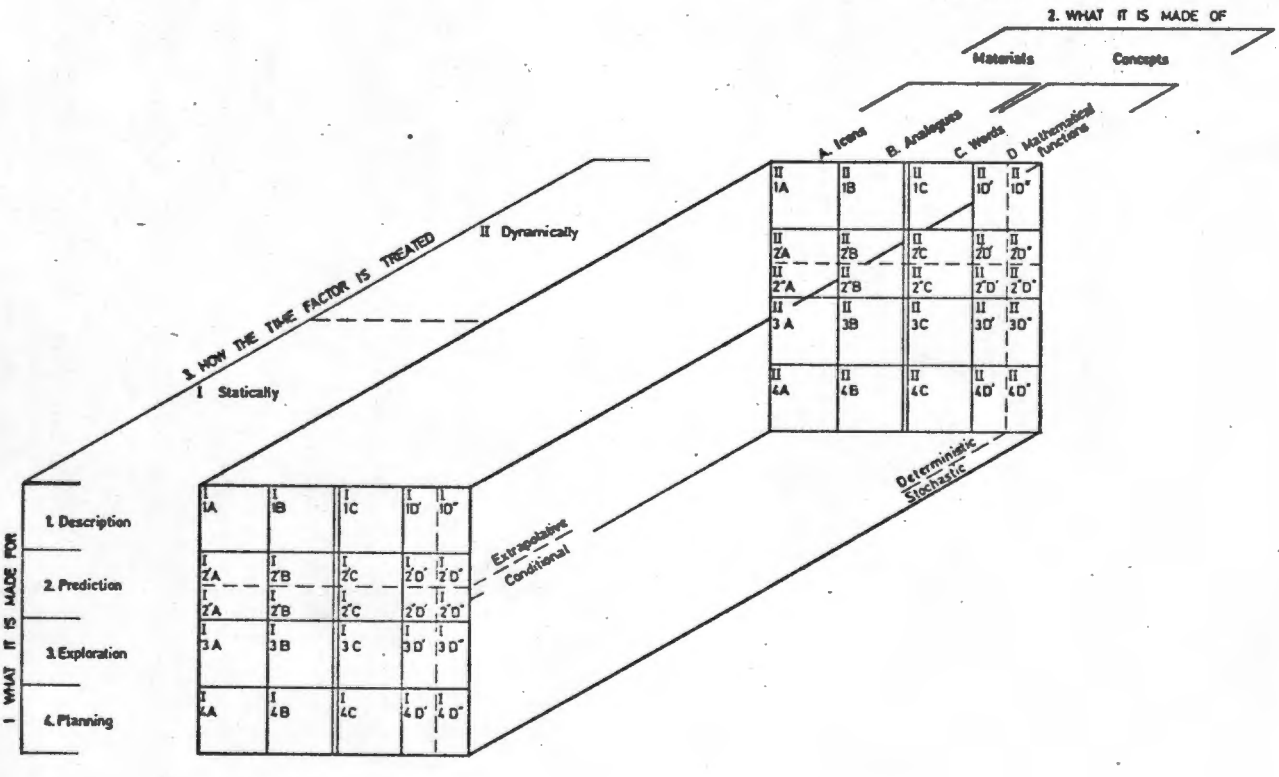
1.11 TYPES OF MODELS

Having defined the main purpose of models, and some of their essential characteristics, it is now possible to discuss and define certain classes and subclasses of models and to concentrate on those that are of greatest relevance for Planning.

For simplicity, a fairly strict classification is used, but naturally the boundaries between the groups and subgroups set out below, are not rigid.

The first distinction possible is that between physical and conceptual models. Essentially the criterion for this division is the stuff of which the model is made. Is it made of cardboard, or is it made of words or other kinds of symbols? Alternative names for these classes that are found in the literature are 'iconic' and 'formal' models; or hardware and software models. These two main categories are both divisible into two subgroups of deterministic and stochastic models. That is, models illustrating the relationships between cause and effect or models explaining the operation of systems where the outcome of each event

depends on some element of chance. These subcategories divide further into dynamic and static types of model in which processes and functions through time and structural equilibrium conditions are described. At this stage the series splits again into descriptive and normative types. The former being usually some form of stylised representation of reality and the latter being an explanation of what might occur in a given situation under certain stated conditions. The final breakdown is into the classes of models of taxonomic and predictive nature. Taxonomic (of classificatory) models are used largely in experimental work while predictive models are of great interest to Planning work in general. Although this seems to be rather complicated, a simple diagram serves to make this point much clearer.



It will be useful to complete this discussion with a rigorous definition of the concept 'model'. Tarski (1953) states that: 'a possible realization in which all valid sentences of a theory T are satisfied is called a model of T'. This concept may be used without distortion in mathematics and the empirical sciences. The differences between the disciplines lie not in the meaning but in the use of the concept. In the established branches of the sciences sentences of the theory are asserted as if they are one way of describing the universe, experimental results are described as if there were but one way of describing them, and notions of common-sense are taken to be appropriately homogeneous with theory. However, in the 'immature' branches, the use of the word 'model' is far more frequent.. For instance, Arrow (1951) refers to a 'model' of rational choice because the theory he has in mind does not give an adequate description of the phenomena it attempts to explain but only provides a highly simplified scheme.

'The concept of model used by mathematical logicians is the basic and fundamental concept of model needed for an exact statement of any branch of science. This does not invalidate the variant uses or concepts now used in many sciences, but in the exact statement of the theory or in the exact analysis of data, the notion of model in the sense of logicians provides an appropriate intellectual tool for making the analysis both precise and clear'. (Suppes, 1960).

Observing models reveals the multiplicity of uses to which they are put. For example, if there is not theory that fits a certain domain of facts, then it is possible to substitute this set for another for which a theory is well known, assuming that the two sets have certain common characteristics. It is then possible to use a model to increase knowledge by allowing an explanatory framework for the first set of data (suggestion). On the other hand, if a theory exists for a domain of facts, but is conceptually too difficult to yield results, we can use a model to outline fundamental ideas of the theory, in such a way that simplifying assumptions lead to solutions (selectivity).

There is also the case where, given two theories without contact with each other, it is possible to use one theory as a model for the other or to introduce a common model, and thus establish the relationships between the theories (re-applicability). Given and incomplete theory which is well confirmed a model can be assigned which could lead to completion (a quantitative model could give precision to a qualitative theory and vice versa) (structuredness). If new data are obtained in a specific field which result in the formation of a more general theory, the old data could be assembled as a model of the general theory to test its relation to the initial data (re-applicability). Models can be

used as explanations of theories about set of facts, and can provide a visualisation of a closed formal structure, and are also used to bridge the gap between theoretical and observational levels. One of the most important uses as far as the planner is concerned, related to the essential experimental aspect of the scientific method, is the case of theorising about objects too big to be observed in detail, or experimented on, in controlled situations. In this situation systems are constructed as practical models, on which experiments can be effected and taken as sufficiently representative of the prototype to yield the desired information.

To sum up, models can be used to form and simplify theories, to reduce or extend them; in explanation, concretisation, or globilisation of theories, experimentation with theories can be carried out by means of the right models. Models are introduced to establish relations between theories and theories, experiments and theories, experiments and experiments, between intellectual structures and the subjects using these structures. This is done in order to dynamically produce new results, tie up new ones with old ones as guarantees or simply to establish relations (Apostel, 1960).

1.12 EXPERIMENTAL MODELS IN PLANNING

An aspect of Planning problems that has not yet been touched on, is uniqueness. The reason for this is that this quality may be no more than a transient aspect of the kind of problem planners deal with, which will become less important as general theories begin to establish relations between apparently discrete sets of data. The bewildering diversity of issues facing the planner is reminiscent of the diversity of natural phenomena that the first empirical scientists set out to investigate and explain. Nevertheless, this quality of uniqueness suggests that for purposes of research and experiment models must be used which are analogues of the prototype system. This type of model can be pre-operated in order to analyse and possibly predict the characteristics of the prototype. The aspect of uniqueness is important in that it is not yet clear to what extent it is possible to depend on existing theory to predict the operation of a given system under a given set of policy inputs. Thus in order to avoid costly mistakes it would be preferable (to say the least) to try to assess these results beforehand in abstract. This yields a two-way feedback, in that the original body of theory can be improved where found inadequate, and the policy inputs changed where they are found to have undesirable effects.

The complexity and physical size of the prototype systems also make it necessary to consider the use of simulation techniques.

Without discounting the use of other model types in the field of Planning research, it seems that simulation techniques are likely to yield the most profitable results. The description of scientific method has shown that the confirmation or negation of theories through experiments is possibly the most important part of the research process, and simulation seems to offer the planner a powerful device for experimentation.

1.13 PROBLEM-ORIENTATION, SIMULATION AND EXPERIMENTS

A technical discussion of the construction of models is not in place at this stage; a number of general articles dealing with this aspect can be referred to (Wilson, 1968, Alonso, 1969, McLoughlin, 1969, Lowry, 1965, Harris, 1965). Model design will be considered later in particular reference to the S.G.P.M. (Chapter 4). In spite of this there are one or two aspects of models-in-research which are relevant in considering the nature of Planning. No mention has been made of the problem-solving orientation of Planning. To a certain extent this is implied in the consideration given to the relationships between Planning and decision-making, and the design-construct origins mentioned before. Sufficient material has been discussed now to enable a specific statement to be made about problem-orientation. The concept of Planning as a science could remain virtually unquestioned were it not for the fact that the discipline grew in response to a problem-solving need. The heavy input from the design and action oriented disciplines (architecture and engineering) is evident in the way many Planning problems are tackled and solved. (Wilson, 1968) It is here that a crucial question must be answered; is Planning simply a problem-solving technique, comparable to architecture and engineering, but differing only in the nature of problems; or can it be considered as an independent discipline, with its own body of theory, based on continuing research through which problems of control in urban and regional systems can be solved?

The more pragmatic answer would be 'yes' to the former, and 'no' to the latter, with some reservations about oddities like Regional science; but it is best to be quite clear about the implications of these two questions: The alternatives are either

1) an action-oriented discipline operating on a stimulus-response, problem-solution basis, dependent on empirical (trial-and-error) methods and and experience (rule-of-thumb) for its immediate technical expertise and

on an eclectic attitude to the Behavioural sciences for some theoretic base on which to build action programmes, relating to urban and regional systems, or

2) a research-based discipline working towards adequate and acceptable theoretic explanation of the behaviour and control of urban and regional systems, as a benefit of which it is possible to assist with specific problems in the control of those systems.

Looked at this way, problem-solving can be viewed either as the raison d'etre of Planning, or as a useful benefit of the study of Planning per se. The answer does not lie in a normative approach to these alternatives. There is no choice. The evidence points towards accepting Planning as a science and getting used to the idea that problem-solving is not the sole purpose of the Planner.

The evidence is the development of structural (non-quantitive) mathematical techniques (Echenique, 1971), which allow description of system-connections in a rigorous or logical way. There is also evidence that Regional science is increasing its scope and application (Isard, 1969) and defining lacunae in the theoretic base of related disciplines which need to be filled in by a 'superordinate theoretic system'. Economics, sociology and politics are beginning to outline areas of concern that obviously need an integrating theory to explain them (Rothschild, 1971). The political and social position of the Planner in his action-oriented role is also being very closely criticised (Dennis, 1970) (J.A.I.P. vol. 34, 1968).

More basic evidence has already been discussed where suspicions about being scientists and thinking like scientists seem to stem from misunderstandings of what science is, or at least what scientific reasoning is. The significance of systems thinking in Planning, and the growth of the necessary tools to be able to analyse complex systems also add weight to a systematic approach to research and problem-solving. Recent developments in model-building and simulation (Hamilton et al, 1969) remove doubts about the feasibility of experimentation.

It seems, therefore, that the development of Planning as a science is not a matter of choice, but a metter of time, and the decision of individual practitioners may slow or hasten the process but will certainly not affect the general movement to any noticeable degree.

The basic research tools of the Planner are models, or systems of models in which the structural connections of urban and regional systems can be simulated, and the effects of changes investigated.

It would seem obvious that a healthy relationship could develop between Planner and decision-maker, only in the situation where there is no commitment to a particular course of action on the Planner's part, but rather an objective interest in the probability of success or failure of a particular decision in relation to the prediction of a particular body of theory.

1.14 CONCLUSION

Planning implies the evaluation of alternative solutions to a given problem. It has been seen how the origins of Planning have obscured certain basic relationships which need to be carefully articulated if it is to be considered as a viable separate discipline. The distinction between technique and ideology, piecemeal engineering and Utopianism, relates to a basic conflict in the understanding and application of scientific thought. In the context of urban and regional systems, Planning begins to take shape, its edges still blurred by overlaps with other sciences and other action-directed fields of study. In this context also the hypothetico-deductive system of thought appears quite compatible with the concerns of Planning, except as far as the strict pure-applied definitions are applied. Here one is forced to fall back on the question of personal integrity and ethics as the final measures of the effectiveness of any human endeavour, with the proviso that a common bond of research attitudes can act as a check on irregular or irrelevant activities.

This question of ethics relates to the question of plans and planned action, and the planner's involvement in the act of planning as such. From one point of view one could say that in order to be strictly objective the planner should disentangle himself from the entire decision-making process so that he can evaluate these situations from a position of neutrality. To what extent this ideal is attainable is difficult to say, but certain developments indicate that it may become much easier to do this. The development of system concepts and parallel with these, model concepts and techniques, give to the planner tools which enable research on urban and regional systems to be carried out with confidence, if not ease. The model system gives the Planner a laboratory within which to perform experiments and to test theories, and in principle the action-orientation of planning need no longer be a major issue. Most important, the goal-setting function of the action-planner can be queried, and sets of goals postulated and tested. In principle it is possible for the Planner to regard all policy inputs as variables, which could have some salutory effects on political decision-making in the future.

More than this, the emphasis on Planning as continuing research rather than action orientation and commitment allows full use to be made of feedback processes. This means that the results of planned actions are as much a source of information and a spur to research as the planning of those actions themselves. The continuity between plan and action, reaction and replan, and therefore the continuing responsibility of Planners and decision-makers in any given problem situation is only fully realised under conditions of constant criticism and review. The delivery and implementation of one-off plan packages is not considered relevant in the light of increasing knowledge, and the phasing and integration of planning, management and control is a crucial issue in all Westernised national administration.

2. PLANNING, POLICY AND CONTROL

In an article in the South African Journal of Economics, Professor Lombard (Professor of Economics at the University of Pretoria) raises a question about the role of the Planner that was the subject of the last section. In the same article, however, he outlines a significant issue. This issue is the place of the Planning phase itself, and the attitudes towards Planning among administrators and the private sector. It is these attitudes towards planning that directly affect its usefulness as a discipline.

"... Government will, of course, remain an art - the art of politics and administration. But to a rapidly increasing extent, objective analytical techniques, not merely in economics, are available to reduce the margin of error, uncertainty and subjectivity in the application of this art of decision-making. These various forms of technical expertise should, however, be mobilised and introduced into decision-making at the correct phase of this process. And here an important functional distinction must be drawn between planning and management.

"The planning phase involves the widest investigation of ideas, and analyses on possible ways and means of achieving objectives which themselves are still subject to critical examination in terms of general welfare propositions. This phase, which requires thorough administrative organisation to mobilise the best ideas and analytical experience in the country, identifies the socially most effective and economically most efficient programmes for Government action.

"This planning phase is the one that is seriously neglected in Government. The administration too often moves directly to specific programming whenever a government objective arises. The result is frequently that action programmes are implemented irreversibly which later either prove ineffective in terms of basic objectives, or prove less effective than they would have been had the problem had the necessary airing provided for in a properly organised planning phase. Since planning involves an additional phase, more time is required between the conception of an objective and its practical application. This makes longer horizons in anticipating future Government responsibilities or in the emergence of problems in existing responsibilities, essential. In this field, much more than in current programming, the administration should make use of the academic and other sources of intelligence available in the South African community." (Lombard, 1971, p.122)

Three important matters are clearly outlined in this quotation. Firstly, the objectivity of planning in its evaluative or critical role and the different functions of planner and manager. Secondly, he points out the significance of the timing and phasing of the planning process and thirdly, in calling for the mobilisation of these techniques, he implies the question of attitudes and understanding of administration and management in respect of the planning process.

In this article, Professor Lombard, urges the reader not to regard the market as the final arbiter of the economic norm, while public enterprise is just as subject to analysis and criticism through the application of that norm. It is this application of the economic norm to government and management that requires the discipline of the Planner. The economic norm, the weighing of benefits against costs, is not particular to economics, but is a measure that can be applied to judge the rationality of most social behaviour (Lombard, 1971). The implications of this kind of thinking is examined here. One point must be clarified though, and that is that the need for planning is regarded as a received principle in this thesis, it is rather the place of planning that is questioned.

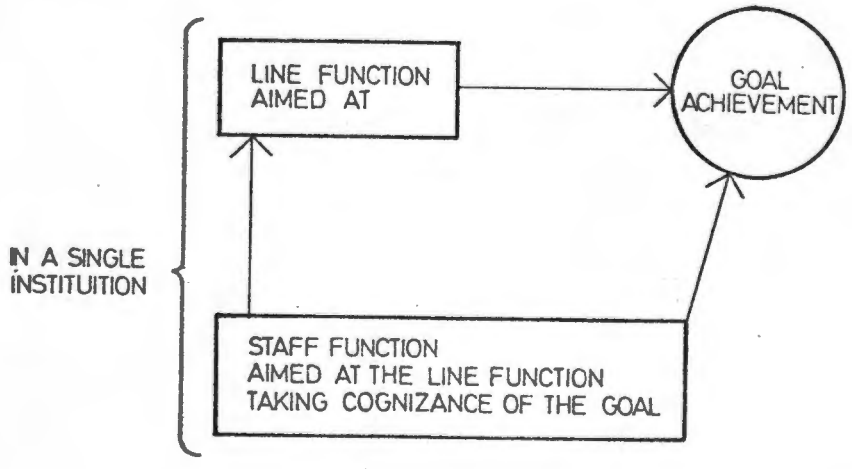
There is a growing concern with the place and phasing of planning in many spheres, and the views expressed above are not limited to the field of economics. The same problems were being critically explored in 1968 from the point of view of the public administrator. In this context Prof. J.J.N. Cloete (also of Pretoria University) sees planning as: "die uiteensetting van owerheidsdoelwitte aan beoogde optrede om die een of the ander faset van die gemeenskapslewe op plaaslike, regionale of nasionale skaal in 'n bepaalde rigting te stuur of 'n bepaalde voorkoms to laat aanneem." Planners are seen as an integral part of the government process, conscious of political goals -

"die politieke bewindhebbers se gemeenskapdoelwittes" - and careful to poiht out the areas of deficiency and the effects of alternative plans - "die deskundiges ... sal verseker dat al die alternatiewe wysers van optrede inderdaad ondersoek sal word en dat elkeen se implikasies tot op die operasionele vlak in berekening gebring sal worl." (Cloete, 1968, p.130)

The evaluative nature of planning is stressed again by Prof. Moolman of U.N.I.S.A. (1968, pp. 170-171) who brings up the problem of public-private sector communication. According to him, planning "moet die owerhede adviseer oor eie fisiese beplanning en op die hoogte hou van die implikasies daarvan, en dit moet op tegniese vlak, koppeling bewerkstellig met die privaatsektor sodat probleme van gemeenskaplike aard bespreek, bestudeer en uitgestryk kan word". (Moolman, 1968, pp. 170-171). In another field, Dr. Du Plessis' comment on the E.D.P. (N10) is illuminating in its emphasis on the directional rather than the coercive nature of this document. Three schemata of the planning process have been included in the notes to this chapter (N11) which should be compared with the comments above.

One thread runs through this discussion which was also dealt with in section 1.3 and that is the nature of Planning as an evaluative discipline. Enough evidence has been gathered to regard this as a received principle.

The major issue which remains to be questioned is the place of planning in that evaluative process. Are there limits to its terms of reference, and are there constants which must guide the direction of this critical process? In order to discuss this aspect, it will be necessary to distinguish between the planning process and the discipline of Planning as previously defined. A convenient way of doing this has been devised by Ben Roux of UNISA (1968, p. 144). He defines what he calls a 'line function' and a 'staff function' in administration:



In his example the line function can be regarded as the 'administration' (including policy planning, programming and budgeting) while the staff function is an on-going research process acting in a consultative or advisory capacity to the line function. In other words the line function is problem-oriented and the staff function is research-oriented.

It is postulated here, however, that the 'staff function' is not necessarily oriented towards the same goals as the line function. Speaking plainly, the line function - or administration - operates within the constraints of overall government policy, which can be regarded as a set of social welfare constants. On the other hand, the staff function - or planning research - does not have to recognise these constraints. In fact, for the sake of continuation of the system one might say that it should not direct itself to the same goals as the line function.

In terms of this scheme, the planning process is represented by the linking arrows (system connections) between line and staff functions. The staff function however (Planning discipline) continues beyond the goals, whereas the line funtion is limited by those goals. Following from this, two propositions are put forward for review:

1) If, as Prof. Lombard says, it makes sense to weigh up costs and benefits, then the costs and benefits of alternative social welfare functions, goals or policies can be subjected to objective testing.

This first proposition is subject to the limitation that these goals can be considered as variables or constants depending on the scale of problem under review. Thus on a municipal scale, national goals would be accepted as a constant, and municipal goals subjected to criticism. On a national/regional level, national goals can be taken as variables.

2) Systems of goals or social welfare functions (at all levels) have two aspects. Firstly, there is the structure or channels through which the goals are affectuated (that is, the voting and bargaining systems, the societal structure - capitalist or socialist, etc.). Secondly, there are the value systems of the society itself, which usually crystallize out into party-political systems that set the parameters for the types of goals and welfare functions that will be proposed.

It is postulated that both aspects of the second proposition are subject to testing in terms of the first proposition. The analysis of the benefit and costs of different political systems (i.e. structural systems) is as

necessary as the analysis of different economic and social systems. The testing of alternative political goals and their possible effects in terms of costs and benefits is likewise as necessary as the testing of alternative economic goals.

2.1 POLITICS, ECONOMICS AND FREEDOM

To support the postulate above, it is necessary to outline a way in which the system and the goal can be effectively and objectively analysed. It is felt that some of the concepts of information theory might be useful.

The market mechanism can be regarded as a device for transmitting information between producers and consumers about the relative values of commodities and the costs of production. The basic signals in this information system are prices, made up of money units, and also messages regarding stocks and flows of goods which tell something about demand and supply. A political system can also be regarded as an information system. The democratic goal to which most political systems aspire is again simply a framework through which the desires of individuals may be transmitted. The signals here have a variety of forms, one of the basic units being the vote, but other forms of transmission are equally admissable; language and money probably being the most frequently used. Regarded as such a political system should provide for two-way information flow, which is essential for a negative feedback system to operate. This provides for replacement or readjustment of malfunctioning components if the need arises. Looked at from this point of view, the market system of a country and its political system are very similar. They not only complement one another, but can in many respects become substitutes for one another. Thus in the United States, the growing pollution problems, although strictly speaking an economic issue involving the social costs of overproduction through abuse of free goods, is being dealt with not on an economic-managerial level, but on a political level through group action, lobbies and effective protest. In South Africa, on the other hand, many of the restrictive features of the political system are being dealt with by economists and managers. Employment mobility, education and representation are not argued in political terms of votes and bargaining, but in terms of production functions, growth ratios and business cycles.

Now consider the concept of freedom in relation to the above. Freedom will be defined as the 'absence of obstacles to realisation of desires'. (Dahl and Lindblom, 1953, p.29) This is not a definition of freedom

as such, but a conceivable condition which could be labelled freedom. There are, of course, subjective and objective attitudes to the presence of obstacles, and desires can be arranged along a continuum from conscious to unconscious and can change radically as expectations change. Hence it is possible to see the political and economic systems as the communication network through which individual desires are transmitted and within which obstacles to those desires are either removed or reinforced. Thus the degree of freedom in a system can presumably be measured by the degree to which individual desires are achieved and the ease with which they are achieved. The achievement of desires, however, immediately implies controls of one form or another. Also, since the achievement of desires necessitates the use of resources, processes of resource allocation or economizing are brought into effect (Dahl and Lindblom, 1953, p.117). This interaction of information, control and economizing creates the dimensional domain in which political systems operate. At this stage one can say that identification of the components and connections between them and measurement of the rates and levels within that system are all within the bounds of possibility, and moreover this analysis is possible without reference to normative judgement. (N12)

Another measurement of the effectiveness of a controlling mechanism is the degree to which precipitate action is taken (unplanned planning), where urgent problems are tackled without reference to an established planning process or information system. The degree to which these precipitate decisions are reversible once made, is also significant. It is here that confusion arises between ends and means. Controls intended as a means of achieving a specific goal often become regarded as ends in themselves regardless of their effectiveness. Control systems require equal emphasis on action and reaction; the feedback process requires properly structured communication channels if effective control is to be maintained over a dynamic system (N13).

2.2 TOWARDS A NON-NORMATIVE APPROACH TO POLITICS

Sections 4 and 5 of Chapter 2 will show that socio-political issues have been major determinants of the growth and development of this country. Through these problems runs the thread of value-judgements, normative decisions, Utopianism... whatever one may care to label it; the tendency to act with reference only to a super-ordinate system of ideas which tends to be static in nature. A plea against this kind of thinking has been made by Prof. Cilliers of Stellenbosch University

in relation to a crucial question in South Africa's development. In his book 'Appeal to Reason', he states: "The main object of this discussion was to deal with the issue of the political rights of the Coloured persons in terms of a rational assessment of the realities rather than in terms of unquestioned ideological premises." (Cilliers, 1971, ppviii). An appeal to reason must be a recognised principle of all the parties concerned in decision-making.

The purpose of this section has been to show that there is no question about the need for planning in this country. It has been shown that there is still some confusion about the part that Planning plays in the decision process, and the terms of reference of the discipline in respect of the goals and value-systems of the administration. Because of this confusion an attempt has been made to show that political systems and the social welfare function (or ideologies) which determine them, are yet another aspect of the spatial domains with which planning is concerned in its research into the nature of urban and regional systems. A non-normative approach to the political structure of these systems is possible. Because those structures are important determinants of the behaviour of urban/regional systems it is necessary to understand them, and moreover to be able to assess the effects of changes to those structures.

This is a crucial issue in this country, because it demands logic and neutrality in an area where emotions and commitments are deep and strong. One is reminded of the situation of Galileo and Darwin and heretical challenges to the established beliefs of their time. It is unlikely that charges of heresy will be generated by a study of political systems today, but the difficulties are not to be minimised.

The possibility of beginning such a research project will be discussed in chapter 3 in sections 1 and 2.

NOTES TOWARDS CHAPTER 1:

N1 It is interesting to note that Carr in 'What is History?' (Carr, 1961) parallels Popper's views on history up to the point where the latter repudiates the significance of the Utopian (Historicist) attitude. Carr's final remark against Popper (p.156) is contained in an argument that smacks more of neo-colonial empire building than a rational view of history. Another of Carr's points, that progress comes not through piecemeal engineering but through presenting the establishment with fundamental challenges (p.155) is all very well but to name one such challenger, Newton withheld the publication of his universal law of gravitation for twenty years until he had developed the necessary mathematics to support his arguments (Bell 1937). The point here is that most of the 'revolutions' of which Carr speaks are the outcome of just such a cautious and piecemeal approach as Popper discusses. Carr misunderstands Popper's argument. After all, the 'dear T-model' that Carr accuses Popper of wanting to 'keep on the road by dint of a little piecemeal engineering' has developed into a Thunderbird through exactly that kind of engineering.

N2 The meaning of complex, or complexity, as used here, must be made clear. In the context it is used in the sense of intertwined or elaborate rather than in the sense of difficult. The complexity of a system means that it is difficult to conceive in simple everyday terms. Once additional terms or techniques are invented to ease conceptualization (and therefore analysis) the complexity of a system does not necessarily form a measure of its difficulty for understanding.

N3 McLoughlin's definition of a generalist:

'Generalists may be defined as people who can"

(i) understand the nature and behaviour of the appropriate system;

(ii) distinguish elements and sub-systems within it and how their problems are approached by people with other skills;

(iii) co-operate in the setting of goals and objectives for the system;

(iv) devise the best methods of improving system performance;

(v) carry continuing responsibility for the performance of the whole system.'

(McLoughlin, 1969, pp. 306-307)

N4 It is not considered necessary here to define urban and regional systems in any detail. Certain aspects of these systems will be discussed later under the 'Definition of regions' and should additional clarification be required, McLoughlin (1969) and Friedman (1964) provide excellent sources.

N5 Both Popper (1969) and Medawar (1969) point out that 'falsifiability' is a criterion for accepting a system of thought as scientific, and to eliminate those statements which 'contain a built-in antidote to dis-belief' (Medawar, 1969, p.50). Nagel (1967) points out that theories are neither conclusively verifiable nor conclusively falsifiable, thus 'differences in the strength of support which hypotheses receive from the evidence for them are not only recognised but ignored only at one's peril.' It must be pointed out that the brief summary of the hypothetico-deductive method set out by Medawar in his book 'Induction and intuition in scientific thought' accounts for this point.

Medawar (1969) sets up certain requirements for a good methodology and tests hypothetico-deductive method against it as follows:

1. Discovery and justification must be distinguishable:-

   This is achieved through the non-logical formation of hypotheses and the strictly logical testing of those hypotheses.

2. The evidence of the senses must not be recognised as authentic:-

   The initiative for scientific action comes not from sense data but from 'imaginative apprehension of what might be true'.

3. There must be an adequate theory of special incentive:-

   Observations are confined to those that have a bearing on the hypothesis.

4. Allowance must be made for repair and modification:-

   This process of negative feedback is implicit in the hypothetico-deductive system.

5. There must be provision for a theory of the prevalence and origin of error:-

   This is explained by human fallibility - a wrong guess.

6. Luck must have a place:-

   A lucky accident can fulfill a prior expectation.

7. 'The hypothetico-deductive scheme gives due weight to the critical purposes of experimentation: we carry out experiments more often to discriminate between possibilities than to enlarge the stockpile of factual information.' (Medawar, 1969)

N6 Within the broad field of Planning there is a range of subjects which vary greatly in their methodological approach to problems. Taking the extremes as, say Regional Science to Urban Design, it is possible to identify dependency on method of a direct and explicit kind in the former and a complete rejection (in general though not always) in the latter. It would seem logical that in order to maximise inputs from the related fields of geography, economics and sociology in particular and in order to build up an accepted and logically consistent body of theory within the planning field, there should be some unity of method.

N7 A melody may be played at different positions on the keyboard of a piano - i.e. different components (notes) may be used, but the variations will not differ significantly to the listener except in tone. The structure - or positional value - of the notes relative to each other remains the same regardless of where the melody is played on the keyboard (regardless of which tonal values are used; where in this case the tonal values are the inherent characteristics of the components).

N8 These characteristics are derived from a discussion by Katz & Kahn (1966) in their book 'The social psychology of organization' pp.14-29.

N9 BEHAVIOUR CHARACTERISTICS OF COMPLEX SYSTEMS:

1. Counterintuitive behaviour:

Because intuition is developed through experience with simple systems, one's perception of cause-effect relationships in complex systems is likely to be misleading. Action on symptoms will rarely affect the underlying causes because of the dispersed nature of the system structure.

1.1 From 1, corrective programs lacking this understanding are often actively resisted by the system.

1.2 From 1.1 also the dispersal of feedback loops in time lead to lags in response to actions which are often interpreted as, or cause, failure in corrective action. (The 'worse-before-better' syndrome).

2. Insensitivity to Parameter changes:

   Complex systems are remarkably insensitive to changes in the system parameters.

3. Control through influence points:

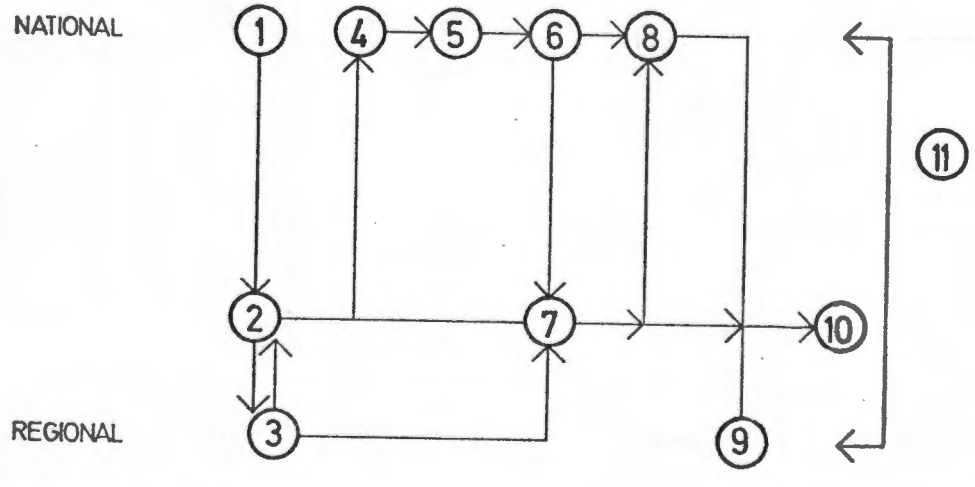
   Conversely to 4, certain parameters and certain structural components are highly sensitive to change.

4. Continual imposition of corrective action without understanding the system structure can lead to a drift to low performance of the system as a whole, due to interference with the natural feedback systems

N10 "Aangesien die woord beplanning destyds te veel met die sentraal-beheerde planne van die kommunistiese lande geassosieer is, is besluit om die woord 'beplanning' te vermy en word die term 'ont-wikkelingsprogram' gebruik.

So 'n ontwikkelingsprogram moet noodwendig inpas by die politieke, sosiale en eknomiese stelsel van die land. Algemeen gesproke kan drie hoogtipe van planne onderskei word. Ten eerste is daar die sen-traalbeheerde planne wat die kommunistiese lande opstel. Ten tweede kan gedetailleerde planne van alle ontwikkelingsprojekte wat die staat oor die beplanningstydperk sal onderneem, onderskei word. Dit is duidelik dat die eerste twee benaderings tot beplanning heeltemal on-vanpas vir die Suid-Afrikaanse toestande is. Daar is dus besluit dat die Ekonomiese Ontwikkelingsprogram van Suid-Afrika slegs rigting-aanduidend moet wees." (Du Plessis, 1968, pp. 186-187)

N11 Friedman's framework for the regional planning process:



11.1

1. Formulation of regional development, migration and settlement policies
2. Preparation of regional strategies, plans and programmes
3. Identification and preliminary evaluation of regional investment projects
4. Integration of development strategies, plans and programmes for individual requirements into a national set
5. Integration of national set of regional strategies, plans and programmes with global and sectoral national plans
6. Preparation of annual programmes, budget guidelines
7. Preparation of regional programme budget
8. Integration of regional programme budget into a national set and integration of this set with programme budget for the nation
9. Co-ordination of regional investment and action programme
10. Promotion of regional development
11. Regional planning analysis. (Friedman, 1968)

11.2 The Planning Process (Roux, 1968, p.148-149):-

'.... the planning process for a comprehensive volume of work e.g. the construction and maintenance of a large irrigation scheme such as the Orange River Project, would normally involve the following:

1. Assistance and advice to policy-makers on the formulation of policy (sets of related goals), which assistance and advice entail
   - surveys and data collection,
   - forecasts,
   - determination of alternatives and their implications which includes reconciliation of considered necessities and available resources, and
   - identification of variables.
2. Assistance and advice to the competent policy-makers on the operational definition of intermediate and ultimate goals.

3. The systematic plotting (using the same techniques as under 1. above of a course of action and decisions on all that is necessary to achieve the predetermined goals), and this entails present estimates, recommendations, decisions on what will be required in terms of
   - organization,
   - personnel,
   - finance,
   - work procedures,
   - control, and
   - external relations.

4. Repetition of any or all of the foregoing steps, usually on a smaller scale, as often as required during the process of implementation.

11.3 Wilson's 'Relevance Tree' for the planning process (Wilson 1968).

See overleaf.

N12 (Isard, 1969, p.57 et seq.) where the potential for participation can be defined as:

$$I_{ij} = G\frac{w_i(m_i)^a w_j(m_j)^b}{d_{ij}^c}$$

Where G is an appropriate constant

w_i , w_j are weighting factors

d_{ij} is the distance between i & j however defined

m_i , m_j are masses at i & j respectively, however defined

a b c are adjustment factors (constant or variable) on m_i, m_j, d_{ij}

This is a refinement of the normal regional gravity model based on the masses of populations. It would be possible to use Dahl & Lindblom's classification to define and identify political systems and sub-systems.

POLICY (Action/decision, goal formulation, evaluation)

1.	Action	Implementation of (sub) plans	decision taking						
2.	Goals	Local groups	residents	workers	employers	shoppers			
3.	Evaluation	Criteria?	Weights relating goals	Derivation of goals	Evaluation of alternative (sub) plans				

DESIGN

4.	Plan formulation	Decide (sub) plan structure	Decide time horizons	Methods of contingency planning; (treatment of uncertainty)	Generation of alternative (sub) plans	System model manipulation			
5.	Design techniques	Data requirements	System model requirements	imagination aids					
6.	Problem formulation	System malfunctions (misfits)							

UNDERSTANDING

7.	System models	Aggregate population	Aggregate economic Structure	Residential	Workplace	Economic activity	Infrastructure	Transport	Social Services
8.	Techniques	System identification	Principles of model design	Eclectic selection of techniques by discipline	Data	Computers			

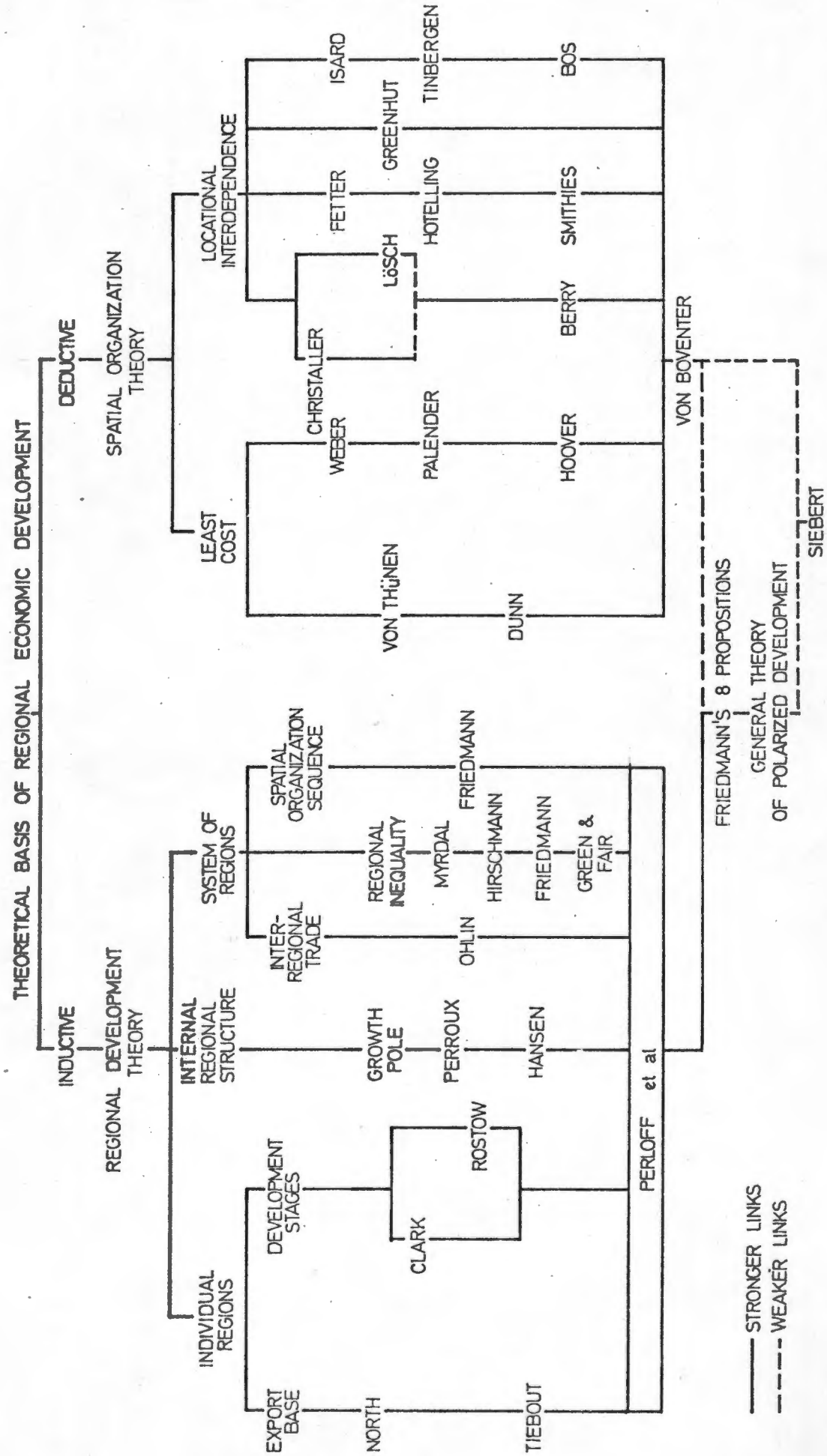
N13 An important example of Government control through information on a high level has been the Economic Development Programme. This programme has been subjected to a great deal of cogent criticism in a series of attacks and counter attacks (Rickert, 1962, Richards & Piercy, 1962 and 1963 a, b & c, Lachman, 1963, Van den Bergh, 1964. and 1965, Richards and Simpson, 1965 and Du Plessis, 1965). This controversy seems to hinge on two main issues, firstly, the technical basis of the methods of the EDP, and secondly, its informational value. The first of these is beyond the scope of this discussion, but the second warrants some comment. Since the release of the first EDP for 1964-69 on 14th December 1964, the EDPs have been regarded as the main public source of information on Government programming policy: "the publication of such a programme is in itself a new source of information which the public and private sectors will take into account when making decisions. Of importance also is the relevance, if any, placed by entrepreneurs upon the information contained in the publication." (Richards and Simpson, 1966, p.6) It is not clear whether the stipulated growth ratio is merely a forecast, or a goal to which public expenditure will be directed, or a policy directive to which the private sector must adhere. Should the private and public sectors differ in interpretation of this, disparities in investment could arise with unforeseeable and unwanted effects on the economy as a whole. The other question that arises is, in the event of the real growth rate lagging behind the indicated rate, what controls will Government impose on the private sector to ensure that the two coincide? Does the EDP get revised to reflect the real situation, or is pressure brought to bear on private enterprise to 'jack themselves up a bit'.

CHAPTER TWO: general analysis

1. THE DEVELOPMENT OF REGIONAL SCIENCE

Regional Science has been acepted as an independent field of study for a very short period. Not more than thirty years ago economists were still engaged in major controversies about the significance of time as a determinant in the growth of dynamic economic systems, but the importance of space in their calculations had not yet been recognised. Similarly geographers were involved in a major reorientation of their own discipline, where the younger geographers were beginning to realise that geography was as much a search for order

TABLE 2.1.a: THE STRUCTURE OF EXISTING REGIONAL THEORY
(Source: Browett et al, 1971)



as any other science, and not purely a descriptive discipline in which the uniqueness of areas remained unquestioned. The dissatisfaction of a few economists with the wider relevance of their discipline, and the search for new directions in geography coalesced into a particular method of study called variously Regional Science, analysis, economics and sometimes planning. Other developments also explain why regional science developed suddenly, mainly after the second world war. Obviously the rapid stride in the computer sciences due to the urgency of war, have their place (N1). Again, the world wars made clear the interdependence of nations in an industrializing and urbanising world. For the same reasons, communication and transport began to make social and economic disparities and their spatial distribution very widely felt. It is significant that in most major work on regional analysis, references in the bibliographies are dated earlier than 1940, but not than 1930. (Isard, 1960, 1969, Friedmann & Alonso, 1964, Nourse, 1968, Perloff et al, 1960, Green and Fair, 1962, and Needleman, 1968). A recent selective bibliography of work relating to regional economic development prepared by the Department of Geography and Environmental Studies at Witwatersrand University (Browett et al, 1971) contains only two references to publications before 1940 (i.e. Hotelling and Weber, both 1929).

The growth of American imperialism - with its emphasis on aid to developing countries, the formation of the League of Nations and the United Nations, and the grouping of Nation-States into economic communities, are major political factors that have emphasised the differentiation in space of economic and social activity patterns.

Thus it is possible to say with some certainty that the growth of Regional Science is a direct response to the immediate problems of the socio-economic milieu of this century. Since the development of Regional Science has occupied a very short period, historical analysis of that development is of no real value. In this case it is more profitable to look at the structure of the ideas behind Regional Science - the generative theories and their ramifications - rather than set these ideas out in the order in which they occurred.

A useful framework for this purpose has been developed by Browett, Haswell & Rossing (1971) and is reproduced here as a basis for discussion. (Table 2.1.a) Friedmann's eight propositions which are isolated by this diagram, are included in the notes for reference (N2).

Before describing the theoretical system outlined in Table 2.1.a in more detail, it is as well to start with a definition of Regional Science; or at least to give an indication of what Regional Science should encompass. According to Isard (1956, p.vii) there should be a "comprehensive theory of society or economy" which "should embrace both time and space dimensions. It should be able to unravel the dynamic interplay of forces not only currently but also over the long past. Its propositions should be testable against the background of historic development in the several regions of the world and concomitantly should offer explanation of this development. Its hypotheses should encompass the influence of past events and intermingling of forces upon existing economic and social structure and conditions. Ideally, its conceptual framework should enable one to anticipate the course of future development, given certain premises and judgements." As a corollary to this, John Friedmann, in an article on educating planners (1968) sets out a series of twelve points with which he feels Regional Analysis should concern itself. These points are reproduced in the notes (N3) for comparison.

It was suggested above that political issues were instrumental in spurring on interest in regionalism. As regional statistics became available, and as concern with undeveloped areas grew, it became evident that market forces do not result in a uniform distribution of income and development over space. It was more and more apparent that movement of factors of production between regions caused dis-equilibriums that did not appear to be self-correcting; the economics of agglomeration favoured investments in one area at the expense of another (Richardson, 1969). The importance of this realization, and its effects on policy-making, gave rise to the growth of a particular discipline which could inform that policy-making. Intra-nationally the obvious poverty of some areas would be of great concern to most governments, as was the apparently uncontrollable growth of the urban centres. Internationally the lot of the underdeveloped nations became a major issue in the ideological and socio-economic milieu. From the point of view of sub-national units, the policy implications of attempting to correct the regional imbalances became a crucial matter: "given that the government feels justified in intervening, the question then arises - how can the government intervene most effectively?" (Needleman, 1968, p.12). The questions of the mobility of labour, relocation of industry through push/pull policies, and the social, political and economic climate, began to raise issues that could not be analysed in terms of spaceless, aggregated economic models.

In the face of this demand, economists (and others) turned their attention towards the explanation of the distribution of human activity in space. From the beginning 'regional science', 'regional analysis' or 'regional economics' has welcomed inputs from the various fields of sociology, demography, geography and history. "Indeed, at times the distinguishing characteristic of regional analysis has almost seemed to be its interdisciplinary aspect." (Meyer, in Needleman, 1968, p.21).

Because of its growth as a response to demand, regional analysis is in many respects an applied science, strictly pragmatic in appearance and heavily dependent on empirical studies. On the other hand, concern with new problems of spatial distribution and location generated considerable interest in the development of a few purely theoretic concepts which were in existence at the time, and hastened the growth of new theories.

A first concern of a great deal of this work has been the definition of regions themselves. This aspect will be dealt with in more detail under section 2.9 of this chapter, but it will be sufficient to say here that in the literature there are three basic attitudes to this question. These attitudes stress either the homgeneity, nodality or policy-orientation of regions as a basis for definition.

1) Homogeneity is analysed in respect of a factor or combination of factors relating to the physical, economic or social characteristics of an area.

2) Nodality is the quality which defines a region as dependent on a central urban place.

3) Policy-orientation is 'concerned mainly with administrative coherence or identity between the area being studied and available political institutions for effectuating policy decisions' (Meyer in Needleman, 1968, p.23).

Regional definition will more often than not depend on the integration of these three concepts. However, each section has received considerable attention in research, and the first aspect is of major concern in this thesis as the basis of analytic techniques.

The inductive-deductive mainstreams in Table 2.1.a represent the concern in Regional Analysis with both empirical and theoretic work. Under the lefthand, or empirical stream, the major theoretical areas can be subsumed under the following headings:

1) National scale spatial models:
Regional income inequality theory
Export base models.

2) Sub-national scale models:
Regional multiplier theory
Growth pole models
Trade-flow theory (input-output analysis)

A bridge between empirical-pragmatic and theoretical work is formed by mathematical models of urban/regional economic differentiation, where attempts are made by means of statistical techniques to define regions, and to explain the causal links between employment, labour, economic structure, etc. Another type of mathematical model is the Markov-chain model which is used to illustrate and explain stochastic processes. The application of these models is in its infancy and can be expected to yield important results particularly in simulation studies (Chorafas, 1965, Keeble, in Chorley & Haggett, 1967, Morrill, 1965, Hamilton in Chorley & Haggett, p.401, Harvey, in Chorley & Haggett, 1967, ch.14). Input-output analysis as developed by Isard and Leontief, can in many respects be regarded as mathematical models, dealing in matrices, as can the social accounting methods of Stowe and the Cambridge Dept. of Applied Economics. Linear programming techniques, as well as many other methods of Operational Research are well established in the discipline, especially in smaller scale studies relating to transport problems and optimisation problems.

Under the heading of deductive theory, the main areas of work are:

1) Location theory

2) Models and theory of settlement location;
vertical -hierarchies of settlement patterns, and
horizontal - areal distribution of settlement.

1.1 REGIONAL INCOME INEQUALITY MODELS

Interregional trade models based on static equilibrium concepts do not explain the regional inequalities in income (absolute and per capita) which can be considered a universal phenomenon. The adjustment over time which the equilibrium concept suggests has little to do with reality, where such inequalities are not only persistent but actually increasing. Myrdal's model of 'cumulative causation' accounts for this discrepancy in equilization models by isolating changes in the

systems which support original movements where 'the play of forces in the market normally tends to increase, rather than to decrease the inequalities between regions' (Myrdal, 1957, p.26). This process also generates 'backwash effects' through migration of skilled workers and capital from stagnant regions. These disequilibrating forces are counteracted to a certain extent by 'spread effects' where growth in the productive regions stimulates growth elsewhere, but usually after a considerable time period.

Myrdal assumes government non-intervention. Hirschman however, in developing a very similar model, concludes that 'trickle down' and 'polarization' effects (or 'backwash' and 'spread' effects) will be counterbalanced at an earlier stage by government economic policies. Both models have had sufficient empirical testing to be considered useful and relevant models of distribution of activity.

1.2 EXPORT BASE MODELS

The exportable commodities or services of a region are seen by some (North, 1955; Perloff & Wingo, 1961) as a major influence on the growth of that region. The export base of a region is postulated as the structuring force behind inflow of capital, development of residentiary industry and footloose industry. Recent work on these models points to differential wage levels and related changes in labour supply as equal in importance to the export base, and therefore the simple export base model needs considerable refinement if it is to continue as a useful analytic tool.

1.3 REGIONAL MULTIPLIER CONCEPT

The regional multiplier concept explains how a rise in income, production or employment in one group of economic activities in a region stimulates the expansion of other groups, through an increased demand from the former and its labour force for goods and services produced by the latter. This rise is usually induced by exogenous regional changes. A major development of regional multiplier analysis has been into input-output analysis, and recently the development of the concept of forward and backward inter-industry linkages. This concept, however, tends to explain growth in terms of industrial sectors rather than regional or areal distribution. To the extent that these statistics are spatially locatable, however, it is a very useful tool. It is heavily dependent on relatively detailed interregional and intersectoral breakdowns of data, and its usefulness for developing countries is therefore limited.

An interesting concept that has been outlined through the use of regional multiplier analysis is that of a market 'threshold' where the size of a region's markets have an important bearing on its economic development.

1.4 GROWTH POLE MODEL

The growth pole concept is inherent in many regional development models, to the extent that its isolation as a separate model is artificial. However sufficient work has been based on this concept (especially by the French School of Regional Scientists) to warrant its inclusion as a separate concept. It is essentially a descriptive device, having little explanatory or predictive powers, although certain variables in the development of the growth centre can be isolated which makes the concept in certain cases a useful technique. It has certainly been warmly received by government agencies as an imagable concept. and features largely in policy and strategy in regional development programmes.

1.5 TRADE FLOW THEORY AND INPUT-OUTPUT ANALYSIS

More a technique than a body of theory, input-output analysis is of great importance in regional economics.

Generally speaking, the objective is an interregional, interindustry matrix of input-output coefficients defined not only by industry, but by geographic area or region. The data problems of this objective are not difficult to imagine, especially in the less developed countries where statistics and data-collection are not very sophisticated. Simplifying techniques have been developed to avoid some of these problems. Of these the most useful is probably the gravity model of regional trade flow developed by Leontief, where the flow of a commodity from one region to another is said to be directly proportional to the product of its total output in a shipping region by its total input in a receiving region, divided by the aggregate amount of the commodity produced and consumed in the entire economy all multiplied by an empirical constant. The constants are statistically estimated by solving the equations of the regional input-output systems including the gravity-flow equations of the system.

1.6 LOCATION THEORY

Most of the location theories, based on Weber and Launhardt's original hypotheses about the relationships between market and materials, have been supported (with considerable refinement) by empirical work, and to a certain extent have been useful as explanatory and predictive devices. The Löschian theory, although logically more elegant, has not yet received such support. There is a feeling, especially among geographers, that this theoretical concept will still prove to be a more powerful tool than Weber's; and Lösch's early death before he completed the main part of his work is often commented on (Haggett, 1965, p.v). There have been numerous additions to the simplistic picture postulated by Weber. Scale, nature of output, social and political factors and particular economic systems have been found to play important roles in location patterns. Optimum location models have given way to satisficing models, which would seem to reflect a real situation where the sheer number of variables influencing location-decisions will result in a sub-optimal location.

1.7 SETTLEMENT THEORY

This area of concern is more closely related to geography (especially the work of Christaller and presently Berry and Garrison). The theories seek to explain regularities in horizontal and vertical settlement patterns in terms of empirically verifiable analytic techniques. A number of models have been developed which all subsume the following six hypotheses: (Garner, in Chorley and Haggett, 1967, p.304-305)

1) The spatial distribution of human activity reflects an ordered adjustment to the factors of distance.

2) Locational decisions are taken in general to minimise the friction effect of distance.

3) All locations are accessible, but some are more accessible than others.

4) There is a tendency for human activities to agglomerate to take advantage of scale economics.

5) The organisation of human activity is essentially hierarchical in character.

6) Human occupance is focal in character.

An aspect of all theory that is being questioned to an increasing extent is to what degree unquestioning acceptance of existing urban forms and transport systems influences activity and therefore distorts the general applicability of regional theory. If more sophisticated communication systems and changing social patterns lead to new forms of urbanisation (as studies by Alexander and University of Cambridge Land Use and Built Forms Study centre have shown) then much existing theory may relate only to special cases of a more general theory.

1.8 TOWARDS A GENERAL THEORY

At present, work on regional analysis is proceeding on a broad front among many disciplines and at government, business and academic levels. It is at this point that the author disagrees with the connection that Browett et al see between the pragmatic and deductive approaches isolated in their diagram (Table 2.1.a) in Friedmann's eight propositions. These propositions, although valuable insights into the workings of regional systems, cannot be considered as generative hypotheses which either integrate existing theories in a logically consistent way, or indicate further avenues of research with any clarity. It would seem that a more appropriate unification is to be found in Isard's latest contribution to Regional Science. Since 1956 Isard has worked towards a general theory of Regional development. However, this early work did not account for industrial location problems, regional income and employment problems, marketing and distribution problems and general 'horrendous' urban problems. (Isard, 1969, p.vii). In Methods of Regional Analysis (Isard, 1960) he set out tested available tools and techniques. After these two works one can say that Walter Isard is probably one of the best qualified regional analysts to pronounce on the probable future development and directions of Regional Science and its techniques; his comments in this respect are significant.

He remarks on the unequal contributions to Regional Analysis of the social sciences. "Economics was the major contributor. The fields of sociology, geography, political science, anthropology and planning were underrepresented and some of these only barely represented. Yet each of these fields is equally as important as economics for understanding and effectively attacking community urban regional and spatial problems." (1969, p.viii). Thus Isard set about developing a general body of theory 'on the social, political and economic structure and function of regions, synthesising strong elements of the fields already mentioned' (ibid, p.viii) and thereby contributing to the understanding of these problems in all the related fields.

This approach and its results, as exhibited in Isard's book, can be taken as a model of Regional Science (and therefore planning) research as a whole, where its eclectic nature is a strength rather than a weakness, as long as there is an internal logical consistency between hypotheses, and as long as a newly stated hypothesis either -

1) "is no less realistic (than existing theories) but at the same time can be related to a broader range of other hypotheses and thus help provide a more effective consistency check;

2) "has no fewer points of contact and is no less consistent with other hypotheses while at the same time the newly stated hypothesis reflects more closely reality, perhaps because it permits the weakening of certain strong assumptions; or

3) "has both a more realistic basis and more points of contact with other hypotheses." (Isard, 1969, p.x).

It is also significant that Isard has purposely abandoned three possible approaches, that of the evolutionary theory (Robinson Crusoe to real world) implicit in much economic theory: the utopian or instrumental analytic method where the goals (world order and urban order) are postulated and means of achieving them outlined; and a purely theoretic n-person game approach which would have involved strong behavioural assumptions.

Modern regional analysis is seen as having two major identifying features. The first of these is its integrative role as a discipline that relates a wide range of theories and techniques from varying fields of study within an overall concept of the distribution and organization of behaviour patterns in space. Secondly, the pragmatic nature of much regional analysis is equally important. Regional analysis (as Medawar said of biology) works very close to the frontiers between bewilderment and understanding, and it travels faster and closer to the ground than many disciplines of the present time.

1600 1700 1800 1900

AGE OF MAGELLAN
DISCOVERY: COLUMBUS
DIAZ
DA GAMA

APIAN 1524
gazetteer of places

SEBASTIAN MÜNSTER 1489-1552
'Cosmographia'

MERCATOR 1569-
map projections

BERKHARDUS VARENIUS 1622-50
'Geographia generalis' 1650
(description of natural phenomena not men)

JAN BLAEU 1654
'Great atlas or description of the earth'

'fathers' of modern geog.
classification of facts
& derivation of laws

CARL RITTER 1779-1859
'Geographic studies' 1863
'Comprehensive geog.' 1865 (Edin.)
(1st professor of geog. Berlin, 1st 'human geographer')

ALEX. VON HUMBOLDT 1769-1859
'Narratives' pub. 1808-1827
'Kosmos' 1845-1862

JOHN PLAYFAIR 1748-1819
'Huttonian theory of the earth' 1802

JAMES HUTTON 1726-1797
'Theory of the earth' 1795

JEAN BRUHNES 1869-1930 comparative method
'La geographique humaine' 1910 (connexité)

(Brückner devised climatic cycles)

ALBERT DEMANGEAN 1872-1940
'L'Empire Brittanique' 1923
'La France economique et humaine' 1947

ARCH. GEIKIE 1835-1924 (geological survey of G.B. 1855-1907)
'Lessons on physical geography' 1884

HUGH ROBERT MILL 1861-1950 (son of J S Mill)
'Realm of nature' 1884-92

DESCRIPTIVE PERIOD

CONRAD BRUN 1775-1826
founded Societe Geographique
'Précis de geographie universelle' 1831

QUANTITATIVE & ANALYTICAL GEOG.

FRIEDRICH RATZEL 1844-1904
'Volkerkünde: Anthropo Geographie (rerum cognoscere causas)'

SEMPEL 1911-
influence of geographic environment

JH ELISÉE RECLUS 1830-1905
....la vie du globe' 1886
'Nouvelle geographie universelle' 1878
'L'Homme et la terre' 1905

CLASSICAL GEOGRAPHY

MAX. SORRE 1880-1962
'Les fondament de la geog. humaine'

V. DE LA BLACHE 1845-1918
Professor at Sorbonne
'Tableau de la geographique de la France' 1903
'Principe de la geog. humaine' 1926

FRENCH SCHOOL: FÉVRE
HAUSER

REGIONAL GEOGRAPHY

2. TOWARDS A MODEL-BASED GEOGRAPHY

The foregoing illustration of the historical development of geography shows that the growth of the discipline was not the product of one country, as in the early stages of economics, but was a cosmopolitan development, with major influences from France and Germany. There are therefore few particular social or political factors that have influenced its development, and it has grown naturally out of a desire to classify and find order in natural phenomena. In this respect it can be set apart from economics, the subject of the next section (2.3). The increase in activity during the nineteenth century reflects the typical growth pattern of most scientific disciplines in this period.

On the development of contemporary geography, Wrigley (in Chorley & Haggett, 1965, ch.1) points out that the main reason for the break with 'traditional' geography was largely due to its inability to explain the growth of industrialised countries and also the surge of urbanisation which followed the Industrial Revolution. He also refers to the growing concern with quantification which became possible with the spread of statistical techniques. These techniques also helped to resolve the physical/social controversy that had worried geographers since Bruhnes had formulated the idea of 'conexité' in geographical relationships.

The lack of unifying ideas or areas of concern that is isolated by Wrigley is taken up by Haggett & Chorley (in Chorley & Haggett, 1967, ch.1) where the traditional data matrix (Berry 1964) is transformed from a matrix of place-bound data units to a matrix of structure- (or system) bound models (N4).

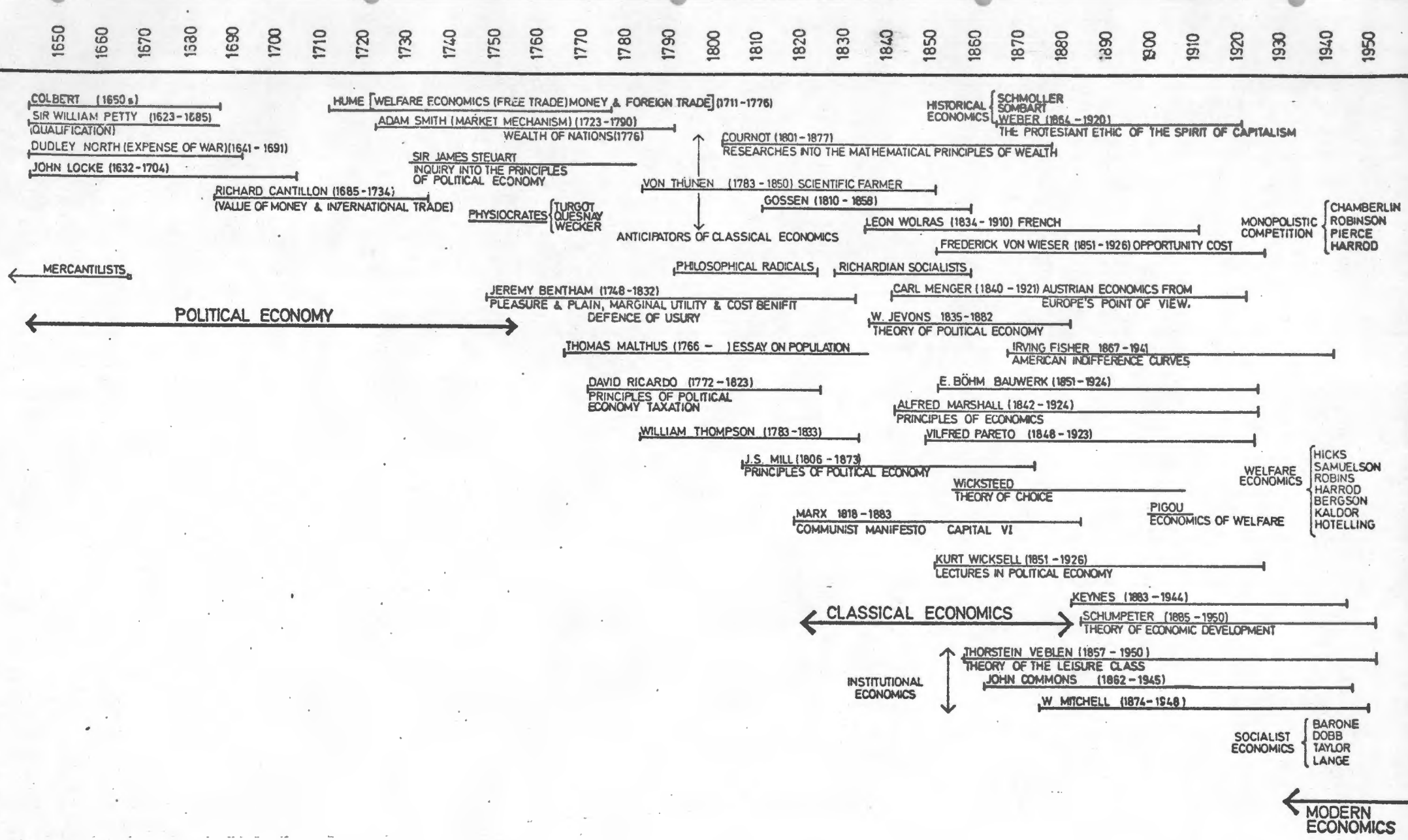
Thus the new image - or paradigm - of geography plays down the traditional classificatory aspect in favour of model-based discipline concentrating on analysis of the spatial (regional) distribution of human activities and natural phenomena. In pursuit of this a model for analysis is constructed by Chorley & Haggett which is reproduced here (Table 2.2.a.) without comment, except to remark that its relevance and similarity to the areas of interest in Regional Science or Planning, is more than significant.

This table will be referred to later in Chapter 3.

TABLE 2.2..b.

THREE-STAGE MODEL FOR THE ANALYSIS OF REGIONAL SYSTEMS

	Stage I System Identification	Stage II A. Form Differentiation (Static)		B. Form Differentiation (Dynamic)	Stage III System Integration
Dimensional Number	0, 2	0	1	3	4	0 4
Geographical Form	City (polar axis) City region (boundaries)	Cities Settlements Urban hierarchies	Transport networks Communication systems	Urban fields Density gradients Land-use intensity	Innovation waves Frontier movements Sequent occupance Colonization	Regional systems Internal feedbacks Interregional systems External feedbacks
Analytical Techniques	Numerical taxonomy Local residuals Regional analogues	Rank-size analysis Nearest-neighbour analysis Quadrat analysis	Graph-theories analysis Connectivity Network geometry	Trend-surface analysis Harmonic analysis Fourier analysis	Physical simulation Monte Carlo models Markov-chain models	Matrix analysis, factor analysis Input-output analysis Interregional linear programming
Spatial Model	Regional hierarchies Formal, functional regions	Central-place theory Gravity models Weberian models Basic non-basic models	Network models Random graph models Geodesic models	Gravity models Absorption m Intervening-opportunity models Von Thunen models Potential models	Diffusion models Migration models Colonization models	Regional climax models Regional multipliers Growth poles
Major sources for Spatial Models	Decision theory (Psychol.) Taxonomy (Biol.) Discriminant analysis (Stats.)	Point set theory (Math.) Organization models (Manag.) Packing theory (Math.)	Graph theory (Math.) Circuit design (Electr.) Search theory (Math., Psychol., Zool.)	Least-effort models (Sociol.) Minimum-energy models (Phys.) Potential models (Phys.) Game theory (Psychol.)	Epidemic theory (Medic.) Diffusion theory (Fluid dyn.) Rumour theory (Sociol.) Colonization & succession models (Bot.)	General Systems theory Ecosystems (Biol.) Interregional trade theory (Econ.) Multiplier models (Econ.)


1650 1660 1670 1680 1690 1700 1710 1720 1730 1740 1750 1760 1770 1780 1790 1800 1810 1820 1830 1840 1850 1860 1870 1880 1890 1900 1910 1920 1930 1940 1950
COLBERT (1650 s)
SIR WILLIAM PETTY (1623-1685)
(QUALIFICATION)
DUDLEY NORTH (EXPENSE OF WAR)(1641-1691)
JOHN LOCKE (1632-1704)
RICHARD CANTILLON (1685-1734)
(VALUE OF MONEY & INTERNATIONAL TRADE)
HUME [WELFARE ECONOMICS (FREE TRADE) MONEY & FOREIGN TRADE] (1711-1776)
ADAM SMITH (MARKET MECHANISM) (1723-1790)
WEALTH OF NATIONS(1776)
SIR JAMES STEUART
INQUIRY INTO THE PRINCIPLES OF POLITICAL ECONOMY
PHYSIOCRATES
TURGOT
QUESNAY
WECKER
HISTORICAL ECONOMICS
SCHMOLLER
SOMBART
WEBER (1864-1920)
THE PROTESTANT ETHIC OF THE SPIRIT OF CAPITALISM
COURNOT (1801-1877)
RESEARCHES INTO THE MATHEMATICAL PRINCIPLES OF WEALTH
VON THÜNEN (1783-1850) SCIENTIFIC FARMER
GOSSEN (1810-1858)
ANTICIPATORS OF CLASSICAL ECONOMICS
LEON WOLRAS (1834-1910) FRENCH
MONOPOLISTIC COMPETITION
CHAMBERLIN
ROBINSON
PIERCE
HARROD
FREDERICK VON WIESER (1851-1926) OPPORTUNITY COST
MERCANTILISTS
PHILOSOPHICAL RADICALS
RICHARDIAN SOCIALISTS
JEREMY BENTHAM (1748-1832)
PLEASURE & PLAIN, MARGINAL UTILITY & COST BENIFIT
DEFENCE OF USURY
CARL MENGER (1840-1921) AUSTRIAN ECONOMICS FROM EUROPE'S POINT OF VIEW.
POLITICAL ECONOMY
W. JEVONS 1835-1882
THEORY OF POLITICAL ECONOMY
THOMAS MALTHUS (1766-) ESSAY ON POPULATION
IRVING FISHER 1867-1941
AMERICAN INDIFFERENCE CURVES
DAVID RICARDO (1772-1823)
PRINCIPLES OF POLITICAL ECONOMY TAXATION
E. BÖHM BAUWERK (1851-1924)
ALFRED MARSHALL (1842-1924)
PRINCIPLES OF ECONOMICS
WILLIAM THOMPSON (1783-1833)
VILFRED PARETO (1848-1923)
J.S. MILL (1806-1873)
PRINCIPLES OF POLITICAL ECONOMY
WELFARE ECONOMICS
HICKS
SAMUELSON
ROBINS
HARROD
BERGSON
KALDOR
HOTELLING
WICKSTEED
THEORY OF CHOICE
PIGOU
ECONOMICS OF WELFARE
MARX 1818-1883
COMMUNIST MANIFESTO CAPITAL VI
KURT WICKSELL (1851-1926)
LECTURES IN POLITICAL ECONOMY
KEYNES (1883-1944)
CLASSICAL ECONOMICS
SCHUMPETER (1885-1950)
THEORY OF ECONOMIC DEVELOPMENT
THORSTEIN VEBLEN (1857-1950)
THEORY OF THE LEISURE CLASS
INSTITUTIONAL ECONOMICS
JOHN COMMONS (1862-1945)
W MITCHELL (1874-1948)
SOCIALIST ECONOMICS
BARONE
DOBB
TAYLOR
LANGE
MODERN ECONOMICS

3. LIMITATIONS OF ECONOMIC KNOWLEDGE

It is not the intention here to survey the breadth of modern economic thinking, but rather to single out points for comment that are relevant to the present thesis. The purpose of this historical picture presented in Table 2.3.a. is to provide a reference framework for the discussion and to provide links with the other evolutionary reviews in this thesis, where the time scale serves as a common comparable dimension. The development of patterns of economics are similar to those of geography (Table 2.2.a.) Again there are the slow beginnings, the proliferation of work in the 19th Century based on 18th Century ideas, and the advance in the 20th Century on a wide front into divergent fields, where individual names give way to the names of general concepts.

Apart from this general structural similarity, there are certain profound differences which tend to set economics apart as a unique discipline. An understanding of these points is essential if full use is to be made of economic theory.

The first unique feature of economics has a somewhat nationalistic undertone. Examination of table 2.3.a. will show that before the middle of last century the study of economics was almost entirely a British concern, with occasional inputs of foreign brilliance (for example, the French 'Physiocrat' school in the late 18th century). Even after economics took on a more cosmopolitan aspect after 1850, the mainstream of thought could still be called British in origin (Marshall, 1842-1924, Keynes 1883-1946).

The second unique feature has been the emphasis on the one hand on scientific method, the constant battle for economics to be regarded as a science (J.S. Mill) and on the other hand the inescapable concern with politics. In fact most of the well known economists were involved directly in politics at one stage or another (Ricardo, Bentham, Mill and even Keynes) and many of the major works are descriptive of 'Political economy' of one form or another (Mill, Ricardo, Jevons, Marx).

The third unique characteristic is the modern insistence that economics is a 'behavioural' or 'social' science (with considerable respect as such among proponents of scientific method; Popper 1961, Medawar 1969). With due respect to economists, the author has yet to find reliable empirical or even theoretical substantiation for the major behavioural assumptions in most economic theory.

A fourth characteristic has been the slow recognition by economists of the dynamic nature of the systems they study. There are cogent reasons for this, such as data difficulties, but these exist in other sciences which have long recognised the dynamic nature of their systems.

Closely related to this fourth characteristic is a fifth, namely the economists' equally slow recognition of the place of government in the economy and the effect of the public sector on the economy of the private sector.

Economics grew out of the British experience in the Industrial Revolution. The significance of this for economic theory is that there is a strong tradition of a market situation where there is a) freedom of entry b) free flow of information and therefore c) perfect competition. This tradition has caused most distortions of the free market to be subsumed under special case theories of monopoly, oligopoly and imperfect competition. The British tradition has further imputed to all of economics a middle class, profit maximising, production-consumption orientation, (Rothschild, 1971). The general applicability of both these aspects is questionable. It is middle class in that neither the activities of the very rich and powerful, nor those of the very poor and helpless are explicitly accounted for. It is profit maximising in that the concept of satisficing is not fully recognised. Further, there is built into economic theory the concept that development is achieved only by the production and consumption of more and more commodities, and that to retire from this cycle means stagnation if not decay. These points are brought out by Prof. Bauer's indictment of development economics (Bauer, in Streissler, 1970) where the application of these principles to the social, cultural, economic and political to the "Third World' is severely criticised for its extra-market, non-economic bias.

The question of tradition in economics is one that cannot be dealt with by additive means, since it does not require additional knowledge to rectify its distortions. Rather it requires a stricter critical discipline in the application and formulation of economic theory and techniques.

The remaining points mentioned above, that is the science/politics issue, behavioural assumptions, dynamics and the place of government, can be joined under the single proposition that economic theory in its present state does neither provide adequate substantiation of the general applicability of its theories, nor does that theory adequately explain many large and urgent problems of society in its latter half of

this century, where even the society from which economics sprung has changed, and other very different societies have economic problems of their own. These problems can be summarised under the headings of development and control.

3.1 ECONOMICS, CONTROL & POLICY

Economic theory operates with assumptions about homogenous blocks of consuming or producing units (firms and households) working within given technological and market conditions. However, just as the concept of the isotropic plane has proved untenable in location theory, so these undifferentiated concepts are proving unrealistic in economics.

The adoption of controls in the achievement of goals related to individual desires has already been discussed (Ch.1, 4) and the ideas of control, freedom, economizing and democracy were found not only compatible, but actually interdependent. Further, the discussion of systems in Ch. 1, section 3, likewise illustrated the aspect of control, from another and equally important point of view, as an essential element in the negative feedback loops that keep complex systems functioning. The idea of control is certainly not foreign to economics, and much equilibrium theory is devoted to analysis of the structure of control mechanisms in the economy. Control in a social system, however, is very subtly separated from Power, and invariably one finds that in reality control mechanisms rely heavily on Power (political, physical, financial and social) to achieve their ends. Given the aggresive nature of the human animal, there is a very fine division between power-based control systems and pressure groups, vested interests, lobbies, cartels, syndicates and the like.

"Seen without the blinkers of neo-classical thought, social reality appears to be a more or less conflict-laden concert of persons associated in social entities of various kinds who, according to their roles, occupy certain positions of power and who represent and promote certain interests (in the widest sense of the word). Society embodies a definite power structure, subject to more or less rapid change under the impact of the social power struggle, influencing the realization of emerging objectives according to the position of the persons aspiring to them." (Albert in Rothschild e., p.31)

The distinction that is drawn between economic and non-economic activities and commodities, the exclusion from theory of activities which do not immediately have to do with the acquisition of goods or

services through the market, are assumptions that deprive economics of a great deal of wider relevance. It can be argued that the achievement of any end which demands the allocation of scarce resources, is subject to analysis by economic theories, but the restriction by the above assumptions defines scarce resources as only those goods exchangeable through the market, and also limits economics to a study of market operation (Walker 1947). It is nevertheless possible to influence public opinion to achieve changes in the market conditions without reference to the operation of the market (for example through advertising). In the next section it will be shown how extra-market operations in the gold mines in 1922 influenced labour policies in South Africa and how socio-political ends were achieved in spite of the operation of the market system, and which resulted in changes to that very system.

Just as it has been argued that political structures are a valid field of study in planning, so are the extra-market operations (these range from violence by one economic unit against another, to informal influence over behaviour patterns through persuasion, a valid subject for economic analysis). Not only are they a subject for analysis, but they must be explained by economic models so that their effects can be understood if not calculated and predicted.

Development, with which control is concerned in spurring or retarding, is a woolly concept that is often not equal to growth. This aspect will be discussed later in section 2.10, but it is sufficient to say here that growth and development can be considered as two separate and often mutually exclusive ideas, depending on one's definition of these terms. If one region regards growth as a positive, calculable term, based on a discussion of arithmetic quantities; and development as a more normative term implying unfolding and expansion in qualitative terms, then the two concepts can be inimical to each other, although an increased growth usually implies an increased development in a given area.

Apart from this confusion with growth, development economics, especially in relation to 'underdeveloped' or 'developing' areas, brings up the question of politics (Bauer, 1970) and therefore the question of power. Perroux (in Rothschild, 1971, p.57) outlines the effect of forces of domination in the economy: "An economic unit exercising this (domination) effect does so through the combination of three elements: its relative dimensions, that is to say, the magnitude of its role in global supply and demand; its bargaining power, which is the power it can apply to fixing the conditions of exchange; and its place in the whole scheme or the nature of its operations". Obviously the power it can apply to fixing of exchange conditions is of great

importance. This power can be classified as physical, personal, social, administrative and organisational, legal and political (J. Pen, 1959).

The distribution of this power in space can affect the development of regions as much as pure market forces or the distribution of raw materials. The urban centres can in many respects be regarded as foci of power structures vying for greater control over larger markets with decreasing reference to the market mechanism.

3.2 CONCLUSION

The omission of spatial concepts from economics (which regional analysis is making good), and the avoidance of extra-market activities in the analysis of allocating resources is seen as a serious limitation to the wider application of economic theory. The lack of attention to questions of power economics is an extension of this weakness. The next section will illustrate how critical these issues are in the development of a non-industrial country, where only a very small section of the population is oriented to profit maximising, produce and consume behaviour patterns based on ownership and achievement.

4. SOUTH AFRICA - HISTORICAL REVIEW TO 1910.

History is essential in the study of systems. The brief description of the development of Regional Science, Economics and Geography in the previous sections have illustrated how different facets of those disciplines become clear when seen in relation to each other in time - where time is regarded as another dimension that both separates and joins components in a system - in this case a system of ideas.

The use of historical data to simulate the working of a real system is a well tried and widely documented method. The kind of data used is usually very specific, and relates to short historical periods; in most cases ten to twenty years is the maximum period over which comparable and reliable historical data is available. Beyond these periods, however, there is a large body of information about the system as it extends backwards in time. This historical information is subject to bias in interpretation to a greater degree than statistical information since the original messages have accumulated 'noise' in their passage through time.

In spite of the possible distortion of information, a sound knowledge of this wider history of a system should enable the researcher to gain a feel for the main forces in the system. If the researcher is to be able to recognise the patterns of connection between the events he is modelling, his first requirement is an historical overview which permits him to make sense of those patterns, and moreover, permits him to check whether his patterns of results are logical in terms of that overview. In this instance where one is studying urban/regional systems on a national scale, it is postulated that it is possible to isolate certain determinants of the development of this country through historical analysis.

This analysis deals with a national unit, therefore it will contain the emotional and controversial issues that make the history of that nation. The author has attempted to avoid normative statements, or bias in selecting material; judgements are made strictly in terms of the systems view expressed in Chapter 1.3.

4.1 METHOD OF ANALYSIS

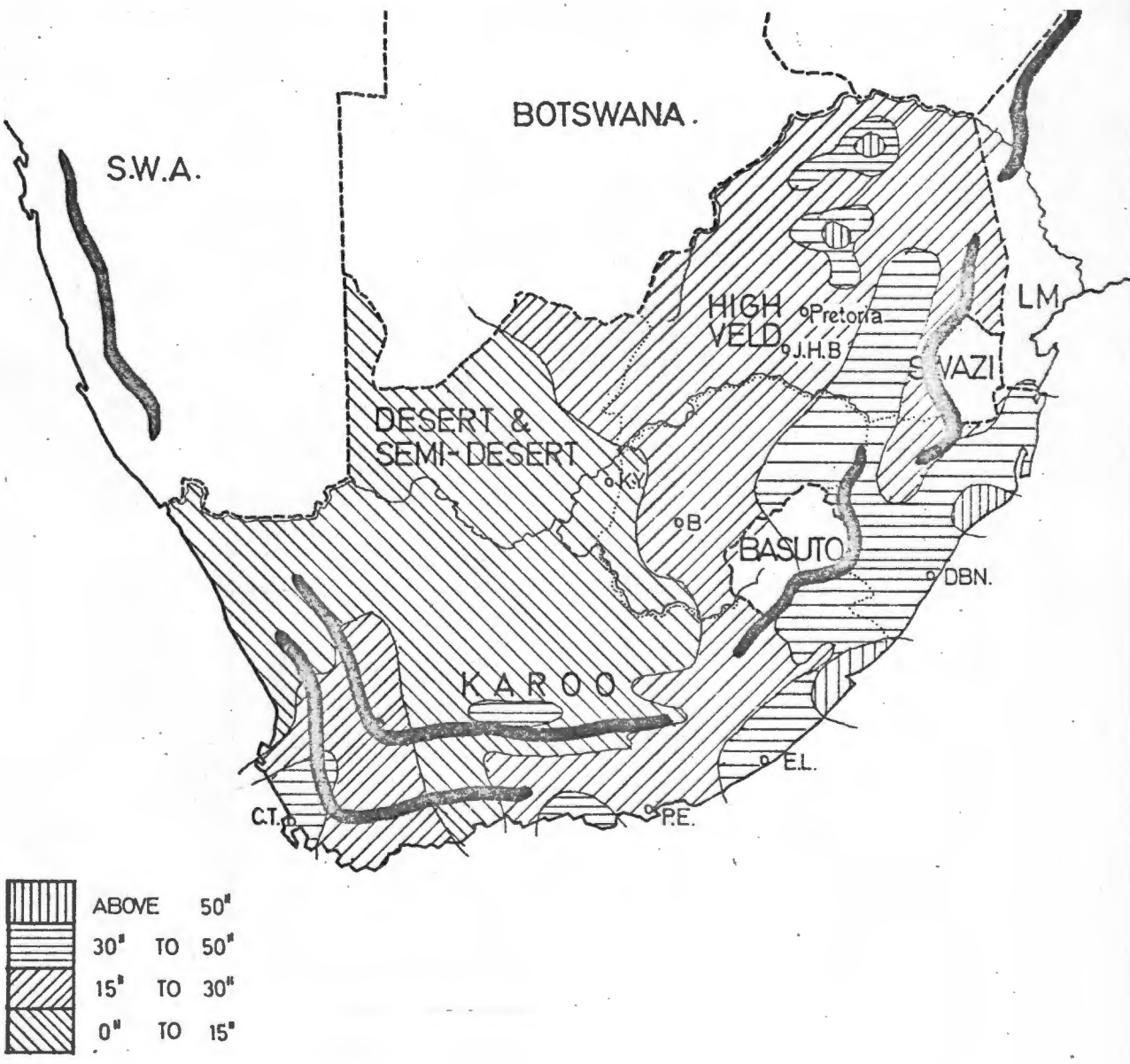
In order to set out the historical review as briefly as possible, a graphical method has been adopted. A chronological table of events with significant dates, is shown in the right-hand column, and description and explanatory notes relevant to these events on the left.

Certain elements have been picked out using graphic symbols:

1. Movement of people - asterisk
2. The use of land - star
3. The development of natural resources - triangle
4. The development of transport - wheel
5. Connections between events are made by arrows and lines.

This provides a very rough sketch of the history of this country, where the intention is to illustrate the continuing importance of a few factors throughout the time period concerned, rather than accurate descriptions of a specific train of events.

4.2 SOUTHERN AFRICA TO 1910



THE TOPOGRAPHIC SETTING:

Longitude 13°-37°, latitude 17°-34° S (approx.)
Easterly rain-bearing winds from warm Indian Ocean.
Dry west winds from cold Atlantic Ocean.
High Inland Plateau protected by escarpment 1300 - 2000 m. high.

Divided in half at long. 25° by 15" isohyet resulting in semi-desert western half and relatively fertile eastern half, with Eastern coastal strip of high rainfall and good lans. Extremely low run-off.
Few large rivers, no navigable rivers, very few natural harbours (8 - 10 over ± 6000 km of coastline).
No readily exploitable natural resources in any large quantity (e.g. timber, hides, minerals).
Climate reasonable because of altitude of inland plateau, but with erratic cycles of drought.
Except in the East, water supplies are limited and very often seasonal.
In all but the most fertile region, the ecology of plants and soil is finely balanced and easily disturbed, most of the soil types are prone to erosion once that balance is upset.

All these factors, each one of them a powerful behavioural determinant, can be regarded as constants throughout the following discussion.

TABLE 4.2.a - HISTORICAL REVIEW TO 1910.

The Khoikhoi & San peoples: It seems that the light-skinned hunter-gatherers and hunter-pastoralists developed and differentiated in Southern Africa over a long period. Very little evidence exists to support the theory of the influx from East Africa.	*		2000 B.C.
Infiltration of an Iron Age culture from northern and eastern areas to the south, carried by the negroid (Bantu) races of stone buildings of Zimbabwe and Kami.	*		500 A.D.
Penetration to Kei of Bantu-speaking people (Nguni to east & Sotho to west of mountains) coincides with 30" isohyet).	*	First documented European discovery of the Cape (Diaz)	1488
		Extensive evidence of stone villages in Transvaal and O.F.S; mining and metal working point to vigorous and well-organised communities.	1500
Khoikhoi and San peoples (hunters and herders) occupying most of the present Cape Province were being driven slowly south-west by increasing Bantu population.			1600
(Formation of Dutch, French and English East India Companies) →			1602-1604
First purposive European settlement on southern coast, but there was no intention of colonization by Dutch. Khoikhoi became major suppliers of fresh meat to the station.	*	Van Riebeeck lands to establish victualling station.	1652
Import of special skills began to give Cape the substance of a colony.	*	Arrival of about 200 Huguenots (600 free burghers in the Cape at this time)	1683
Action against W.A. van der Stell and his monopolies was the first indication of the decrease of the power of the VOC at the Cape.		The Van der Stels	1699
Trekking of semi-nomadic pastoralists (Trekboeren) was economic response to poor returns to labour and investment. But land was cheap and readily available. Mobility meant they could take advantage of fluctuation in rainfall and fertility (See O.U.H., p.211) (De Kock, p.52-66) (Muller, p.49-52)	*	Khoikhoi decimated by smallpox. Granting of loan farms Expansion along coast Great Fish River declared the frontier First Frontier War	1713 1730s 1775 1779
After 100 years of peace in Holland, trade with the East increased enormously, but in spite of this there was very little investment in the Cape, therefore very slow growth.			
(Holland declares war on Britain) → (VOC almost bankrupt)			1780
		Second Frontier War	1789
		First British occupation	1792

Cape still a poorly productive colony unable to contribute or compete on world markets to any great extent. Enlightened control not given chance to come to fruition.	Rebellions led to independent republics of Swellendam and Graaff-Reinet	1795 -
	Third Frontier War	1799
	Cape handed back to Dutch. Janssens & De Mist governors.	1803
Population: At Cape: 76000 (26000 whites, 30000 slaves, 20000 khoikhoi) covering 80,000 sq. miles	British re-occupation	1806
Brought permissive economic practices and the beginnings of social conscience (exports increased by 6, no. of cattle by 3)	Slave trade abolished at Cape	1807
	Hottentot ordinance	1809
	Fourth Frontier War	1811
	'Black circuit'; the protection of the law was extended to servant as well as the master.	1812
✱ Land: From 1812, 31900 acres of land were alienated at a total price of £46000 yielding an annual quitrent of R13818 i.e. 1d/acre. Thus one of the bases of income for administration and control of use of land was ignored. Land was a free good abused as such.	Quitrent farms established ✱	1813
	Cape ceded to British	1814
	Fifth Frontier War	1818
✱✱ Settlers sent to relieve British unemployment and 'stabilise' the frontier, placed in the district of Albany, with an outlet at Algoa Bay to serve also as competition for the local Dutch farmers.	4,000 immigrants from Britain ✱	1820
	Neutral belt established at fronteir	1824
This caused temporary inflation	Rixdaller replaced by 1/6 in British silver.	1825
	Port Elizabeth established	1826
The British rule can be regarded as a legacy of grievances or of conscientious government. Their policy was one of small commitment, closer settlement and more intensive economic life. However the triumph and failures of liberalism and missionary zeal forced the government to take actions that might otherwise have occurred slowly and been more readily accepted.	Ordinance 50 - vagrancy no longer an offence and 'pass laws' were abolished, This was a rude disturbance in an unsettled labour market for an impoverished colony trying to get on its feet internally and internationally.	1828
Sever drought	Sixth Frontier War	1834
Proposed annexing of the Transkei turned down by British Government. This nullification of D'Urban's proposal shows how the British government kept staving off the day when the Colonist-Native issue would have to be squarely faced. In detail this war and its consequences show also that the Government had not yet learned the lesson that magistrates were cheaper than soldiers.		
Population: Europeans 66000, 'Coloured' 30000.		

* Though several hundred Trekboers had crossed the Orange by 1835, this was the first organised trek and on an unprecedented scale. The Voortrekkers differed from the people into whose midst they trekked in two major ways - their technology (guns, wagons - portable fortresses -, horses and books), and their convictions (racial and cultural superiority, portable territorial imperative).	Beginning of the Great Trek - 'rebellion by escape' *	1835
** This resulted in the complete devastation of the Free State country, the establishment of Mzilikatse's kingdom in the Transvaal and the Sotho pushed west into N. Cape and east into Maluties leaving Orange-Vaal scorched and empty (See O.U.H. p.391-408)	Difaqane (Mfecane) 'forced migration' with the rise of the Zulu nation. Rule under Shaka led to three tribes, Ngwane, Hluti and Ndebele being forced onto the Highveld pushing before them the Sotho inhabitants *	
** The story of the frontier in the 1800 to 1850's shows the quarrelling of similar peoples doing similar things and differing only in technology and colour - a competition for land, grass and water.	Fixing of Colony boundaries to prevent further dispersion	1836
	Republic of Winburg	1837
	Mzilikatse routed by boers; the first African kingdom dispersed	
Boers in control of a port and their independence is assured	Blood River Battle; the second African kingdom is conquered.	1838
British Government's attitude to Colonial expansion cooling but events forced their hand.	Natal annexed	1843
Drought	Seventh Frontier War	1846
* This dispersed the Africans in Natal to the north and south in 8 locations of 1,700,000 acres. The first specific directive of its kind, left Africans outside the locations with no legal or civil rights.	The Native land allocation commission	
* Growing realisation that colonist and native could not grow separately but were interdependent	Sir Harry Smith forms British Kaffraria	1847
* At this time land contributed only 1/10 the revenue to Government of the colony.	Orange River Colony annexed.	1848
Also trouble on the Free State-Sotho border.	Eighth Frontier War	1850
* Immigration totalled about 750 per annum. Cape still a small Colony dependent mainly on a slow-growing wool trade for main source of foreign capital.		
Territory north of the Vaal to remain independent	Sand River convention	1852
Qualified vote excluded Africans (about 8000 whites)	Representative government in Natal	

There was no capital inflow to the colonies except at very high interest rates. Because of this no capital projects of any scale could be undertaken to generate further growth. Port and railways grew very slowly (83 miles to Wellington, and 2 miles in Durban at this date)

Orange Free State returned to Britain by request of the Free Staters themselves.

First Basuto War — 1858

* Land: Policy of Boer and Briton was simply that of, land to the whites, labour to the Africans. There was an intermingling on the land, but no rights of ownership to the Africans. Imposition of taxation put a great burden on the African, and a time of general depression, drought and pestilence (rinderpest) took its toll in life, land and malnutrition (Probable cause of traditional accusation of stupidity and laziness)

The Boer system of establishing 6000 acre farms led to a great paucity of land for settling immigrants. This wasteful and inefficient system of land tenure marked by land-speculation, absentee landlords and primitive farming methods, caused great damage to ecological systems. To the European, ownership was more important than use, to the African it was the other way round.

2000 German and English settlers emigrate to Natal * — 1860
Indian labour introduced to Natal

Free Staters suffered a long and mutually exhausting conflict with Sotho.

Second Sotho War — 1865

→ Potentially a major source of income at ports lost.

Opening of Suez Canal — 1869

Population at Cape: 2000 whites. Afrikaner Republic: 45000 whites.

* During this time internal differences among the Voortrekkers and their dispersal over a vast area prevented any really concerted action against the African States (Venda, N-E; Tswana, W; and Pedi, E; civil strife in Transvaal, 1860-64) and abortive attempt to unify Transvaal and O.F.S. accentuate intragroup differences.

Diamonds discovered △ — 1867
Basutoland annexed by Britain — 1869
Britain annexed Griqualand West after the value of the diamond fields had been proved. — 1871

△ Diamonds: Instead of the demoralized American mining rushes, the nature of the mining problem in Kimberley demanded organised managerial solutions. The industry soon used the same social distinction as the agricultural industry had to date.

Population of Kimberley grew rapidly to 50000

→ From the time of the discovery of diamonds, imports to the Cape doubled.

Responsible government to Cape Colony — 1872

* Skilled labour had to be imported to work in the mines, the first really significant influx of Europeans.

President Burger of Transvaal floated a loan of 3,600,000 guilders to finance rail line from Pretoria to Delagoa Bay. ⊛

This war, and the severest drought in 20 years, financially weakened Transvaal.

War against Pedi (Sekhukhune chief) — 1876
British annexed Transvaal — 1877

Ninth Frontier War — 1878

* Exposed the political disunity and hopeless agricultural and economic structure of Southern African Colonies

Zulu War — 1879

Transvaal boers and Pedi at war again *

Quarrel between a cash economy and a subsistence economy but the withdrawal of British forces would not mean withdrawal of the economic forces of a new age.

Transvaal Revolt (First Anglo-Boer War) 1880
Convention of Pretoria - British withdrew 1881

This shocked Britain into realizing that she did not have monopoly on colonization and spurred on series of annexations

Germany annexed S.W.A.

Establishment of Stellaland and Goshen Republics in W. Tvl. cut off the road to North and impeded expansion across the Limpopo.
Kruger elected president of Transvaal 1883

State of German South West Africa declared. 1884

△ First important gold discoveries made at Barberton
Netherlands Railway company formed.
⊛ Rail link from Tvl. to Delagoa Bay begun and link from Cape to Kimberley completed. 1885

The British Government reluctantly followed the Imperialist zeal of Rhodes in South Africa, Kirk in East Africa, prompted by circumstances and events often beyond their control.

Bechuanaland Protectorate established.

1884 Transvaal revenue virtually nil
1887 Revenue equalled Natal at £638,000
1889 it equalled Cape at £1,500,000

△ Witwatersrand goldfields proclaimed. 1886

Zululand annexed. 1887

△ In 1871 there were 70 different mining companies at Kimberley mine. By now Rhodes had unified the entire mining operation under De Beers, a single company. This was the managerial expertise that was to be the hallmark of S.A. mining.

B.S.A. company founded - Cape O.F.S. Customs union formed 1889
⊛ Natal railway built up to Transvaal border 1891
⊛ Railway from Cape to Rand was connected across the Transvaal border (3 lines: from P.E., East London ard Cape Town) 1892
⊛ Netherlands S.A. Railway Company controlled all the lines inside the Transvaal. Thus Cape-Natal competition was mullified by increased rates immediately across the border.
Responsible Government in Natal. 1893
Matabele War
Pondoland annexed 1894

The Glen Grey act introduced by Rhodes was first major move to rationalise the 'native problem' in the Transkei - an important issue being right of ownership - 50000 individual titles granted from 1894-1922. This act, however, still remained but a single step in the many that needed to be taken.

Kruger began to appeal to foreign powers for aid, especially Germany

⊛ The rail developments are significant; the rapid growth of railways in a chronically underserviced country was due entirely to diamonds and gold.	⊛ Natal rail link connects to Rand and Tongoland annexed.	
⊛ Kruger closed drifts to prevent rail goods being changed to wagons at the border (to avoid high Netherlands S.A.R.C. rates)	Jameson raid - biggest faux-pas in S.A. history. The Drifts crisis.	1895
✸ Paddocking and fencing of farms in Eastern Cape. Rhodes fruit farms established.		
✻ Question of the 'Uitlanders' was becoming critical. People began to realise that the gold mining industry was permanent. Though the industry appeared to be colossally wealthy it was also mightily costly and the levels of managerial and technical skills required, together with support services, juxtaposed in the Z.A.R. the conflicts of dynamic and static social forces. The civil rights of Uitlanders became a major political issue. The Z.A.R. could not deal with whites in the same way as it dealt with Africans. (For excellent description of events, see Muller, 1969, p.289-319)	Transvaal and O.F.S. defence alliance. ⊛ Rail link to Bulowayo via Bechuanaland completed. Droughts and rinderpest in O.F.S. killed 45000 head of cattle. ✻ Kruger re-elected with overwhelming majority.	1897 1898
✸ This war and in particular Kitchener's scorched earth policy did incalculable damage to the land. This action ranged over the belt of Savannah in the 15-30" rain belt, already disturbed by the Difanqane and white agricultural practices.	Second Anglo-Boer War	1899
	Treaty of Vereeniging S.A. Customs Union reformed ✻ 10000 Chinese labourers introduced to Transvaal Native Affairs Commission Responsible Government in Transvaal Zulu Rebellion Reconstruction under Milner's 'Kindergarten' Responsible Government in Orange River Colony	1902 1903 1904 1905 1906 1907
At Union two questions remained unanswered and almost forgotten - the relationship between Europeans and African, and the question of political disunity among the Europeans themselves.	Union	1910

5. SOUTH AFRICA - HISTORICAL REVIEW, UNION TO REPUBLIC

5.1 INTRODUCTION

The population at the time of Union was about 6 million in an area of 472000 sq. miles. (4m Africans, 1.25m Whites, .15m Asiatics, .5m Coloureds).

The act of Union achieved the ideal that many statesmen had striven for during the latter half of the nineteenth century, but it achieved this at a cost. This cost was the omission of significant guarantees for three-quarters of the population of the Union. The rights of the remaining quarter were scrupulously observed. The future of three-quarters of the population was delivered into the hands of the quarter of the population who called themselves White or European.

The new Union government was the South African National Party under Botha, holding 67 seats with Jameson's Unionists (39 seats), and Creswell's Labour (4), and 11 independents in opposition. They had a stupendous task of reconstruction and development ahead of them. After the world depression of 1873-1896, the last years of the century saw a revival of trade and industry, and twenty years of prosperity followed. During this time Canada, New Zealand and Australia put their agriculture on a sound and scientific footing. The South African States, disunited and at war, or recovering from the devastations of the war were not able to take advantage of this situation before the uncertainty of a much greater war overtook the world.

LABOUR: The mineral discoveries and related investment caused the pursuit of productivity within a market economy to interact with far-reaching adaptation on the whole social system. The integrating effects of economic development, change and innovation emphasised the clash between economic rationality and tradition which centred on the use of African labour.

The first indication of the depth of feeling is evidenced by the violence of the strikes of 1913-1914, which had in this sector a distinctly syndicalist aspect and led to the rise of the Labour Party, with communist and nationalist factions in an unlikely combination. 'Workers of the world unite and fight for a White South Africa' was written on a banner at a protest march in Johannesburg in 1922. The Volkslied and Red Flag were sung together at workers' demonstrations. The white worker was fighting against competition from the Africans, as their position was being aggravated by the increasingly serious 'Poor white problem'. This in turn was caused by agricultural problems as 'bywoners' moved off the lands into the cities. The strikes were a case of the proletariat battling for bargaining power with the capitalists, and also fighting against the integrative effects of a least cost substitution approach to running the mines. (De Kiewiet, p.162-201)

During the Rand rebellion of 1922, coal and gold mines closed down, power stations and engineering shops were out of action. These strikes occurred during the severe international slump after post-war inflation. The gold price fell from 130/- to 95/- (1920-1921), production costs rose from 22/11 to 25/8 over the same period. However, the pact government of Hertzog-Creswell saw a period of boom (influenced not a little by the rational employment policies of the mines after the 1922 strikes which enabled gold output to be increased enormously (Horwitz, 1967, p.236-237, table) and the government had sufficient surplus revenue to make a start with Iscor and other capital expenditure projects.

5.2 TABLE 5.2.a - HISTORICAL REVIEW TO 1960

Passive resistance of Indians led by Ghandi	1913
Strikes on mines and rebellion as a section of Afrikaners objected to joining the War and were defeated by Botha (Muller, 1969, p.347-351).	1914
Mandate of S.W.A. granted to South Africa	1916
General election	1921
Bulhoek; 163 Africans killed in riots	1922
Bondelswartz rebellion; 100 of the tribe killed in S.W.A.	1922
Rand rebellion	1922
Very serious nationwide drought and locust plague in OFS. and E. Cape.	
General elections: Hertzog & Creswell combined to take over government.	1924
'Civilised labour' policy of Hertzog formulated	1925
ISCOR established	1927
Carnegie report on 'Poor white problem'	1928
S.A. leaves gold standard	1932
United Party in power, but lost 19 seats shortly after election when Malan broke away and formed 'Purified Nationalist Party'	1934
S.A.B.C. formed	1936
Formation of Reddings daadbond, Ossewa Brandwag	1938
United Part split over joining the war, Hertzog resigned and Smuts took over. Dr. H.J. van der Bijl appointed Director General of war supplies.	1939
I.D.C. formed	1940
C.S.I.R. founded	1945
S.A.B.S. founded	
Racial criticism of S.A. begins to grow. In spite of international acclaim, Smuts had not been paying enough attention to affairs at home.	1948
S.W.A. given representation in South African Parliament	1949
Bantu Self-government act	1959
Sharpeville	1960
Republic of South Africa	1961

5.3. UNION TO REPUBLIC - SUMMARY

Since 1910 the comments in the list above have shrunk to statements of events, dates and election results. From 1910, diverse events of history fade in relation to the central government's attempts to grapple with the major structural problems of the country as a whole. These problems have not changed, and discussion of them here will serve as a conclusion to this section.

The change which makes 1910 a significant date is that through Union, with the advantages of a centralised Government, methods might have been evolved to deal with the country's real problems. Apart from this very little changed. The 15" isohyet stayed in the same place. Droughts followed good years; the escarpment did not ease its slopes; the 'natives' did not evaporate. The land continued to erode and waste away, while outside its boundaries the world continued on its inexorable path of technological development. An analysis of the action of these successive governments, however, shows a tendency to worry about intergroup ideological refinements while the real issues of soil and society remained unsolved. The party-political history of this period is the history of how the white polity took charge and eventually took control. The general socio-economic history of this period is a continuation of the struggle between economic rationality and the ideology of the white polity.

Behind the political in-fighting was the day-to-day battle to get a country on its feet. Eighty-seven acts were passed between 1910 and 1935 rendering permanent assistance to farmers. A great deal of time was spent drawing up legislation to regulate labour, steering a delicate course between least-cost substitution and 'civilised labour' until the policy of civilised labour became entrenched under the Hertzog-Smuts government in 1927. The transport system, originally intended to be run on business principles, with carefully worded legislation to ensure that this was done, was very soon used as a means to serve extra-market ends. Protection of local industry through tariffs, duties and bounties subsidised inefficiency and pushed costs upwards. Marketing control boards substituted legislation and government control for the price system and market mechanisms. In addition to this, the rights and bargaining power of over three-quarters of the population of the country were increasingly proscribed.

The major part of this government activity was made necessary by the structure of the socio-economic system - capital-intensive, labour-extensive industry was bringing pressure to bear on a struggling agricultural indsutry both in its demand for produce, and in its demand for

labour. Social value-systems caused a partial collapse of the primitive agricultural system and at the same time actively and violently prevented least-cost substitution of labour in the country's most profitable industry. The nature of the country itself and the natural resources it contained demanded high-skill, capital-intensive developments. An incipient secondary industry had to be nurtured in competition with Canadian and Australian products and processes, which had had almost three decades of development behind them before the South African industries began to expand. Major industrial centres on a high inland plateau with widely separated port facilities added transport problems of large proportions. In addition, 250 years of abrogation of responsibility to the indigenous population had to be made good in one way or another. These would be stupendous tasks for any government. Obviously private enterprise could not be left to sort these problems out by itself. The spread of agricultural poverty after the 1889-1902 war seriously affected the ability of a significant proportion of whites to contribute to the growth of the country. White and African social and cultural structures prevented an efficient market system developing. The building of the infrastructure necessary to carry the country forward into greater productive efficiency, was beyond the financial capacity of the private sector. Therefore government control and action was vitally necessary. It was a task that would have daunted any government, and was not made easier by the disruption of two world wars and the international censure of South Africa which developed after 1945.

The governments from 1910 to the present have undertaken that task with a mixture of brilliant 'piecemeal engineering' and dubious Utopianism, with results that have caused reluctant world admiration and recently recognition in Africa itself. But history does not stop gently at the present. The determinants that moulded the trekboers, the Uitlanders and the Kafirs are still operative. As the population grows, those determinants begin to work more and more effectively.

Out of this one major question dominates - how long can the Utopianist tradition of the white polity prevail against the implacable logic of rainfall, drought, birth rates and the growing interdependence of nations and peoples? This question leads to some conclusions that are relevant to the main thesis.

5.4. CONCLUSIONS

The main conclusion is the lesson to be learned from the influence of political ideologies on the effectiveness of government as a control mechanism. There are two aspects of this: firstly, political systems as a field of study in itself (i.e. as a variable in the long term), and secondly, political systems as a determinant of possible alternative actions (i.e. as a constant in the short or medium term.)

A second conclusion is that the history of the country shows that its topography, climate and ecological systems, are major determinants of human behaviour. Economic or social theory based on simplifying assumptions of the isotropic plane (e.g. most basic location theory) is highly suspect under these conditions. It is essential to work out realistic measures of distance (defined in terms of cost and time) and spatial dispersion that can take into account the locational effects of natural phenomena. Importation of analytic techniques from countries where these effects are minimised through long historical development (as in Europe) or through the sheer momentum of the economy (as in the U.S.A.) could lead to serious distortions in theoretical work.

Thirdly, the social interaction of Whites and Africans is an area of study that has been neglected for too long. An objective basis must be discovered from which the prejudice and folklore surrounding interracial sensibilities can be analysed to determine the parameters of social action in this country.

Fourthly, there is the interaction of man and land - the ecological balance between veld, animals and rainfall, between soil type and productivity, to quote Muir 'this is a difficult land', it will have to support a burgeoning population and meet the demands of increasing industrial development and it is a land that has never taken kindly to overuse.

Fifthly, there is the significance of the growth and development of urban systems and the infrastructure that supports these systems. Since this aspect is of the greatest direct relevance, it is dealt with more fully in the following section.

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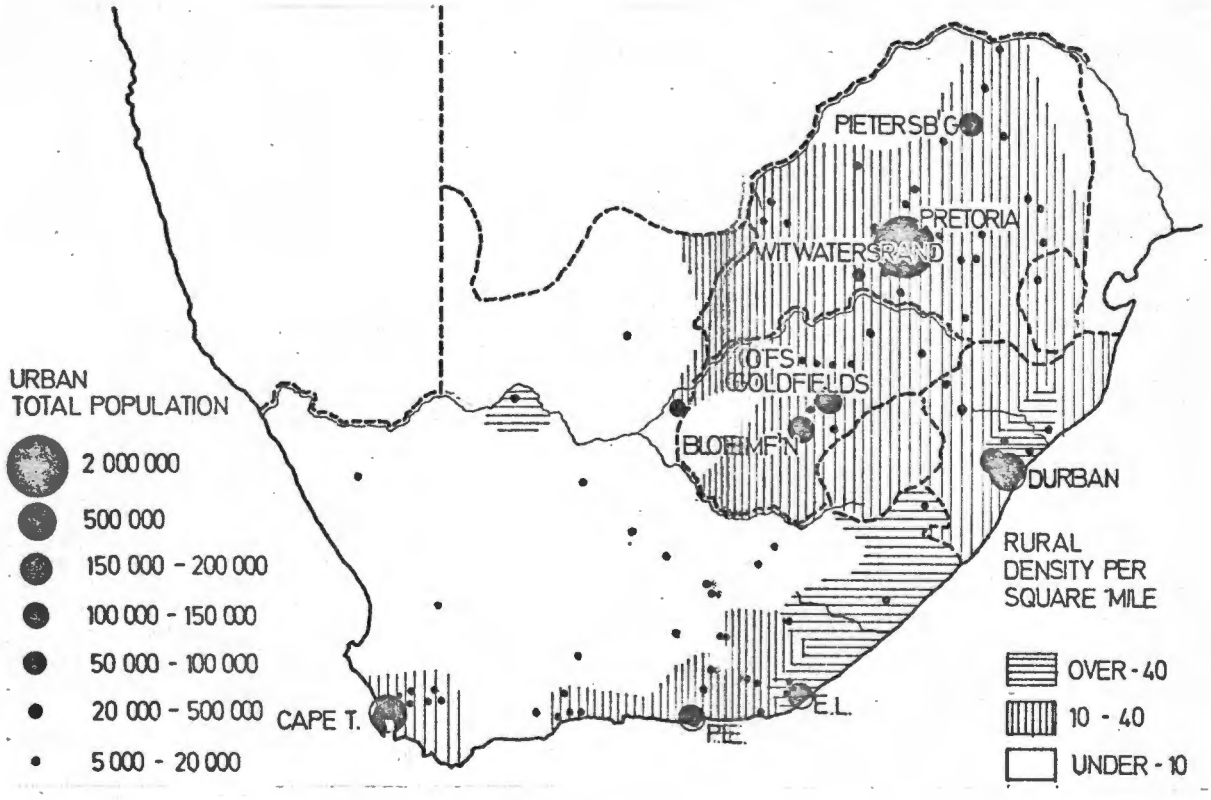
6. URBANISATION IN SOUTHERN AFRICA

Professor Mallows puts forward three propositions concerning patterns of urbanisation in Southern Africa (Mallows 1968):

Firstly, he suggests that urbanisation and industrialisation are parallel phenomena intimately connected with the growth and stability of the country. Secondly, the historical development of urbanisation in South Africa has resulted in a framework with certain peculiarities which set it apart from other urbanised regions in the world, and thirdly, he proposes that this pattern has special significance for future development, and should guide thinking in terms of the system itself, and in terms of that system as part of a larger continental system.

This urban system takes the form of a 'spine' of development on the high inland plateau, with cities and towns (usually of mining origin) about 350 miles from the coast. This 'spine' is supported and serviced by a parallel line of port-cities on the east coast. The spine extends north into Rhodesia and Zambia and is also visible in Kenya (see maps).



Source: Green and Fair (1962)

There are in all cases strong transport links between a port and its inland neighbour, but the port cities depend to a large extent on the development of the spine cities for their own development. In this respect, they differ from most port cities which are usually productive centres in their own right.

There is one aspect of these inland spine cities which is of utmost importance. They have grown without a sound agricultural support base. In fact, the spine is usually a stimulation to the agricultural resource base.

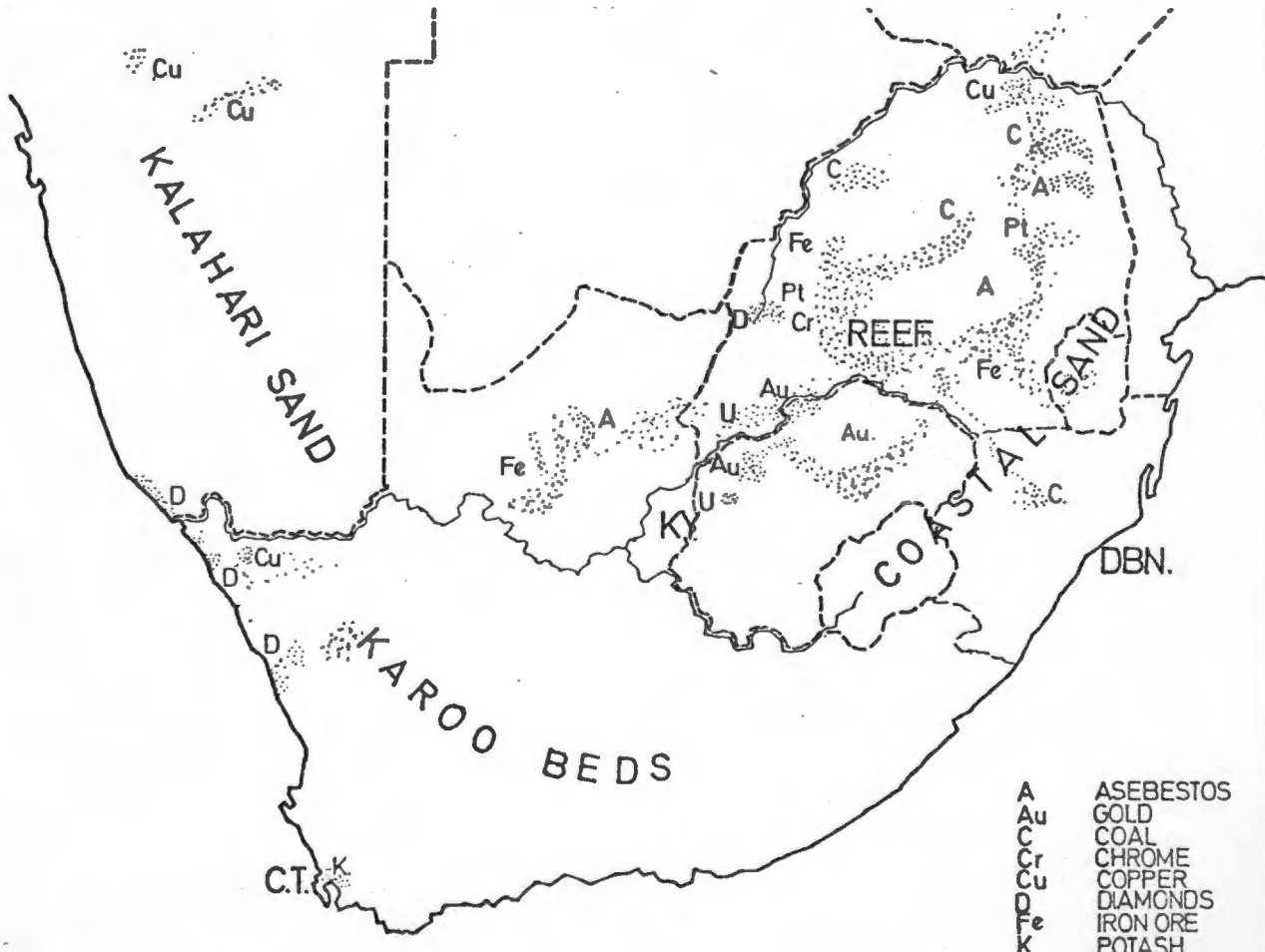
The inland spine is dependent mainly on rail transport for bulk movement of goods and resources, and the cheap bulk transport systems based on water are an impossibility in Africa. Water, in general is chronically lacking for most of these inland cities. The generation of power shows the same characteristics of cost and distance as water and transport. These three determinants of the framework of urban development demand the most critical planning and investment techniques.

The urban industrial civilization in Southern Africa is an artificial thing. It has no place on the high, dry inland plateaux. The ports do not serve an accessible hinterland rich in natural resources, they are not at the mouths of great rivers opening channels of communication into the interior.

The Western urban and industrial techniques depend on an abundance of water both for transport and for the generation of power. (Cook, 1971). United States, British and German industrial conurbations are situated either on the coast, or on major rivers or both (London, The Ruhr, the Eastern seaboard conurbation). South American and Asian urban complexes also relate to abundant water supplies. In South Africa these wet techniques have been imported from countries where water is freely available.

The urban complex in South Africa, then is deprived of a cheap transport base, and there is a serious limitation in the supply of the main factor in power production. This factor will be aggravated in future, as more of the country's mineral resources are exploited. The map shows the distribution of these resources as a swathe of deposits underlying the existing spine and turning west across the driest and least accessible part of the country.

As far as the future of the country is concerned, these factors are going to demand increased attention to the technology of the communication network of its urban spine. This urbanisation, based on extractive industries with an advanced technology, which in turn generates agricultural and other industrial activity, totally dependent on artificial transport and communication networks for its continued existence and growth.



MINERAL RESOURCES

7. SUMMARY

The purpose of this chapter has been to take the three disciplines most directly concerned with Planning at present, and to look at these in relation to each other and to their position and development over time. Following this, the particular system being studied in this thesis is reviewed in the same historical framework in order to find some structure to its development.

The result of the three foregoing analyses was that (outline) certain directions, and lacunae which can be summarised as follows, were found. All three disciplines are making more and more use of models as a basic research tool, but as far as urban/regional systems are concerned some of the theory behind that model-building effort is open to question.

In regional theory there is an important integrative movement, represented most effectively by Isard et al in their latest publication, where a General Theory of urban/regional systems is sought. Geography displays a similar unitary approach to the concept of analysis of regional systems as an area of prime concern, where an eclectic use of theory from the discipline is advocated (Table 2.2.6) as in Isard (1969).

Economics, however, is found to be lacking in its content as a true behavioural science, where certain aspects of human behaviour such as extra-market resource allocation and the use of power is not explicitly dealt with. The same historical reasons that give rise to this lack also call into question the general applicability of economic theory to the situation in developing countries. (This does not in any way minimise its contribution to regional economics, and the development of model-building techniques in econometrics).

The review of the South African History served to outline the importance of the features that economic theory is not fully equipped to explain. The effect of socio-economic forces on resource allocation, extra-market activity in the form of war, strikes, and sheer prejudice, have too direct an influence on economic issues to be left to the sociologist to investigate.

The review also points out an incipient weakness in regional economics and geography that is not explicitly stated in the analysis of those subjects. This weakness is highlighted by the critical part that the

natural environment plays in the development of a socio-economic system. The physical barriers of mountains, and the long term effects of ecological imbalances caused by mismanagement in agriculture are aspects that are sometimes ignored by disciplines which originated in the well established economics of Europe or the vital economy of America, where environmental effects are minimised both by the nature of those countries themselves and by the highly technical nature of the socio-economic systems. Just as development economics does not take into account the real socio-political climate of Non-European and Non-American countries, so does regional analysis and Geography tend to minimise the effect of environment and climate on socio-political systems in those same countries.

This aspect is emphasised in the section on Urbanisation, where the concept of an urban spine as a foreign element in an uncompromising landscape concentrates attention on the tremendous technical inputs that will be required to maintain this system. The lack of water as a transport medium and as a vital commodity for use and power generating, coupled with the natural configuration of the spine, shows the need for a completely man-made system of connections to maintain the vital flow of energy and information through the system. This and the underlying social tensions, make informed technical expertise in resource allocation and control a structural necessity.

8. NOTES TO CHAPTER 2

N1 THE HISTORICAL DEVELOPMENT OF ELECTRONIC DATA PROCESSING SYSTEMS:

COMPUTING DEVICES	DEVELOPMENTS DIRECTLY AFFECTING COMPUTER DESIGN	DATE
FINGERS		
ABACUS		
	Logarithm tables (Napier	1600
	Slide Rule (Oughtred)	
First Adding Machine (Pascal)		1642
Stepped wheel calculator	Binary number system and	1671
	Symbolic logic (Liebnitz)	1694
Automatic computer design, Paper by Müller	Loom operated by punched paper tape (Jacquard)	1780
Difference Machine (Babbage)		1812
Working Model		1822
	Boolean Algebra	1864
'Brunsviga' pin-wheel adder (Odhner)		1878
	U.S. Bureau of Census used punched card counting	1880
AT THIS STAGE THE DEVELOPMENT OF AUTOMATIC CALCULATORS WAS RETARDED BY THE LIMITATIONS OF MECHANICAL EQUIPMENT.	techniques (Hollerith)	1890
	Formation of Computing, Tabulating and Recording Company (CTR) later to become IBM (Hollerith)	1911
4 CTR machines on market		1914
	VACUUM TUBES PROPOSED FOR ELECTRONIC PROCESSING	1915
	Development of CYBERNETICS (Wiener, Ashby, Walter, Couffignal, etc.)	1930's

COMPUTING DEVICES	DEVELOPMENTS DIRECTLY AFFECTING COMPUTER DESIGN	DATE
ASCC Automatic Sequence Controlled Calculator (Aiken & Stibitz)		1932
	Binary numbers used in Electronic circuits (Wynn-Williams)	1937
	Boolean Algebra used in circuits (Shannon)	1938
Partially automatic computer (Stibitz at Bell Telephone Labs.)		1940
ENIAC Electronic Numerical Integrator and Calculator (Goldstein & Goldstein et al)		1946
DEVELOPMENT OF 'FIRST GENERATION' COMPUTERS:		
IBM-SSEC, Pilot-ACE (Turing, England), Raytheon-RAYDAC (Bloch, et al), Bell Tel-MODEL 6 (Andrews)		1948
EDSAC (Wilks & Renwick, Cambridge)		1949
Descendents of ENIAC and EDSAC		1950
A comprehensive list of developments in chronological order is too confusing from this time on. The growth of computer design and development over the next decade follows an exponential curve.		
	DEVELOPMENT OF TRANSISTORS This may be regarded as the most significant step forward in the design of computers.	1957
Second generation computers. Refinement of 'Hardware'		
	Solid State Physics Enabled the design of miniaturised and therefore more efficient circuits.	1960
THIRD GENERATION COMPUTERS		1965
	Refinement of 'Software', more efficient methods of using computers and so on.	

COMPUTING DEVICE	DEVELOPMENTS DIRECTLY AFFECTING COMPUTER DESIGN	DATE
FOURTH & FIFTH GENERATION COMPUTERS		1970
	LASER beams, using light to transmit information instead of electricity. Magnetic bubbles to increase memory storage.	

N2 FRIEDMANN'S EIGHT PROPOSITIONS FOR REGIONAL DEVELOPMENT:

1) Regional economics are open to the outside world and subject to external influence.

2) Regional economic growth is externally induced.

3) Successful transpiration of export sector growth into growth of the residentiary sector depends on the socio-political structure of the region and the local distribution of income and patterns of expenditure.

4) Local leadership is decisive for successful adaptations to change yet the quality of leadership depends on the region's past development experience.

5) Regional economic growth may be regarded, in part, as a problem in the location of firms.

6) Economic growth tends to occur in the matrix of urban regions. It is through this matrix that evolving space economics are organised.

7) Flows of labour tend to exert an equilibriating force on the welfare effects of economic growth. But contradictory results may be obtained.

8) Where economic growth is sustained over long periods, its incidence works toward a progressive integration of the space economy. (Friedmann 1966, ch.2, p.20-38).

N3 REGIONAL ANALYSIS:

These activities define step 11 of Chapter 1 (N11).

1) Analysis of spatial organisation (analysis of spatial structure of relevant variables for regional analysis) delimitations of regions, city functions, urban influence areas, gravity models.

2) Location analysis industrial/agricultural location, location factors across inter-regional space, central place theories, etc.

3) Urban complex analysis:
Physical structure of principle urban areas - transport, infrastructural needs, housing, land use, etc.

4) Regional land-use analysis:
Erosion, land use need of programmes, tourism, conservation.

5) Demography:
Structure, urbanization, migration, labour, participation, dependancy rations, etc.

6) Human resource analysis:
Manpower requirements, skills, institutional capacities, problems and policies for development.

7) Natural resource analysis:
Resource complexes per region, technical innovation, trade and markets.

8) Economic activity analysis:
Sectoral studies in terms of firms, employment, production, efficiency, linkages transport and energy requirements.

9) Regional trade patterns analysis:
Input-output analysis, interregional flow patterns, market analysis of region's products.

10) Regional accounts and development models:
Regional product account framework and corresponding time-series; indicators of regional economic performance, regional economic forecasting models, quantitative development planning models permitting integration of regional with national, global and sectoral targets.

11) Project analysis:
Feasibility, cost-benefit studies of major investment projects in a regional context.

12) Regional programme budget analysis:
Optimal allocation and time sequences, investment and operating capital requirements, financial resources, etc. (Friedmann, 1968)

N4 TRANSFORMATION OF VECTORS IN GEOGRAPHICAL DATA MATRICES
(Chorley & Haggett, 1967, p.29)

	TRADITIONAL DATA-MATRIX	TRANSFORMED DATA-MATRIX
	Major World Regions	Spatial Models
	Region 1	Polar axes
	Subregion 1a	Central-place model
	...	
COLUMN VECTOR	...	Gravity model
	Place 1a (1)	...
	Region 2	Linear axes
	...	Hortonian model
	...	Colonization model
	...	
	Region N	Model N
	---	---
	Elements:	Geometrical Dimension
	Human Elements	Zero-order form
	Population	Cities
	Settlement	
	...	...
	...	First-order form
ROW VECTOR	...	Networks
	Physical Elements	
	Landforms	...
	Vegetation	Order combinations
	...	...
	...	...
	...	
	Element N	Combination N

CHAPTER THREE: technical analysis

1. GENERAL CONCEPTS IN SPATIAL ANALYSIS

Space has been the central issue of much of the discussion so far, but no specific meaning has been put to the word except its general contextual sense. This section brings into focus some general concepts regarding the analysis of phenomena in spatial terms, therefore it seems timely here to give a clearer idea of the meaning intended by the use of this word. 'Space' is 'that which accommodates or may accommodate activities' according to McLoughlin (1969, p.133) who goes on to limit this broad definition with the proviso that it 'compromises the surface of the earth, including water surfaces, the airspace above the earth, and space underneath the surface'. In terms of the discussion on systems (Chap. 1.3) it would seem preferable to retain the generality of the definition, since the dimensions of the spaces that can accommodate activities are not necessarily limited to the length, breadth and height of 'actual' space. The position of a point in these dimensional spaces is defined by a set of three numbers or co-ordinates, within a specified frame of reference or co-ordinate system (e.g. x,y,z, or length, breadth and height for rectangular spaces). From this it is possible to propose an N-dimensional space defined by a set of N numbers denoted by (x^1, x^2, x^1.....xN). "The fact we cannot visualise points in spaces of dimension higher than

three has of course nothing whatsoever to do with their existence" (Spiegel, 1959, p.166). Although the Planner is basically concerned with actual space, it is possible to interpret the distribution of activities in space too liberally, and to bind oneself to the transformations of space that occur. Space will be considered in the widest sense implied in McLoughlin's definition as the domain in which human activities take place. In this sense it becomes a dimensional domain similar to that described by Angyal (see Ch.1.3) within which a system may occur and in terms of which the structure of that system may be described.

If one considers all urban and regional systems as an integral set of human activity patterns then the problem of finding a point of entry through which one can begin to isolate and define some of these systems is considerable. As Peter Haggett says, 'the more integrated the system, the harder it is to crack.' (1965, p.36) The approach that is adopted here is that whatever kind of space is being considered, there are a limited number of ways in which elements of a system can be arranged in that space. Therefore, by building up a 'language' of these patterns, it is possible to start from the simpler, and familiar spatial patterns, and by a cumulative process of pattern-recognition, to build up an understanding of those systems. From this consistent and realistic models of their operation can be developed.

The following sections are directed towards identifying these basic patterns, and describing how the patterns can be used to build models of urban and regional systems.

1.1 NODES, NETWORKS AND SURFACES

The spatial distribution of many, if not all, human activity patterns can be grouped into three basic categories of nodes (points), networks (lines), and surfaces (planes). A group of towns (nodes) is connected by roads (networks) which is determined by topography (surface). It is possible to visualise the economic intensity over this group as a variation of topography or relief (surface) where ridges and valleys correspond to high and low levels of economic intensity. It is possible to move from the 'actual' space of cities and roads on the land, to concentration of decision-making potential (nodes) connected by and dependent on lines of communication (networks), which gives rise to a distribution of decision-making potential (or surface) overlapping the whole group. In addition it is possible to start with a group of cities (nodes) in actual space, define the links between the nodes by some dimension other than miles (say transport cost) which can in turn be used to define

a different surface where contours measure not height above sea level, but accessibility or differentials in transport costs.

Thus one may say that wherever human activity takes place, and at whatever level of abstraction one may decide to observe activity, that activity can always be interpreted as nodal concentration of activity, networks of links between these concentrations, and intersticial forces which may be described as density surfaces. A very important proposition follows from this concept. Node, network and surface are geometrical concepts that are subject to the full range of mathematical and statistical analysis. Once these simple geometrical patterns are recognised they can be analysed by applying a number of mathematical and statistical operations. Many of these operations are based on well established mathematical theory (N1). Briefly the relevant techniques are as follows:

1) Nodes: Point set theory, Packing theory, Probability theory (distribution).

2) Network: Combinatorial analysis, graph theory, lattice and matrix theory, probability theory and stochastic process theory, vector analysis.

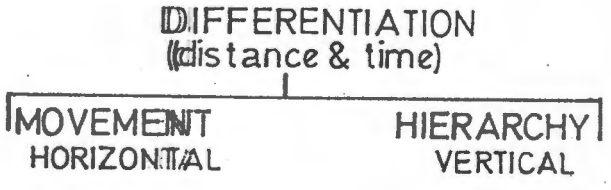
3) Surfaces: Topology, Tensor analysis, trend surface analysis, Harmonic and Fourier analysis. (Haggett, 1965, 1964, Chorley & Haggett, 1969).

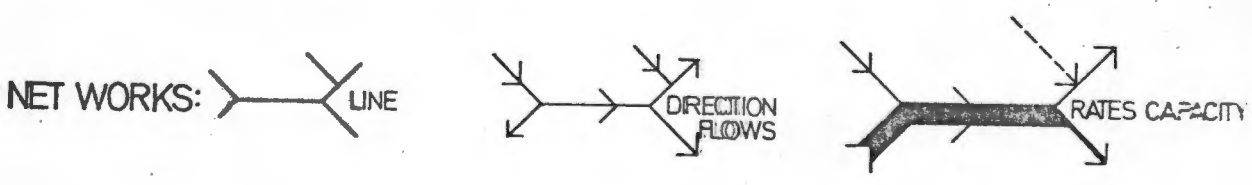
If urban/regional systems are analysable in terms of nodes, networks and surfaces, then it can become possible to build up a picture of how they are structured and how they interact. Since there are idealized patterns of nodes, nets and surfaces that are fully described by the mathematical theories above, it also becomes possible to classify patterns and most important, to measure the extent to which real patterns vary from the ideal. Consistent distortions can give clues to cause and effects, and can explain the interactions of systems. Sufficient work has been done on these concepts to accept that urban/regional systems are arranged in patterns of point nets and surfaces, and that these patterns show sufficient regularity to permit analysis in quantitative and structural terms. Christaller and Lösch can be considered among the first to recognise this quality, and recent work in urban geography and regional science has confirmed much of what they postulated about the patterns of human settlement. (Berry and Pred, 1963, Haggett, 1965, Chorley and Haggett, 1965, Berry and Marble, 1968).

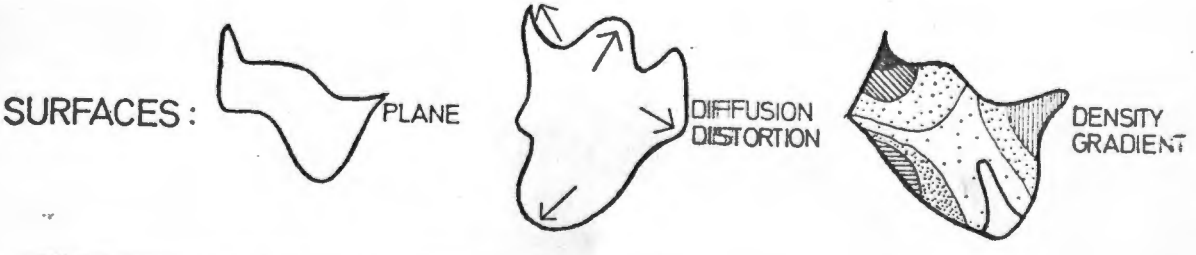
Although recognition of these patterns is necessary for beginning an analysis of urban/regional systems, the result will be a static picture of an existing arrangement. These concepts alone are not sufficient for an analysis which requires changes in the systems to be interpreted. Therefore, it is necessary to bring in an additional concept which is complementery to the concept of Node, net and surface. This concept is that of differentiation, specifically the differentiation through movement within the system.

1.2 MOVEMENT AND HIERARCHY

The concept of differentiation can be broken down into two components, namely, movements (in the horizontal sense) and the formation of hierarchies (or movement in a vertical sense).. Patterns of differentiation also assist in the recognition of system characteristics, and analysis of processes of differentiation lead to the construction of models with predictive power. A sketch will illustrate the main points so far.

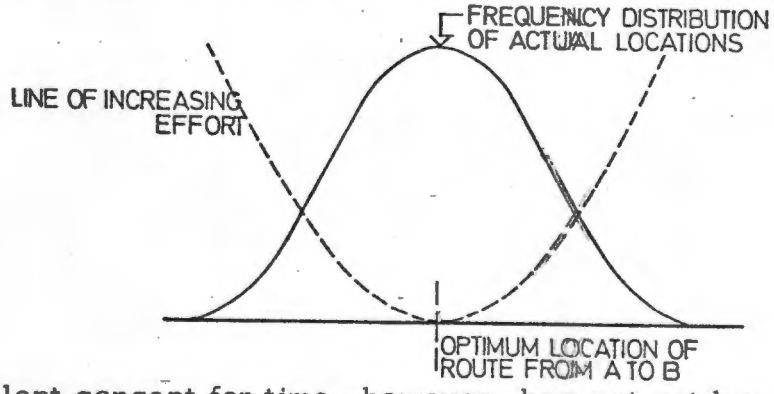






Movement cannot become a useful concept until it is assumed that movement occurs in time and that it is also limited by distance. Both these assumptions are made because in real systems it is impossible for a movement to occur instantaneously, and overcoming distance involves friction and loss of energy. It is sometimes difficult to decide whether concepts of time and space are not more important than movement itself, until one realises that within the system it is the connections that are important, and time and distance are merely limiting factors of the domain in which these systems exist.

Distance can be relatively clearly defined, and moreover its effect on movement in a system can be conceptualised by the 'law of minimum effort' which suggests that events attempt to reach goals by the shortest routes. Isard suggests a measure of effective distance (N2) and Haggett (1965, p.33) suggests a probability theory explanation of least effort where most of the actual locations of a route from A to B would occur round about the optimum as shown in the sketch.



The equivalent concept for time, however, has not yet been developed. One suspects that evolutionary processes, and time cycles of day, year and season have some structuring effect on movement as well as the fact that it simply 'takes time' to get from A to B. The principle of least effort would seem to apply to time as well as distance. Unfortunately, there does not seem to be a common agreement about the conceptualisation or measurement of this factor yet. Isard himself in a discussion of this aspect becomes involved with transcendental concepts in a most unscientific way (1969, p.580) which is some indication of its difficulty.

With these four concepts - Nodes, networks, surfaces and the differentiation through movements within the limits of time and distance, it is now possible to analyse both the static and the dynamic aspects of a wide range of urban/regional systems. It must be made clear though that there is no strict demarcation between node, net and surface. Concentration in a network can become nodes, and surface can in some respects be regarded as a system of nodes or networks. The question

of scale has a direct bearing on this, where all the patterns are visible in one node (or city) at a fine grain, while on the large scale peaks and ridges in a national surface, may be regarded as nodes and connecting links.

The following tables illustrate how this concept might be applied to the analysis of urban/regional systems, where both 'actual' and 'abstract' spaces are taken into account:

TABLE 3.1.a.

Space	Concept	Components, Connections & Fields	Movement (Horizontal)	Hierarchy (Vertical)
Actual (Geographic)	Node	City	Agglomeration, scale	Village, town, city
	Net	Roads, rail	Direction, quantity	Track - freeway
	Surface	Land use patterns	Extension, succession	Rural - CBD
Economic	Node	Behaving unit Household, firm	Agglomeration of wealth	Single unit - corporation
	Net	Communications Media, management.	Volume of transaction	Bit - multi-message
	Surface	Market areas	Expansion-contraction	Stagnant-growing
Sociological	Node	Behaving units, Family, institutions	Accretion of power Mobility (influence)	Worker - aristocrat Lower - upper class
	Net	Communication, kinship	Volume of transactions, birth and marriage, etc.	Single bit - multi-message
	Surface	Potential field Interaction field	Diffusion - Density	Family circle - jet set
Political	Node	Voters, parties institutions	Adaptive - conservative	Local - national single - bloc, lobby.
	Net	Delegation, communications	Direction, quantity, concentrations, dispersion	Dictator - Democracy.
	Surface	Action/decision space	Reduction - expansion	House, magisterial district, nation

This table, although very arbitrary in its divisions, will serve to point out one important factor. There is sufficient connection with 'actual' space in all cases for it to be considered as an important determinant in the same way that time and distance were used to limit movement. Without doubt many topographical features will be measured in terms of one of the definitions of the distance function, but factors of climate, attractiveness, and so on, have hardly been given any general significance in a model system.

1.3 SPACE, DATA & MEASUREMENT

The four concepts point, line, area and motion, permit the researcher to recognise patterns within the system he is attempting to study and describe. Referring back to the discussion of scientific method in Chapter 1.3 and also the subsequent discussion on models (Ch. 1.3) it was shown that models assist with the determination of significant fact, matching those facts with theory and thereby refining and articulating those theories. Therefore, by means of four concepts it is possible to build up models of urban/regional systems for the purposes of articulating and testing theories. The nature of these studies can be categorised to a certain extent, and this categorization can give some clue as to the nature of the data and systems of measurement that are used.

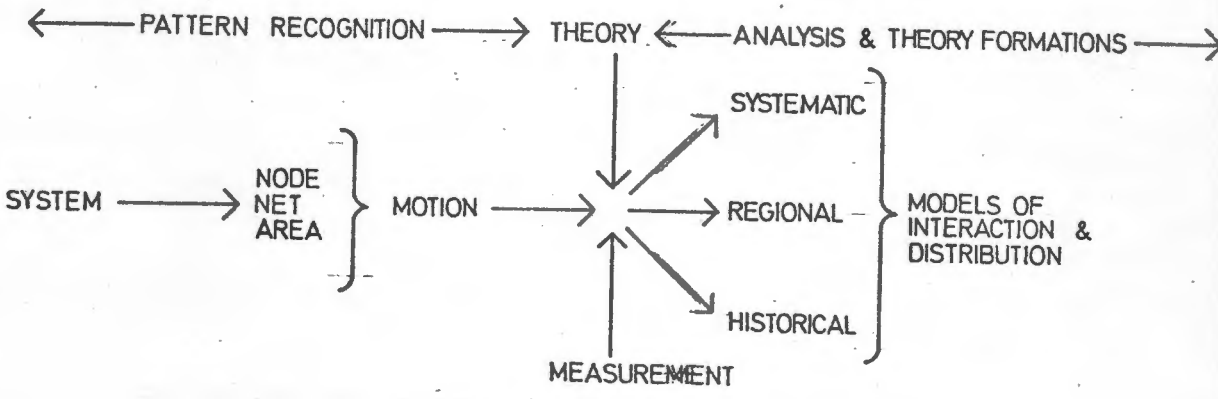
The kind of study processes are:

1) Systematic:
   a) the nature of spatial distribution
   b) spatial association, and distribution or interaction of spatial distribution.

2) Regionalisation and areal differentiation:
   The description of particular places and the codification of their having characteristics over space, or inversely, the building up of region systems from detailed analysis of spatial distributions as in 1) above.

3) Historical:
   Systematic and regional studies are taken as continuous processes through time or as an exercise in comparative statics where cross-section at different time periods are compared.

Again a sketch is useful for summarising the discussion so far:



The critical point that has not yet been discussed is whether there are any general principles which can give some hint as to methods of analysis to use. Since most analysis depends on measurement, and measurement in turn depends on the quality and structure of the data that is available, a brief look at these two aspects may give some direction to the discussion.

Systematic, regional and historical studies of urban/regional systems will necessitate the use of two kinds of data (Berry and Marble, 1968, p.5). The first is structural data dealing with connections between components of a system and measures the flows, rates, capacities and directions of those links; their number, configuration and their differentiation. The second type of data is functional, and deals with the function of the component of a system, their properties and characteristics that establish their position in the system, and their hierarchical position as the system moves (N3)

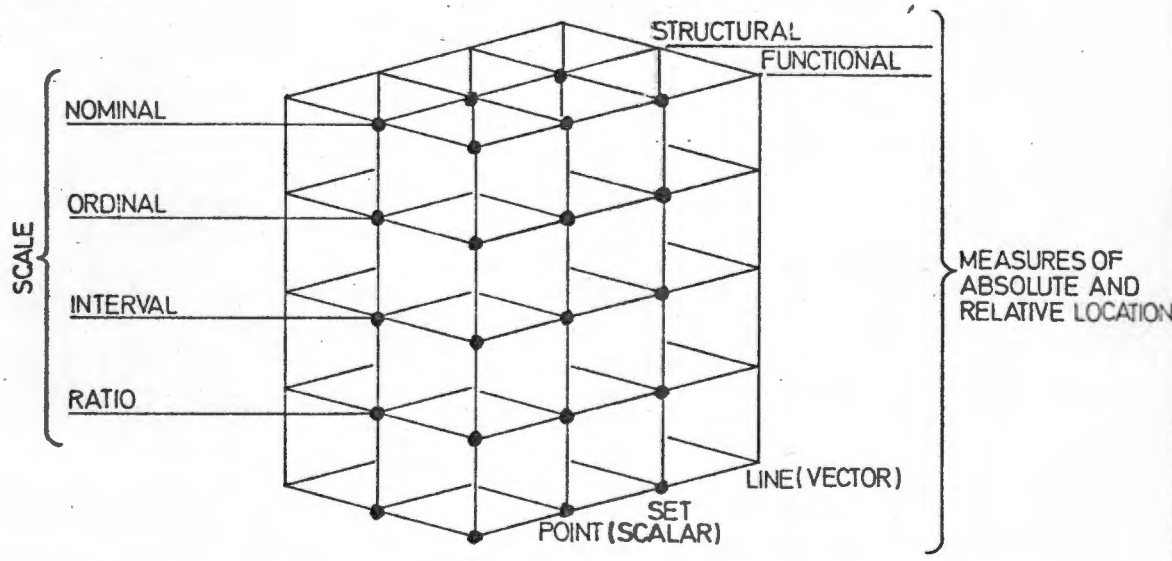
There are four basic scales of measurement used to interpret functional and structural data:

1.	Nominal	Classification	one, two, three, type one, type two, etc. e.g. Land use map.
2.	Ordinal	ranking	First, second, third. e.g. urban hierarchy scale.
3.	Interval	measures without ratio properties	1-5, 6-10... continuous or discrete measurement, generalised from average or point observations e.g. rainfall, temperatures.

4.	Ratio	full measurement, true zero	percentages, probabilities, e.g. an input-output matrix.

In addition to this breakdown, it is argued that spatial data has two basic characteristics, it is either locational or areal (Kao in Berry and Marble, 1968). That is to say, locational data are the values of a 'point function' (scalar) and areas data related to the value of a 'set function'. (See also the distinction between absolute and relative location below).

There is another data form which is related to movement, but which also relates to the quantification of lines and networks and that is vectoral data, where a vector is defined as a 'quantity having both magnitude and direction'. This data-matrix is illustrated in the diagram below:



In the overall view, to describe patterns and connectivity it is necessary to use data relating to absolute and relative location, and also to make use of scale concepts. Measures of absolute location (position) and relative location (geometry) can be used to analyse patterns in terms of density, density gradients, spacing, hierarchical structure, accessibility, and so on.

The three themes of data, measurement and pattern merge in spatial systems analysis to yield models of the associations and interdependency of urban/regional systems.

1.4 SYSTEMS, ENERGY AND INFORMATION

The definition of a system as a distribution of members in a dimensional domain (where those members can only be described in terms of their connections and their position relative to the dimensional domain, although their inherent functional characteristics may be co-determinants of position) has provided a logical and consistent means towards applying techniques of pattern recognition and measurement which could assist in the building of analytical models of the systems, and further could lead to prediction from those models.

This hypothetical construct of systems is the unifying idea that integrates the diverse approaches to spatial phenomena, and permits simple mapping techniques developed in geography for "actual-space" events to be extended into the economic, social and political spaces that are the domains of the behavioural sciences. There are, however, two concepts, those of energy and information, which have not been explicitly dealt with up till now, but which merit some discussion. The author feels that he is in no way qualified to tackle these concepts with any certainty. To provide an entry into these ideas, consider two further definitions of systems, both proposed by systems engineers (in the operations research sense).

Ackoff (in Emery, 1969) defines a system (from the point of view of systems research) as 'any entity, conceptual or physical which consists of interdependent parts' (p.332) and which moreover displays goal oriented behaviour characteristics. This definition is then further limited to Organisations, which are behavioural systems subject to control by human beings, and which can be recognised by four main characteristics; namely, content (people and things), structure, communications and decision-making procedures. Herman Affel (1964, p.19) in similar vein, defines a system as 'a set of operations organised to satisfy a definable user requirement'. Both definitions stress the importance of information - 'the effectiveness of an organisation depends on its having the right information at the right place at the right time'. (Ackoff, p.338). This concept of an organisation depending on information is critically important. It becomes even more important when the relationship of information to energy-flow is investigated.

Open systems depend for their continued existence on an input of energy which maintains negative entropic forces within the system. Accessibility and use of this energy is controlled by information. Information in turn consumes energy, although in microscopic quantities compared to

the amount it can release and control. Most systematic behaviour can be interpreted in terms of flows of energy and information (Cook, 1971, Tribus and McIrvine, 1971). This aspect remains an open question, however, since there is very little work on it in the literature; it is raised here merely to indicate that there may be deeper and simpler patterns which will explain system behaviour more logically than the patterns which are used at present.

2. ON THE DEFINITION OF REGIONS

Regional definition creates two problems. The first demands a clarification of the concept itself; what is a 'region". The second is a technical problem of determining the boundaries of a region in such a way that it can be redefined by someone else using the same data and techniques, and so that it is meaningful or useful in the research context.

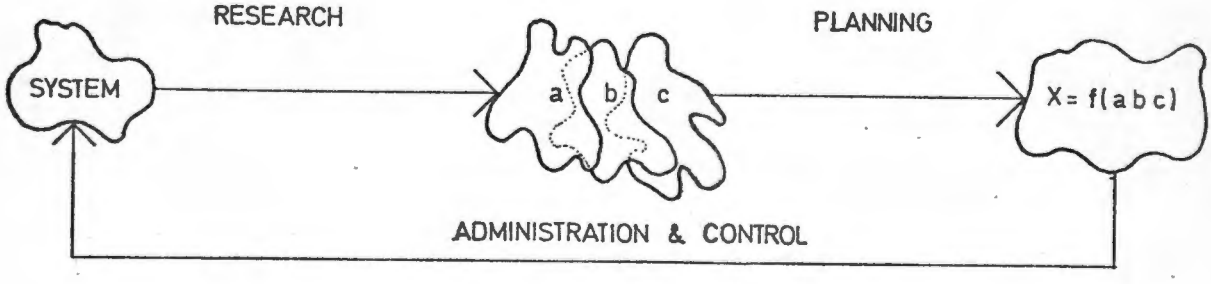
The first problem, the clarification of the concept, revolves around the essentialist controversy about whether a region is a part of the earth's surface or whether it is a mental construct. A quotation from the report of a study on the 03 region done at U.C.T. Dept. of Urban and Regional Planning, will suffice to settle this issue.

"The regional planner is concerned with regions. His definition of the region is necessarily arbitrary, and is usually attempted with an eye to a particular problem, ease of study or of statistical reference. He should be aware, however, of the interdependence between the region and the wider universe. Regions should thus be seen as inter-directional flows. A region is a system within a system of regions.

"Within his arbitrarily defined region, the planner works in a continuum of time and space. His essential concern, however, is with space, viewed over time. This space is not only physical, for the properties of space vary with the functional meaning of the interrelation being considered. It is possible, therefore, to think of a superspace in which there would be as many dimensions as there are modes of interrelation. Essentially, however, the planner is concerned with physical or geographical, temporal, social and cultural, and economic space. It is his job to co-ordinate these dimensions into a synthesised whole." (Fish, Dewar, Neveling and Overton, 1968).

A region can be both a mental construct, a device for classifying and explaining systems characteristics, and it can be a piece of actual space - a tract of land. More than this, the tract of land and the mental construct are often related, since the process of regionalisation can isolate a particular area with similar social, economic and political characteristics.

An urban/regional system which obviously has actual or geographical space as part of its spatial co-ordinate system, can be classified into several types of regions for research purposes. Many of these regions may have nothing to do with the surface of the land. For example, a region defined in terms of social distance between different groups of people, or accessibility to decision-making nodes, would bear very little resemblance to an actual-distance map of the places in which those groups and nodes were located. However, during the experimental and planning stages, these regions must be integrated to be able to relate the data to actual space, and finally the effectuation and administration stages will probably require the planning considerations to be related to magisterial districts or some form of administrative region in actual space. In sum, a system can be defined in terms of region a, b, and c, but in order to effectuate and administer planning proposals stemming from this regionalisation, an administrative region x is devised which can be regarded as a function of characteristics a, b and c, but related to an actual geographic area.



In this study, therefore, 'regions' will be regarded as both research tools for classification and explanation, and as actual areas in conventional three dimensional space.

The technical aspect is not so simply dealt with, however, and warrants independent discussion.

2.1 TECHNICAL ASPECTS OF REGIONAL DEFINITION

The picture of spatial analysis developed in Section 1 of this chapter proposed that the regional nut could be cracked by using a 'language' of patterns and measurement which could apply to most of the structures of an urban/regional system. This concept is illustrated graphically in the table 2.2.a (Ch. 2.2).

Although table 2.2.a refers specifically to geographic form, its application to other forms is not limited. It was shown in the previous section that social and economic phenomena display the same node, net and surface structure as the 'geographic' system of cities, transport nets and urban fields described in 2.2.6 (See table 3.1.a). This table is in fact a model of regional analytic method which proposes a staged analytic process, outlines the techniques to be used, and corresponding models in each case, and further indicates the theoretic sources for the analytic and synthetic techniques.

The first stage is a process of system identification, where the structure of the regional systems are discovered and classified. The second stage is the analysis of processes of growth and interaction, where the systems identified in the first stage are examined to discover the connection between the parts (static analysis) and the effects of movement over time (dynamic analysis).

The first and second analytic stages are then syntehsised in the third stage where the continuous interaction of several regional systems are investigated. It is at this stage that complex simulation models become operative, once the groundwork of classification and analysis has been carried out (Hamilton, et al, 1969).

It is the primary stage of the analysis that is the subject of inquiry here. Where regional systems are identified, and boundaries drawn around those systems with a view to applying whatever analytic techniques are relevant or feasible within the local context and subject to limitations of what data is available.

1.1 CATEGORIES OF REGIONS:

Regional units can be classified into three major groups: single feature regions, multiple feature regions and total regions.

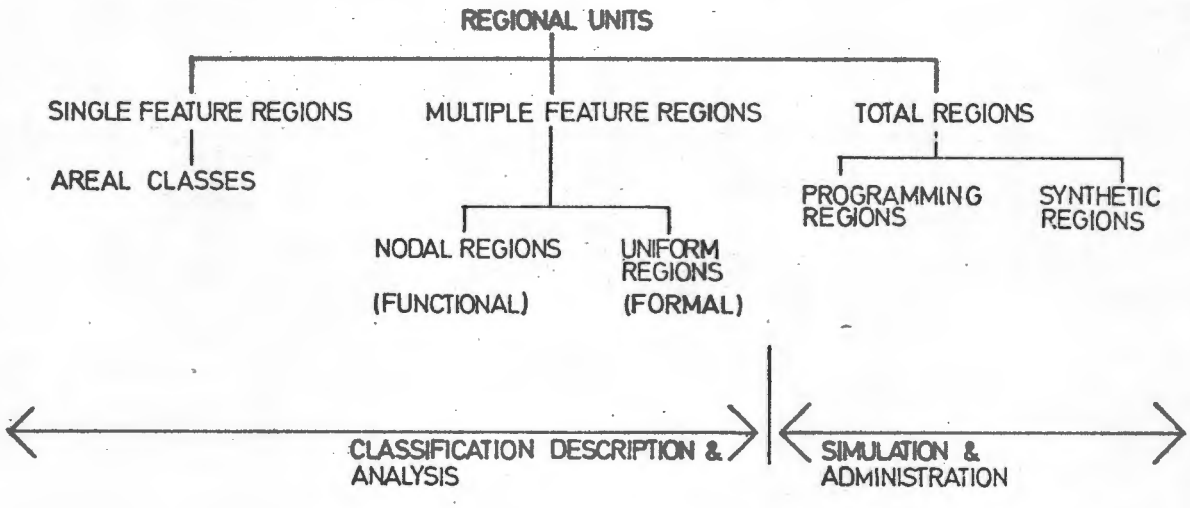
1) Singe feature regional units or areal classes are self-explanatory, in that only one factor is used to determine the boundaries of the region. An example of this kind of region, would be the tsetse fly belt of the north and eastern Transvaal, where the presence or absence of a certain feature (or statistical incidence of that factor) determines a boundary.

2) Multiple feature regions can be divided into two subclasses of Nodal and formal (or uniform) regions. These two types seem to be the most useful in the analytic stages, since they correspond with the node net and surface concepts defined previously.

   Nodal regions are organised in relation to some focus and generally speaking are defined by the lines of communication linked to that focus. The regions of industrial intensity around the Reef, or the Reef-Durban complex are examples of nodal regions that have been intuitively recognised by Planners for some years. Nodal regions are sometimes called Functional regions.

   Formal (Uniform) regions are defined by surfaces and the slopes and gradients of these surfaces. Examples of this type of regionalisation would be the classification of areas according to economic intensity or population density.

3) Total regions: This form of regionalisation is less useful analytically than the functional group, but it important because a great deal of traditional geographic work is available in this form. Regional development associations are also concerned with Total Regions, and other political or administrative functions are best served by total or synthetic regions. The use of total regions in simulation studies has been noted already, but this aspect seems to warrant a distinction between total and synthetic regions, where the former is understood to be a tract of land with some common problems, while the latter is an experimental device made up of Nodal and Formal analytic regions. A diagram will serve to summarise these points:



CATEGORIES OF REGIONS
AFTER HAGGETT 1965 p242

1.2 QUALITATIVE AND QUANTITATIVE ANALYSIS

Regions may well be recognised informally and intuitively. The importance of this has already been stressed in the introduction to the historical review of South Africa (Ch. 2.4) where intuition - based on sound knowledge - is pointed out as an important check on results of analysis and experiment. The section of urbanisation (Ch. 2.6) depends heavily on this method, and the conclusions that can be drawn from this type of analysis are often valuable and informative in guiding research. Qualitative analysis cannot be relied on at all stages in Planning Research, however, and the quantification of regions becomes necessary. The point of quantification is that a certain logical consistency is required which opens the analysis to testing, and further, the effects of changes on the region can be accurately or logically assessed within the limits of available data. In addition, numerical analysis allows the introduction of powerful statistical techniques to assist regional definition. Differences in opinion will invariably occur in spite of the logical processes of numerical analysis. There is, however, far greater chance of tracking (quantifying) these differences if the parties concerned state their methods and data sources clearly. More often than not, it is such differences that indicate fruitful avenues for further investigation.

1.3 CONTIGUITY AND ABSOLUTE LOCATION

Once the basic spatial patterns have been identified they can be mapped and the values of the components can be measured exactly, using dimensional analysis in relation to each regional system pattern or combination of patterns (Berry in Berry & Marble, 1968). Once their similarity is known, the components can be grouped into regions displaying the greatest similarity. There are two possible results of this. A 'region' of similar components where related to its actual'space' co-ordinates, may appear to be scattered over the whole study area. Alternatively, the components may be clustered. There is no way of saying which of these aspects of more valid since it depends entirely on the aims of research. Should the intention be to establish actual space regions relating to some factor, then a contiguity constraint may be built into the analysis which rejects all those components which are neither similar nor contiguous. The implications of the contiguity problem are closely related to another difficulty in regionalism - that of absolute location.

Absolute location is the position of a place or component, usually given by latitude and longitude or a co-ordinate system related to latitude or longitude. The significance of absolute location in regional analysis must not be forgotten in the concern with mapping 'real' as opposed to 'actual' spaces, where relative location is a key factor. The analysis should at some point relate to the practical issues of administration and control, and in that case the actual space co-ordinates of data and regions into which those data are grouped, are very important if the research is to have practical value. The effect of a new link in a road network will distort social, political and economic spaces, but in the end the actual location of that link will have to be ascertained, and the physical effects of the other distortions quantified.

2.2 A FIELD THEORY & PRACTICAL APPLICATION

Berry (in Berry & Marble, 1968, p.419-420) provides a concise and rigorous treatment of regional analysis in terms of formal and functional regions in the development of what he calls a 'general field theory of spatial behaviour'.

He starts with an attribute matrix (place by attribute) which is transformed into a structure matrix (place by spatial variation of attribute) and from that into an interaction matrix (pairs of placed (dyads) x interaction) which in turn is transformed into a behaviour matrix (spatial interaction x functional organisation). These matrices are cross-

sectional in their treatment of time and comparison of such cross-sections could be made.

From this Berry postulates two basic theorems (1968, p.420):

"1.a. Dyadic spatial behaviour is a function of the ways in which the fundamental spatial patterns characterise places.

b. Changes in spatial behaviour result in changes in the character of places as spatial processes run their course.

"2.a. The characteristics of any place are largely dependent on its relationship with other places.

b. Changes in spatial interactions give rise to changes in the character of places."

Berry supports the theory with a set of multivariate techniques as follows:

1. Factor analysis, 2. Dimensional analysis, 3. Grouping analysis.

Throughout these analytic processes the principle that every place must be positioned in a region is adhered to.

The basic rules for the regionalization process are as follows:

1) Places to be studied and their attributes are established.

2) The place x attribute matrix is constructed.

3) The variations of place and attribute, and the spatial associations of attributes are examined and basic patterns are mapped using multiple factor analysis.

4) These basic patterns are mapped after identification and the values of places in respect of each is determined. Dimensional analysis is used to determine similarity.

5) The places are linked into regions using grouping analysis.

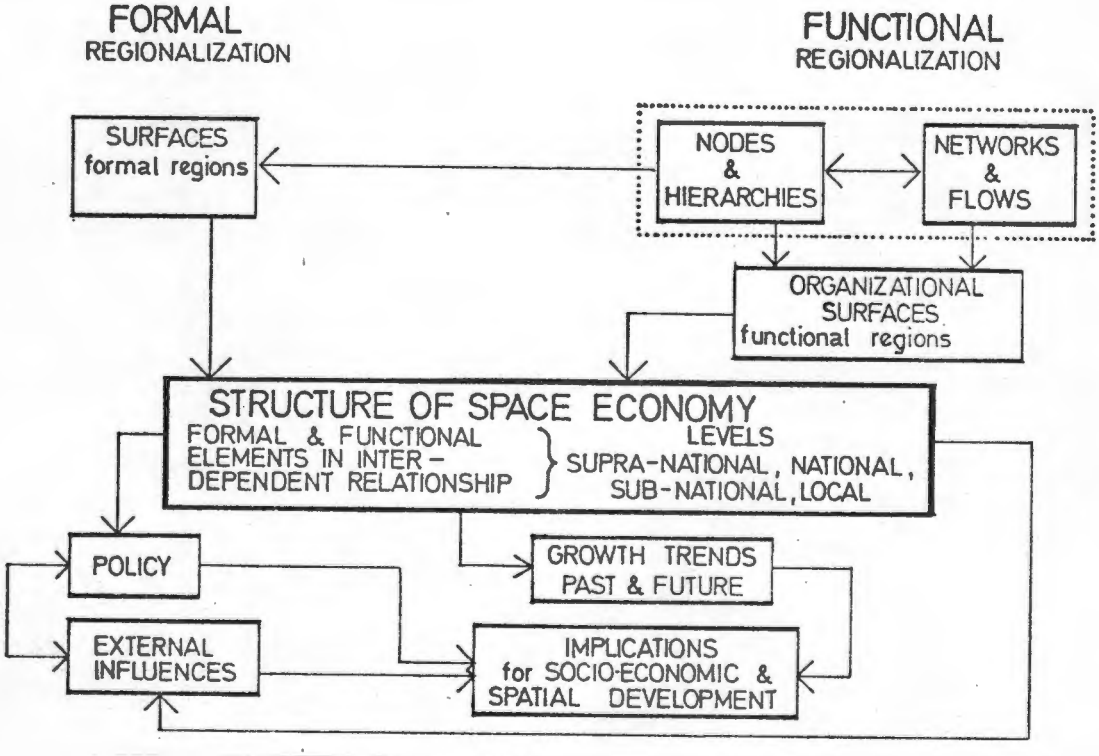
A mathematical statement of the above verbal description is given together with some results of the application of the theory to a piece of research in India.

Two factors make this an important contribution as far as the thesis is concerned. Firstly, it is a method which could well have been used (with some simplification) to continue the S.G.P.M. program. Secondly, it depends on geographic and economic data inputs. Social and political factors are not specifically recognised, but in terms of a previous argument (Ch. 3.1) there is no reason why this kind of data could not be used in this model.

2.3 THE SPACE-ECONOMY OF SOUTH AFRICA

A recent study by Board, Davies and Fair (1970) illustrates a similar approach within a South African context. In the preamble to their study the authors state: (p.367) "Government..., increasingly involved in local and regional planning, finds it necessary to view their efforts in nationwide integrated spatial terms...." The similarity between this statement, and the objectives stated in the program of the S.G.P.M. is marked. In fact, the authors state that the purpose of the study discussed here was to 'present as far as possible an interconnected view of the South African space economy of the early 1960's'.

The essence of the study is a breakdown of the country into surfaces of economic intensity reflecting the underlying formal structure, the status, character and economic level of nodes, network flows of labour and of telephone, road, rail and air traffic, in order to describe the formal and functional spatial structure. Table 3.2.a illustrates the framework of this study.



The method of this study follows essentially the same pattern as set out by Berry above, but the scope of the study has been limited to specific and well defined elements. This tends to limit the study to a purely descriptive effort. The application of the notions of node, network and surface in the South African context is seminal, and the significance of this study lies in its pioneering quality as a first major attempt at a quantified study in South Africa. Since the published article is in the nature of an interim report on an ongoing piece of research it is assumed that the data presented in the form of maps is also available in disaggregated form for further research. Comments in the text suggest that this is true. A second important aspect of the study is the imaginative approach to data and data sources in a country that is seriously short of reliable information for planning purposes.

Once again social and political factors are not explicitly accounted for, but nothing in the methods used suggests that this could not be done.

These two studies are examples of the application of the techniques and concepts which have been described in general terms in these sections. As such they are of considerable importance as models for further research of this nature, and for comparison with the methods adopted in the S.G.P.M. The limitations of both must be borne in mind, however, as far as social and political behaviour and its effects on spatial distribution is concerned. Neither study acknowledges the importance of these aspects explicitly.

3. GROWTH & DEVELOPMENT CONCEPTS IN THE RESEARCH PROCESS

The title of this thesis is 'spatial analysis of development potential' and the title of the research that gave rise to this thesis is 'a spatial growth probability model of the Republic of South Africa'. The spatial aspect of both studies has been dealt with at some length, therefore, before passing on to a detailed review of the S.G.P.M. itself, the growth and development aspects of these studies should receive some attention. Development, it was suggested earlier, is a more general term than growth, which was why the title of this thesis contains that term as opposed to the more specific growth orientation of the S.G.P.M. Both terms are used interchangeably in economics, and there seems to be little distinction between the definitions. Strictly speaking, development would contain many normative connotations which are not easy to analyse. For the purposes of this study, the main point to be clarified is whether the orientation towards these concepts will in any way affect

the nature of the research process, in particular any of the concepts of Regional spatial analysis and methods outlined in the previous sections.

Dr. L.P. McCrystal (1969) argues that there is a positive feedback loop between economic development and spatial distribution of development. The historical review (Ch. 2.4) would seem to support this view in the case of this country in particular and the argument has a direct intuitive appeal as well. If this is so, then the absence from the preceding discussion of any reference to economic growth and development may appear strange. The reason for this omission is that the type of spatial analysis reviewed in sections 1 and 2 would pick out these growth patterns and the interaction between space and growth. Comparison of successive time cross-sections would have to be made to obtain a reliable picture and to determine accurate parameters, but the patterns would nevertheless emerge. It has been postulated throughout this thesis however, that patterns are not recognised unless looked for, which is why a 'language' of spatial distribution patterns was built up to try to assist this recognition: Some of the main topics relating to economic growth and development are outlined here in a similar attempt to sketch some of the main patterns. These topics are then related to a study of development patterns in South Africa where some differences of opinion will become apparent.

3.1 GROWTH & DEVELOPMENT - DEFINITION AND DIFFERENCES

A critical factor in economic growth is the level of investment in the economy. Variations in the level of investment will directly affect the productive capacity of the economy. Obviously the productive capacity of a country changes slowly, which would not explain short-term variations in the growth rate. These variations are explained by the fact that in the short term there are changes to the percentage utilisation of the productive capacity. Thus the first major point to be made in the consideration of economic growth (as measured by growth rates) is that comparative income figures should be divided into two indexes - changes to the growth rate (absolute and productive capacity) and changes due to variations in the use of productive capacity.

The growth rate itself is measured in many ways; money national income, real national income, per capita income (as a measure of living standards) or the rise in total output/man hours (as a measure of labour productivity). The highly aggregated nature of many growth indices make interregional comparisons very difficult. Such measures should be critically analysed

and the origins of the data allowed to limit the generality of conclusions drawn from them. It would seem at this stage of economic research that no really sinsitive or reliable measure of economic growth has been devised. Except in the case of homogenous and well developed economies, most growth rate indices hide broad variations in levels of productivity and living standards within the regions of which that rate is measured.

If direct measures of the growth rate are likely to lead to distortion, it may be possible to assess the level of the economy if the causes of growth are understood. Capital accumulation, level of technology, education and physical health are obviously related to growth. Unfortunately the structural relations between these and actual productive capacity is not clearly understood. Social and legal parameters are also important, but again the level of analysis of these is mainly intuitive.

It would seem that because of this dearth of sound theoretical explanation of growth processes, empirical studies will have to be used to establish parameters and variables in particular cases. Once the main causes are understood, these factors could be isolated and studied at different time sections and their interactions with, say, surfaces of economic intensity, investigated. This type of study would be the first step towards establishing a set of structural equations that would be used to build a simulation model.

The object would be a statement such as: given quantity x of education at cost y, the effect would be an increase in productive capacity of z over time period t.

When considering growth, it is not only the causes of growth that need to be investigated, but also the effects, or the Costs and Benefits. Resources are scarce, thus to achieve a certain future growth rate requires investment in present time with resulting reduction in immediate availability of consumption goods. This opportunity cost of growth in terms of investment and consumption goods can become a major political and social factor, where immediate comforts are sacrificed for long term gains since in the long term we are all dead, as Keynes said.

The social effects of growth in terms of 'structural employment' is another factor of potentially important political concern.

DEVELOPMENT:

As measured in economics (specifically with regard to underdeveloped economics) development is an extension of the concept of growth, in that the factors measured are those which would affect the productive capacity of the economy concerned. The factors that 'cause' underdevelopment are the same as those that lead to an increase in the growth rate; capital accumulation (measured by saving and investment), education (skills), technology (culture), social and political factors and so on.

A wider meaning of development which sets it apart from simple 'growth' is when it is taken to include concepts of economic health or welfare, when the distribution of income and potential for further development are implied concerns. An interesting example of the application of this is to be found in the article referred to in section 2 (Board, et al, 1970) where economic volume (G.D.P./magisterial district) and welfare (based on a principle component analysis of 15 variables) is used to outline a socio-economic landscape for the country.

Development in a normative sense - that is, not of necessity related to growth - is a difficult concept to define. It could happen that a socio-economic system does not need to grow continuously to be able to maintain itself. This steady state implies an equilibrium condition resembling the perfect competition model where production = consumption, inputs = outputs, births = deaths and so on, in a situation where there is no apparent contribution to increase in productive capacity. These situations might actually occur in an economy but overemphasis on growth economics does not allow them to be recognised. It is also conceivable that an economy of a very high level of technological (and social) sophistication would achieve such balance on a large scale, but the present state of economic theory and policy-making would make these states difficult to recognise and to achieve. This hypothetical state of balanced <u>development</u> opposed to balanced <u>growth</u> serves to accentuate the fact that slow-growing or 'stagnating' communities are somewhat arbitrarily treated by theory, without any attention being paid to the question of whether growth (productive capacity) is in every case a measure of social, economic and political health.

This is a subtle distinction to make, and very little evidence can be brought to support it, except to remark that tracts of undeveloped (in the sense of unproductive) land are essential in an urban environment, for recreation, breathing space and other forms of amenity. It is in this sense that this point is made, where criteria could be set up to

determine when areas might be left to 'stagnate' with benefit. Analysis of a high degree of refinement is required for this, but again, unless the pattern is known, it will not be looked for and therefore not recognised. There may, for example, be regions where the optimum form of development would be conservation (of a natural state or an existing community) and in that case a system of quantification must be established which allows such 'soft' development to compete with 'harder' forms of development in the analytic and simulation stages of model building.

It is in this sense also that Bauer's comments on development economics (1969) are pertinent. The application of western economic development techniques to non-western societies and cultures, is a questionable activity and has seen many failures. In South Africa his warnings on this score should be particularly carefully heeded where three-quarters of the population are non-western in origin. It would seem reasonable to expect that economic theorising on these issues should be tempered with considerable sociological research before policy recommendations are made. The plural nature of this country's society makes generalisations unreliable in both research and administrative spheres.

3.2 DEVELOPMENT, GROWTH & SPACE IN THE SOUTH AFRICAN CONTEXT

A significant piece of research into the relation of growth to the space economy has been carried out by Dr. McCrystal of the Natal University. Since this is one of the few works of its kind commonly available in South Africa (McCrystal, 1969) it is worth commenting on it here, since its implication both for policy making and research methods are valuable. Dr. McCrystal undertakes a study of the South African economy with emphasis on the manufacturing industry, in which he attempts to establish the 'stages of growth' of the economy. Much theoretic work is quoted from overseas sources to establish a conceptual base. Comparative studies of growth rates, rates of decentralization and dispersion, policies for the same, and effectiveness of those policies, are carried out related to USA, Australia, Canada, New Zealand, United Kingdom and Italy. A brief analysis of urbanisation caused the author to establish the optimum largest size for any city in South Africa to be 300,000 people. A great deal of painstaking research, including interviews with 76 industrialists on location decisions, brings him to the conclusion that dispersal policies will work only after a certain level of economic development is achieved. Furthermore, this will most likely not be a natural process and will require Government intervention. Policies for this intervention are suggested, where site selection, transport linkages, psychological factors and fiscal measures are

considered. Since a great deal of the author's argument in this book rests on the establishing of the stage of growth of the South African economy and the relationship of that growth to the degree of urbanisation and structure of the space economy in general, some comments on the methodology are warranted.

Dr. McCrystal's argument is weakened on several counts if the postulates of this thesis have any significance. In his book he makes no reference to the plural nature of the economy, and the major socio-political factors revolving around this fact are not taken into account in his analysis. The arbitrary fixing of urban size at a maximum of 300,000 as well as the environmental factors and the historical causations that led to the growth of the existing urban pattern leads to considerable distortion of the logic. In addition, the comparisons with such widely diverse economics as the U.S., Italy and New Zealand, are not weighted in any way to compensate for some of the major structural differences in the S.A. economy, which makes such comparisons of doubtful value.

His argument established that dispersal may not be a solution in South Africa at present; in spite of this he outlines a strategy for dispersion should this be decided on. This strategy suffers from the same weakness as the main argument, where a deterministic attitude to spatial location limits the general application of the strategy. Location of an industrial unit is considered relative to existing centres and transport links only, and little cognisance is taken of the social and political systems. The wider effects of some of the strategy is not realised, and methods of accounting for costs and benefits (themselves not fully documented) are not mentioned, neither is there any mechanism for determining the opportunity cost of investment and location decisions.

Simplistic attitudes to complex situations, usually due to transplanting theory without due regard to the constants of the particular system being studied, are limited in application. Simplifying assumptions made to permit international or interregional comparisons, lead to distortions that render conclusions meaningless. Criticism is made in order to show that growth and change cannot be isolated from urban/regional system without reference to an integrated view of the whole system. If McCrystal's argument could be placed in a wider framework which would permit full testing of the location and investment decisions he discusses, it is felt that his conclusions, although possibly not basically different, could be made with far greater certainty.

3.3 SYSTEMS, ENERGY & INFORMATION: A POSTULATE

The concept of energy and information are mentioned again briefly since the author feels that measurement of growth and development could well be made in terms of energy and information flows. Considerable work has been done on the consumption of energy in different types of society (Cork, 1971) and it is postulated that a measure of energy flow, or consumption such as daily per capita consumption measured in kilocalories, would serve as a more useful growth indicator than the economic indicator used to date. Data of this kind could serve to distinguish between contemporary regions and between differed stages of those regions over time. The energy flows and consumption patterns are quite different in the U.S., South Africa and say Tanzania, at present, and these patterns would vary significantly between different periods in this country's history. The patterns before the discovery of gold, and after the second world war would show interesting structural changes. The level and distribution of energy in a country or region can be regarded as a superior measure of development compared with economic measures. A kilocalorie is a neutral and unchanging quantity, obviating the need for price adjustments, and the concept of energy inputs and outputs are so basic to systems operation, that many of the subjective overtones of traditional growth and development measures could be avoided if relative efficiency can be calculated from energy wasted and energy converted into work.

Similarly, information seems a likely candidate as an alternative measure, especially when such factors as technology and education have to be quantified. Information theory is well beyond the scope of this discussion, but one point worth making is the relatedness of information and energy. (Tribus and McIrwine, 1971)

These concepts would seem to have great significance, although many theoretical difficulties exist, not to speak of available data. It may well be worth considering, in a research project, the relative costs and benefits of collecting information on the productivity of labour or the flow of energy in a region, if the intention is to measure growth.

4. SUMMARY

In this chapter several important subjects were discussed which have a direct bearing on the methods that could be used in a research study such as the S.G.P.M.

The main point made is that given a systems theoretic background, urban/regional systems can be discussed, analysed, and put together in various forms to suit research purposes. This process depends mainly on a pattern-recognition process for its success.

In section 1 these patterns are shown to be relatively simple, and a basic language on nodes, networks and surfaces, is outlined. Movement over time and space is also considered and found to have certain recognisable characteristics itself. Types of data that relate to these patterns are considered, and particular forms of data are found to relate to particular system forms and movement patterns.

The question of regional analysis, which is considered mainly with defining regions, is discussed. Regions are taken to represent both actual areas of land and analytic devices.

Regions as analytic devices are grouped into three categories, single feature, multiple feature,(Formal/Functional) and Total regions. The purposes and nature of each category in the research process is discussed. Specific problems of qualitative and quantitative analysis, and the problem of location of factors in actual space, are discussed briefly. The conclusion is that although qualitative work is valuable, quantification is necessary for experimentation, and in order to preserve the reality of a study, absolute location of factors in the analysis is a necessary constraint.

Two examples (Berry, 1968 and Board et al, 1970) are discussed, the first a field of theory of regional analysis and the second an application of that theory in South Africa. The integrative aspect of this research is of utmost importance.

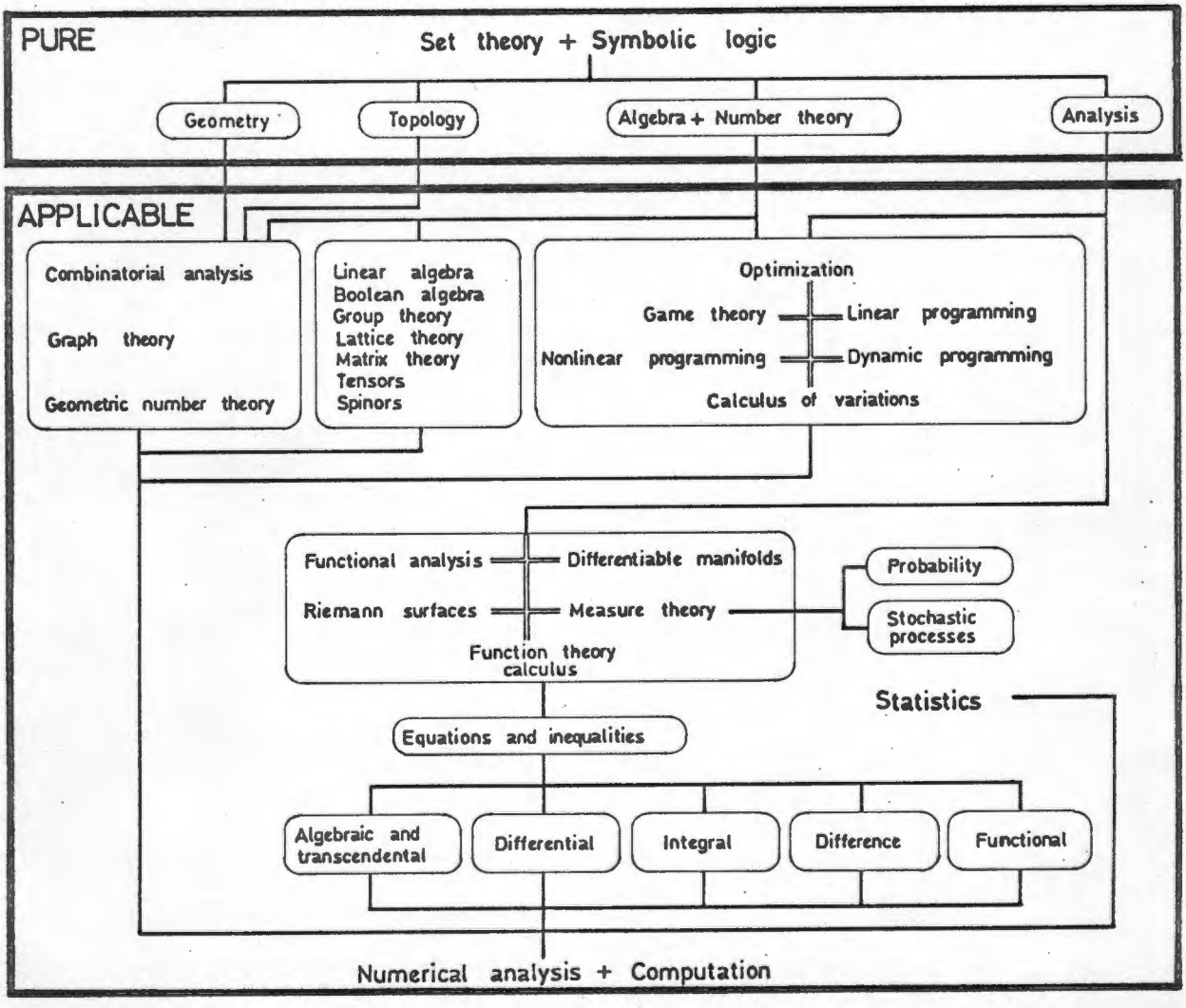
Lastly, growth and development is discussed, where the implications of these measures in relation to spatial analysis is the subject of inquiry. A description of growth concepts, development as distinct from growth, and a review of a book by McCrystal (1969) which deals with these subjects in relation to the space-economy, leads to the conclusion that growth can be measured only with references to the whole socio-economic system. The same criticism applies to

decision-making in general, where reference to arbitrary growth indicators can lead to sub-optimal policies.

Finally, the idea is put forward that energy flows and information flows might provide useful and comparable measures of the efficiency of growth and development in system terms if single indicators of these factors are necessary.

5. NOTES TO CHAPTER 3

N1 MATHEMATICAL DIAGRAM



N2 DISTANCE:

Isard (1969, p.871-874) describes a useful method of defining effective distance (d_{ij}) between vector categories or places i and j as:

$$d_{ij} = Z_{ij} \quad W_{ij}$$

Where X is a vector in N-dimensional space where each component measures one aspect of distance (physical, transport cost, social, political and so on) and W_{ij} is a weight vector in N-dimensional space, each of its components being the weight applied to the respective component of the distance vector. The first element of X_{ij} is multiplied by the first of W_{ij}, the second by the second, and so on to the nth component. The n products are then summed to yield the scaler d_{ij}.

This scaler recognises that distance between two components of a system will vary for each limit of transaction between them.

N3 Berry & Marble (1968, p.5) regard functional and structural data in the reverse order as stated here. The author feels sure, however, that structural data will describe structure - which implies connection, and functional data describes function - that is the inherent qualities of component that determine their position in the structure of the system. This method would seem to be in keeping with the definition of systems expressed in Ch. 1.3.

CHAPTER FOUR: synthesis

1. S.G.P.M. - CRITICAL ANALYSIS

The ideas put forward so far in the thesis are now brought together in this chapter. A piece of research done in the Department of Urban and Regional Planning at U.C.T. is used to illustrate how these concepts could be integrated in a research project. As was pointed out previously, the main purpose of this thesis is to devise a methodology which could be applied to the problems outlined in the S.G.P.M. project, and also to build up some background knowledge which could better inform particular approaches to that project.

This project was undertaken by the 10 members of the second-year class of post-graduate students in 1969. It took five months to complete, working mainly in the evenings and over weekends. Because it was a student project, time and money limited its scope as did a lack of sound statistical knowledge. These factors must be borne in mind when judging the results of the project. It must be seen in its context as an educational device to introduce a group of students to

the concept of regional analysis. In spite of this, there are some important ideas which the project outlines, which can be grouped into two sections: Firstly, ideas about an integrated view of the urban/regional system of a country and the significance of this for decision-making, and secondly, the problems of method that arose during the course of the project.

The success or failure of the S.G.P.M. in relation to these will be pointed out and some new directions will be proposed. In this first section, criticism of the S.G.P.M. will be in detail, and in subsequent sections, where different methods of approach are proposed, more general criticism will be pursued.

Note: i. The program for this project is reproduced in Appendix 1 (A.1.1). ii. A brief summary of the project itself appears in Appendix A.1.2 to A.1.5. iii. In order to preserve continuity of discussion some of the detailed criticism is given in the notes to this chapter.

1.1 OBJECTIVES - EXPLICIT & IMPLIED

The broad intention of the project as expressed in the program (A.1.1), and as understood by those who worked on it, was to find a way in which investment on a national scale, especially by the public sector, could be rationally allocated to that location in actual space where it would generate optimum growth. Location of investment came to mean location in actual space, and allocation between sectors of the economy. Within these broad goals which were specifically expressed, there were implications which are worth mentioning since they add a more realistic dimension to the study. There was obviously an implied dissatisfaction with the way the national government allocates its investment, which is a natural dissatisfaction that planners feel in most countries. The logical answer to this is that given sufficient information, or the opportunity of investigating alternatives on a properly comparable basis, such decision-making might be improved. There was a similar dissatisfaction with planning research itself, both in respect of work done in the School and in general. This dissatisfaction stemmed from the notion that many planning studies are rather parochial in that they tend to concentrate on a particular place, outlining its problems and solutions to those problems without due regard for its relationship with other places. Further implied concern was that it would be very useful to have a device which could put the claims and demands of vociferous Regional Associations into a national perspective.

These broad goals can be summarised in point form as follows:

1) To assist in rational allocation of investment according to place by making the opportunity cost of that investment apparent.

2) To test Government policy with regard to this allocation.

3) To broaden the concerns of Planning research into an integrative or systems view of the national or interregional economy.

4) To test claims of vested interest which could influence the allocation of resources.

The actual immediate objective of the study was more specific than this. It was expressed in terms of the program as a study of factors of the economy which could be considered growth factors. The objectives being to put these together in a model so that the likelihood of growth, or potential for growth could be assessed for different parts of the country.

Throughout the course of the project, these objectives generated discussion in two fields, that of context and method. The idea of developing a way of testing major policy decision on a positive basis became quite fascinating, on the other hand the methodological issues that intervened between intention and goal seemed insuperable.

The objectives of the project itself then can be summarised as follows:

1) To decide on an areal grid for location of data.

2) To collect data relating to growth factors within the framework.

3) To build a model with this information according to the limitations of readily available or measurable data and by a process of trial and error, determined largely by the nature of the data.

4) To achieve a form of model within the constraints of time and resources even if strong simplifying assumptions became necessary.

5) To limit the study to a static framework based on the 1960 census.

1.2 OBJECTIVES & RESULTS, LIMITING ASSUMPTIONS

The S.G.P.M. must be criticised in two ways. Firstly, it must be judged within the context of its own stated objectives, and the second evaluation must take account of its richness in terms of indicating new directions and possibilities. This sub-section attempts the first kind

of judgement, making use of the ideas put forward in this thesis. The following sub-section (1.3) deals with the new directions indicated by the project.

Strictly speaking, the program was carried out with a moderate degree of success. A growth model was constructed for the Republic, in which growth potential indices for a group of factors were assembled for the economic regions of the country. If one assumes these indices are reliable, it is possible to tell which regions show most potential for development in a given sector of the economy. More than this is not possible, because of limiting assumptions in the construction of the model. These limiting assumptions and their effect on the integration of the factor indices into the model, will be discussed first. The reliability of the indices used is dealt with subsequently.

LIMITING ASSUMPTIONS:

1) Time:
The decision not to take account of trend data is understandable in the context, but imposes strong limitations on the model. Even if the eventual model is static with respect to time, some study of trend data should have been made if only to give more substance to the weighting of growth factors (N1).

2) Areal Grid:
The uses of economic regions as an areal grid is also understandable in a project with limited resources, in fact it is difficult to see what other method could have been used in the time available. However, no attention was paid to the distortions caused by such a grid and the comparability of much of the data is therefore limited (N2).

3) Politics:
Politics was to be treated as an exogenous variable in the project. This was a reasonable assumption since the idea was to test policy, therefore to built it into the model would seem to be illogical. However, it could be argued that this was a rather idealistic point of view, and in fact tends to limit the reality of the model. Simple assessments of accessibility to decision-making might have affected the weights of certain factors (N3).

4) Power:
Power was also omitted as a growth factor in the model, since it was held to be ubiquitous due to the development of the National Grid System by Escom. This can be said to be one of the least justifiable assumptions in the model, if one considers that its inclusion could lead to large changes in the growth potential indices (N4).

5) Education:
The spatial distribution of education facilities and the effectiveness of these; the proportion of skilled and educated people per region, and the effect of this on growth, was not accounted for. A few indicators were included to partially compensate for this, (See factor analysis, Population and Social Capital, A2) but are inadequate. Data and time are the justification for this omission, but again relatively simple measures such as the area of influence of a university (which could have been obtained from the University of Cape Town Planning Unit for example) could have been included. With Power, this is considered to be one of the major omissions in the model.

6) Theory:
The theoretic base of the model was weak, in that no specific bias towards any particular theory was expressed other than basic notions about cumulative causation, which affected the weighting of factors at the data processing stage. A common-sense view that urbanisation affects growth positively was held generally by the class, which also affected factor weighting. The industry weights emphasise comparative advantage. Apart from this it cannot be said that any particular theory influenced the structure of the model. Generally speaking, lack of particular theoretical inputs is not considered a major disadvantage in view of the purely descriptive nature of the model, but further development of the model would need much closer attention to this aspect.

7) Method:
Method obviously includes theory, but rather more specific theory than that discussed above.

There are firstly the methods used to analyse each factor, and secondly the method used in the construction of the model itself. It is not the intention here to go into the method used to analyse each factor, but rather to discuss the method of S.G.P.M. in general. The two are linked in that weighting procedures were used in both cases, but they will be discussed separately.

A general comment must be made first; although there was no specific approach to the problem of method, which could be construed as a weakness of the S.G.P.M., one must be careful in criticism here to distinguish between what <u>was</u> done and what <u>could have been</u> done. At this stage the author is looking at what <u>was</u> done. Subsequent sections will deal with what could be done.

The basic method was simply to collect data in whatever form available, and process that data so it could be allocated to economic regions if not already in that form. The data was processed further by isolating a set of weights so as to arrive at comparable index numbers of growth potential per region per factor.

The final table of growth indices was then weighted in relation to industry, agriculture and tourism in turn (A.1.4) and the best scoring regions for each factor picked out.

This system of component standardisation through ranking and weighting is quite a common method, being simple to operate. Depending on the original data and the intelligence of the weighting procedures, it is reasonably reliable.

Refinements could have been made, however, which would have rendered the results more realistic. For instance, all factor indices below 1.0 were rounded up to unity, sometimes from as low as .03 and even 0 (in the case of minerals).

The weightings used in the final working of the model (A.1.4) are very arbitrary, and the weighted tables (not included in the appendix) must be considered as a purely arithmetic exercise. The basic index table is the key to the model, and given the reservations expressed above, remains a viable piece of research (N5).

1.3 OBJECTIVES & RESULTS - RELIABILITY INDEX

This aspect of the model is the most questionable. Again, from the point of view of what was done, there is nothing intrinsically wrong with the weighting system used. It should be realised however, that the intuitive methods of weighting adopted in most factors (except possibly industry and social capital) were in effect replacing sounder and more reliable methods. The worst aspect of the weighting system as used here was that the hypotheses on which the allocation of weights were based, were rarely clearly stated. The effect of this is to render the entire model useless as far as testing, replacement or development, is concerned. Since there are no explicit hypotheses stated, it is difficult to criticise this model.

It is suggested that the lack of formal statements of hypotheses is the most important criticism of the whole project - the soft underbelly as it were - which allows value judgements to be made about its general

effectiveness and applicability. It is also suggested that this weakness is due to a lack of attention to methodical procedure and critical analysis. Because the author was involved in the project he can say that in his opinion, most of the reasoning that went into these indices was valid, and that they are reasonably reliable, but there is no possibility of repeating the process that went through the minds of members of the class as they assigned weights to factors. Replication is a prerequisite of any piece of research. It is further postulated that much of the work is not repeatable in that future workers could assign their own intuitive weights according to their own private hypotheses and arrive at widely divergent factor indices.

If this project were to be repeated in the same form, the first step should be a set of clearly stated hypotheses about the relationship of the factors to growth potential. This would establish a framework for the allocation of weights. The intuitive approach to weighting need not be limited by this, but opens that procedure to criticism, testing, repetition and replacement.

3.1 SUMMARY AND ASSESSMENT:

Some of the limiting assumptions may have affected the validity of the model (e.g. the omission of power, education and politics), but the other assumptions, although serious at first sight, can be considered as refinements if relaxed, rather than major structural changes. In considering the methods used for allocating weights, however, the reliability is questioned because the hypotheses which generated the weighting factors are not explicitly stated as part of the model. If one accepts that the weights are reasonable then the model as a whole is a valid answer to a given research problem, and achieved its objective by using a simple and direct method well suited to the resources available.

However, the criticisms outlined in this section when taken together, cast some doubt on the validity of the model in its wider relevance. It is with this aspect that the next section deals.

1.4 OBJECTIVES AND RESULTS - A WIDER CONTEXT

In the foregoing sections the S.G.P.M. was analysed strictly within the context in which it was set, i.e. as a 'study of differential growth potential factors in the Republic of South Africa, and their synthesis in a spatial growth probability model' (A1). In this context it was found to be an adequate answer to a problem. Given a modicum of refinement it could be converted into a useful and quite reliable descriptive static model of the S.A. space economy. Judged by the standards implied to the broader intentions of the project, however, the model must be regarded as a failure. The four goals outlined in 1.1 above, which included concepts of opportunity cost, testing of policy, a systems view of the nation, and testing the claims of pressure groups, have not been achieved. To a limited extent, a systems view of the economy began to emerge, but not in an explicit or structured form. The quantitative testing of policy, where a given investment in an area or sector would have to be judged according to its effect on the space-economy as a whole, is not possible (N6). The measurement of opportunity cost in this respect cannot be achieved. The purpose of this would be to assess the value of a given investment in relation to the returns of that investment in alternative uses - in different locations or different sectors. Because the interconnections between factors are weakly specified and the factor indices themselves are arrived at through weak hypotheses, the possibility of putting additional data through the model is limited, and it must be regarded as a closed model with very little predictive power.

The extent of prediction in this model is the projection of an existing growth pattern arrived at through analysis of existing socio-economic conditions. There are no opportunities in the model for effecting structural changes to those conditions, which is what would have to be done to test new policies.

The question now arises whether there are any indications in the model that point towards the possible achievement of these goals. In a critical analysis contained in the explanation of the S.G.P.M. several areas of concern were outlined by the authors of it. These are given here to indicate the kind of thinking the project generated.

1) The limitation of the economic regions data grid were realised, and the possibility of using different grids for different factors was mentioned.

2) The omission of time was recognised as a drawback.

3) Lack of statistical insight was also recognised as a drawback.

4) On-going research - several areas of work were outlined. The analysis of factors to express their interrelationships and effect on growth and change, together with a critical attitude to published statistics, should be undertaken. The importance of adding data to the model and putting data into the model was realised, and it was suggested that the lower growth regions might be isolated as a separate study.

If the success of the project can be judged by its richness in indicating further avenues of research, the S.G.P.M. can be regarded as an unqualified success.

To sum up, one can say that the model itself, within a limited context of the objective set by the program, was moderately successful. It worked, and could be made to work very efficiently within that context using only slight refinements of method.

Taking the broader intentions of the project as a whole, however, the model is a failure. It is static, closed, and deterministic. It cannot be used to meet any of the testing requirements. In order to achieve this, a complete recast of the model would be necessary.

In terms of indications for future research, the project was extremely fruitful, where areas of additional work were outlined by weaknesses in the model as they appeared. It is this aspect that the author is most concerned with. This direction will be explored further in the next section.

2. S.G.P.M. - RESTATEMENT & NEW DIRECTIONS

In the previous section it was shown that the S.G.P.M. fell far short of answering the problems set by the broader intentions of its original program. The reasons are to be found partly in the detailed criticism of the project, but more important reasons for the failure will be mentioned here. The possibilities for further work will also be discussed and some new directions proposed.

The author must make it clear that the S.G.P.M. itself is no longer under review, although for convenience these letters will still be used as a reference to the program. It is in effect the program itself which is being reviewed, since it has brought to light some extremely important issues. The S.G.P.M. is taken as one possible and very limited

answer to that program. The intention here is to devise a more comprehensive procedure, with the advantage gained through experience on the S.G.P.M. and in this thesis, which will permit this program to be carried out and possibly extended in scope.

If the S.G.P.M. is looked at in relation to the ideas put forward in this thesis, a number of critical weaknesses appear. The first of these is a disregard for sound methodical approach to a piece of research. The ad hoc basis is inadequate to cope with the collecting and processing of massive amounts of data necessary in such a program. Added to this is the need for a synoptic overview which can synthesise that data into a meaningful model in order to build up a useful and comprehensive tool for planning research. Thirdly, insufficient detailed knowledge of the system being studied can impair the explanatory power of the models of that system. It is often said that models, and predictions from models, are only as good as the data put into them. However, the author suggests that the data in turn is only as good as the insights that the researcher has into the workings of his prototype system. In other words, an intuitive understanding of the prototype system, which permits its primary patterns to be recognised, is as important as having reliable data.

The concepts discussed in this thesis are proposed here as a set of ideas which could structure the approach to the problem set out in the S.G.P.M.

1) A scientific process is aimed at, with models as integral experimental devices, such that hypotheses may be constructed, tested, refuted, adjusted, or replaced. The aim would be models of predictive power which could be built up from less ambitious models through careful testing and evaluation of results.

2) An integrative overview can be considered essential, both in the method of research itself, and in the formation of hypotheses about the prototype system, where the interaction between components and the position of those components in space, is stressed. A consistent and logical systems approach to the problem seems likely to yield greatest benefit in terms of the explanatory and predictive power of research results.

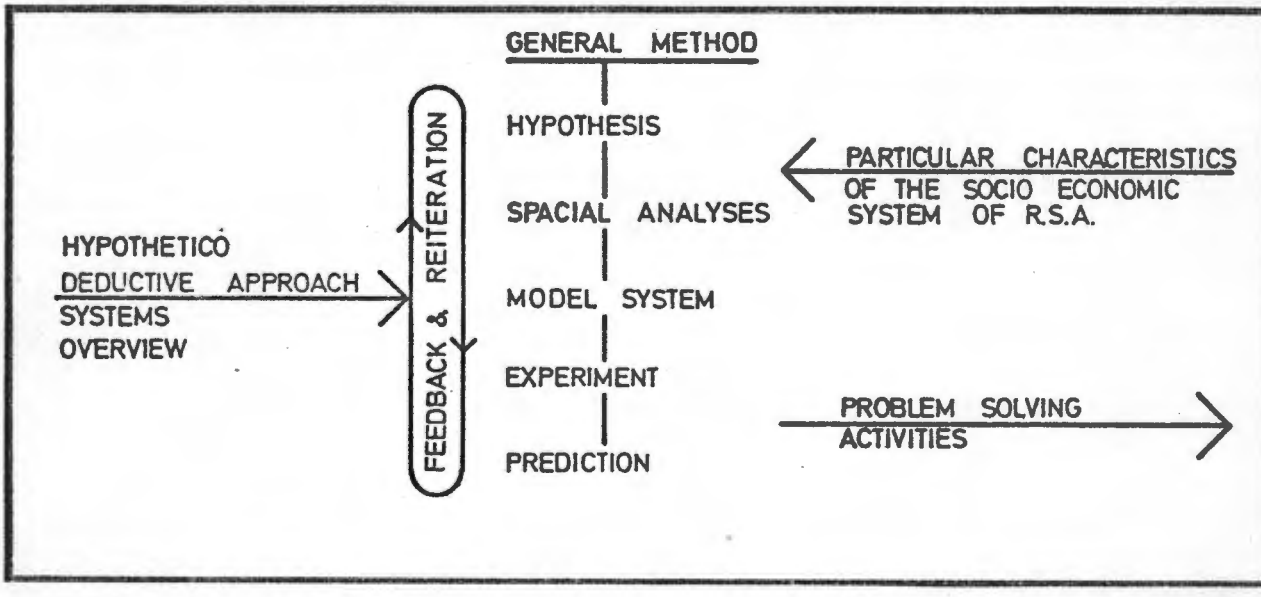
3) Based on this systems approach, a program of spatial analysis could be undertaken bearing in mind the concepts outlined in Chapter 3.

4) Detailed models of the prototype system could be built up using these forms of analysis which would enable the broad goals of the S.G.P.M. to be achieved.

This is a generalised picture, and therefore not very realistic. It does emphasise four major points which could form the core of the approach to the S.G.P.M. problem. A system of models is proposed, built up by means of spatial analysis of the national socio-economic system based on a systems view of human behaviour and underpinned at all stages by a logical and critical approach to method and hypotheses.

This formulation can be regarded as being applicable to most research situations of this kind anywhere, but an important matter that has been brought out in this thesis is that there are forces in this country which must be recognised as having a direct bearing on the course of any research that is undertaken. It is not sufficient to say that these forces will be automatically taken care of and analysed in the research process. It is suggested that they be explicitly accounted for, and moreover used as key factors through which the more subtle aspects of the national socio-economic system could be uncovered. The political structure of the country is one of these factors and a second is the transport and communication network. A third is the country itself, including the natural characteristics of soil, topography and climate. The author has picked out these three aspects of the national space-economy from the work done in this thesis. There may be others, but the point to be made is simply that any system will have distinguishing characteristics which could provide clues to guide the direction of a research project such as the S.G.P.M.

A diagram will serve to illustrate these ideas more clearly:



Here one can see the mainstream of research with the normal stages of formulating hypotheses, doing the analysis, building models for experiment and prediction. Between all these would occur the usual feedback loops and iterative processes that take place as results are checked, errors discovered and models reworked. This process, however, is structured on the one hand by the basic notions of scientific reasoning and the systems view discussed in Chapter 1. On the other hand, a vital impetus is given to the research by the particular characteristics of the Republic of South Africa socio-economic system. The application of the research to problem-solving must of course not be omitted. Note that no statements are made at this stage about the scale of the project, or inputs that may be needed from other disciplines. It is postulated that if this framework is used to support the S.G.P.M. research, then the actual projects could be expanded or contracted to fit with available resources as required. But regardless of the scale of the project, the results would be reliable or at least subject to testing and logical criticism. Although this framework would establish a basic qualitative standard of research, general applicability is not ensured, and the problems posed by the S.G.P.M. have not yet been fully answered.

A restatement of the goals of the project is not necessary. Sufficient evidence has been brought forward to suggest that methods of analysis do exist which permit such a study to be carried out with fair chance of success. Such analysis would have a twofold purpose in that it would lead to a refinement of the theoretic base in Planning and would also have practical application in terms of the goals stated here. What does need restatement, however, are the immediate objectives of a research program to achieve these goals.

It will be remembered that the four broad intentions of the S.G.P.M. were to test in detail the efficiency of investment location in terms of costs and benefits, and especially opportunity cost, to test administrative policies, to place the claims of vested interests in perspective and to widen the application of planning research. So far only the last point has been made possible. In order to achieve the first three goals, a detailed specification of the research process will be necessary. To this end, three possible directions of research are explored, divided crudely into short, medium and long term solutions.

The first can be considered as an extension of the S.G.P.M. (that is the model itself), involving refinement in method, but no major renovation of the method. The second would demand recasting the method of the S.G.P.M., and would be a larger scale project, and the third would

require total replacement of the model and could conceivably lead to a large scale on-going research project involving many disciplines.

These three directions with some of the analytical methods that might be applicable to them, are sketched in the next section.

3. THREE PROPOSALS

The intention here is to outline briefly three possible ways of achieving the goals of the S.G.P.M. The significant thing about the different proposals is that in all cases, the underlying method will be the same. Although their individual success relative to the goals of the S.G.P.M. will vary in degree of explanation and prediction, and to a certain extent in accuracy or detail of prediction, they can be considered as members of the same family. The purpose in describing three proposals is to show that the ideas covered in the thesis can apply to research projects varying widely in scale. Basically this is an illustration of the postulate that if it is desired to explain and to control urban and regional systems, there is a fundamental language of method which can apply to the research project aimed at fulfilling that desire. The S.G.P.M. highlighted such a desire, and because of the scale of prototype system, the solutions to the problems set can vary greatly. Therefore, it is taken as a useful way of investigating the validity of the above postulate.

3.1 SHORT TERM PROJECT - REFINEMENT OF S.G.P.M.

The essence of this proposal is that it accepts the method of the S.G.P.M. where factors of the economy were analysed and a method of component standardisation was used to render these factors comparable. This was done by using growth potential as an index for each regions from which the potential returns on investment in that region could be (intuitively) assessed.

Given the refinements expressed in the criticism of this project in section 1, this model could be developed into an accurate descriptive model. Additional factors could be included that would increase its scope and a reformulation of the comparative weightings of the index table (in relation to the particular growth factors) could increase its general application. The requirements for refinement of the model are as follows:

1) Formulate hypotheses (even if intuitive) affecting the allocation of weights to indexes very carefully and clearly to allow testing and reiteration.

2) Add factors such as Political structure, education and power to make the model more general.

3) Use statistical methods to account for major distortions (see notes 1 and 5).

4) Establish the theoretical basis which informs the data processing stage, and clearly formulate hypotheses here as in 1. above.

5) State clearly the boundaries of the model system with respect to time, space and data, and also establish clearly the limits of application of the model.

The data processing and analysis stage of this model are critical (as in any model) and determine the limits of the model's use. If the same method is used, then the benefit of a fully integrated approach to the space-economy will not be gained. In spite of this, the relative importance of many economic factors are spatially located, and given a quantitative evaluation in terms of growth potential. As a tool for decision-making, barring gross errors, it is better than no frame of reference at all.

The concepts in this thesis can be applied in a general way, in that hypotheses are clearly formulated; the systematic structure of the economy, although largely unquantified, will inform the construction of these hypotheses; the particular characteristics of the country will also define the kind of factors to be included and will directly affect hypotheses about weighting of indices.

It is suggested that this proposal could be carried out with a group of students similar to those who worked on the original project and in the same time if the existing S.G.P.M. were used as a base. The data could be updated for the 1970 census, and as further information becomes available.

The use of this model in terms of the goals specified is obviously limited. As a planning research tool, it is interesting but tends to become a closed system in that it does not generate further research. It is in effect a one-off solution to a given problem, and has little structural application to a wider range of problems. Because all factors are generalised into growth indices, no structural changes can

be made. Its use in decision-making, therefore, is that of a heuristic rather than an algorithm, since it is largely descriptive and does not go into the nature of the underlying processes of the system. (Harris, 1965, p.94). It would serve to show areas of potential existing in a factor within a given region which might otherwise be considered a lagging region. Advice on decision-making based on this model would still be normative, but with the advantage of sound information on which to base that advice.

3.2 MEDIUM TERM PROJECT - RECASTING THE S.G.P.M.

This project can be regarded as an extension of the S.G.P.M. program into a predictive model. In order to do this the original S.G.P.M. model would have to be recast, although some of the basic characteristics could be retained.

Growth indices could still be used, but in order to better understand the interaction between factors of the space-economy, the data processing and analysis stages would need to be considerably expanded and refined, possibly into a sub-system of models within the main model.

It is proposed that the method of principle components analysed (N7) be used to identify the relationship between factors, and that in addition historical data should be investigated to further explain these relationships.

This method does not represent a drastic departure from the previous proposals, other than to feed into the main model specific information about the way in which each factor reacts relative to changes in the other factors. Because of this, predictions can be made from the model, although these are still limited by what is essentially a static model.

This model would have the advantage of openness, where the sub-models could be enlarged into predictive systems in their own right but still feeding information back into the main model.

One of the main distinctions between this proposal and the previous one, is that, whereas the short term project could well be carried out by means of manual computation, the principle components analysis proposed here would suggest that the data be electronically processed.

The medium term project begins to answer the S.G.P.M. goals more fully and the concepts of systems analysis starts to bear fruit. Although detailed testing of investment decision would still not be possible, advice on policy could be placed on a much sounder footing. Broad investment policies could be explored, but they are limited by the descriptive nature of the model.

3.3 LONG TERM PROJECT - REPLACING THE S.G.P.M.

This proposal would require a basically different approach to the project. Instead of trying to achieve a single index of potential, or a single table from which information can be obtained about the relation of factors in different regions, the project could work towards an integrated system of models which could be worked simultaneously or independently to simulate the operation of the prototype system or parts of that system (N8). It is this proposal to which the effort of the thesis is directed, since it seems that the goals of the S.G.P.M. can be fully achieved only through the development of such a system of models.

In terms of this proposal, the economic regions would be abandoned as a data grid, in favour of more meaningful definitions as discussed in chapter 3.2. A program of spatial analysis could be carried out as defined by Berry, and by Board, Davies and Fair (see chapter 3.2). As the scope of the project widens, however, the importance of a basic theoretical understanding becomes more important, and some of the cautionary remarks about this in chapter 2 should be borne in mind. In order to achieve a fully developed simulation model, formal expression of hypotheses becomes essential, and verbal setting out becomes too vague and unreliable. Therefore mathematics and statistics assume increasingly important roles in the structuring of the models. This implies either a re-orientation of the average planner's training, or a direct involvement in interdisciplinary research.

The accessibility and standardisation of all the data themselves is called into question, and gives rise to the necessity for establishing some form of data bank (N9). The areal standardisation of data is also a very important factor and must be accounted for. (N10)

In some respects the construction of a simulation model of the nation's socio-economic system is an ideal. It is, however, not an impossible ideal. Although it is unlikely that such a proposal could be effected in the near future, it is worth attempting. To this end the basic structure

of such a model could be laid down, and research projects designed to fit into that structure, so that a large-scale simulation model could be made up from a series of building blocks, as it were. Each one of these blocks could be a self-contained research project in its own right, as long as it has the possibility of being connected into a larger system at a point in time where that becomes possible.

In this proposal the goals of the S.G.P.M. are taken as direct objectives in setting out a complete research project. Simulation techniques are postulated as the most efficient means of achieving these goals. The structuring of such a simulation model, or system of models would be directly related to the argument of this thesis for an integrated approach to spatial analysis.

4. SUMMARY

The purpose of this chapter is to bring together the concepts outlined in the thesis in constructive criticism of a piece of research in which the author was directly involved (the S.G.P.M.).

The S.G.P.M. is criticised on two levels - in detail, where refinements are proposed that could make it a more reliable model, and secondly, in general. This general criticism takes the goals set in the S.G.P.M. and investigates ways of achieving those goals, given the addition of concepts defined by this thesis. The failure of the S.G.P.M. in respect of these goals is discussed briefly. Three proposals are put forward, showing how better solutions could be achieved. The proposals are classified as short, medium and long term, indicating the scale of the projects envisaged.

The first is an extension of the S.G.P.M., and follows on from the detailed criticism of that project. The second is also based on the S.G.P.M., but gives more meaning by the use of principle components analysis. The third, or long term, is a new approach entirely, involving the use of simulation models.

Detailed description of some of the points raised in the text is contained in the notes to this chapter.

NOTES TO CHAPTER 4

N1 TIME:

The inclusion of time in models will depend on the type of model being built. In the case of the S.G.P.M., which is a purely descriptive and static model, it is not necessary to include time as a variable, or to account for the changes in other variables and parameters over time. Trend data could have been used in the model, however, in the data processing stage to gauge the growth of the nine factors in relation to each other. This kind of data was used in the industrial and population indices to arrive at weightings. A factor militating against the use of trend data was that there is no data available pre-1960 on an economic region basis. Data is available for magisterial districts, however. Thus aggregation (and in some cases, disaggregation) of data could make information on trends available. The reliability of this data is probably limited, but not to the extent that it is totally unusable.

The treatment of time in models is succintly dealt with by Lowry (1965, p.161). Once the parameters that relate the variables are established, time can be treated in the form of comparative statics, recursive progression or analytical dynamics. The choice of treatment depends on the assumption about the equilibration of the system and the degree of closure. Recursive progression is used most, where a set of lagged variables causes the model system to chage over time. This method also affords an opportunity of injecting changes at point in time, and of checking the reality of the predictions. It is important to remember though, that before time can be incorporated into a model, the structural relationships (or parameters) between the stocks and flows of the system, must have been established.

To do this in the S.G.P.M. would have required an input of statistical knowledge which was not available.

N2 The question of an areal grid, or rather a data grid, will come up again. It is sufficient to say here though, that given the limitations imposed by having to use the economic regions as a data grid, there are ways of compensating for distortion. These were not used; the main reason for this was lack of statistical knowledge.

Although density factors, size, and area factors were used in the weighting of indices for population and transport, the effect of region size on the other factors was not taken into account.

Consider the economic regions as a grid for sampling the spatial distribution of a factor. Then the measure of that factor occuring in any one cell of that grid can be thought of as a measure of frequency i.e. measure of the chance of finding that factor within that cell at any one (random) placing of the cell in a given area. Obviously, if the size of the cell varies between placings, the frequency distribution will be considerably distorted. Therefore, a simple way of compensating for this would be to weight the frequency by some measure of the difference in size or shape of the cells. It would not be an arduous task to work out a standard deviation statistic related to the mean size of all the regions. This could be applied as a positive or negative weight to the factor indices depending on how one considers size affects a particular factor. Thus region 40 (Johannesburg) and 21 (Transkei) have approximately the same population, but the region sizes vary considerably (301 sq. miles for Johannesburg and 8132 sq. miles for the Transkei). This will obviously affect the relative efficiency of road networks, water resources, industry and so on. The standard deviation would be more meaningful than simple density figures, which tend to be rather arbitrary because of urban concentrations in a region.

N3 Refer to Chapter 1.2, and Chapter 1, N12. The use of this formula (based on the gravity model theory) would require very refined data processing, but simplifying assumptions could be made which would be better than complete omission. At a much lower level, the following procedure is suggested, well within the context of the S.G.P.M:

1) Define the basic political structure of the country, locating the structure by place, where possible. In other words, position the major administrative agencies within their respective regions.

2) Accepting the plural nature of the society, quantify 'voting power' of regions and allocate weights accordingly.

3) Allocate weights to regions according to number of MP's and MPC's (These figures might be adjusted on a per capita basis as well). These factors are purely descriptive and need not bias the model in favour of any particular political system, but would give an indication of accessibility to decision-making, and a rough quantification of influence or power.

N4 Analysis of energy consumption figures in terms of KWh/capita, the actual location of the National grid, location of power stations on a hierarchical scale if necessary, location of fuel for power generation and so on, would give positive indication of the availability of power for further growth and should be built into a model of this kind. The data is not difficult to find.

More basic concepts of the flow of energy in a system have already been mentioned (Ch. 3.3) and should be pursued if a more sophisticated model is to be constructed.

N5 Haggett (1965, p.222) proposes a simple effective way of reconstructing a table of this kind which depends in effect on a ranking of weights to achieve comparability of widely divergent data. In order to retain the relative differences of measurements over their respective ranges (e.g. Population: 167680 to .8, Minerals: 9.030 to .002, Tourism: 276,850 to 660, Transport: 1000 to 73) he suggests the use of standard scores or W-values. These values are obtained from the formula:

$$W = \frac{(x_i - \bar{x})}{S_x}$$

where x_i is the factor index for the ith region
$\bar{x}$ is the arithmetic mean
S_x is the standard deviation.

Then for any index, the w-score is expressed as a deviation from the mean value in units of standard deviation.

This method would retain a very large amount of detail lost in the S.G.P.M. basic index table, where in the population index, for example, 31 out of 51 regions are labelled '1', covering a range of weights of 1.4 to .03.

N6 Some justification should be given for this statement. Testing is not possible in this model for two main reasons: 1. There is no statement of interaction between factors. 2. The process that led to the allocation of weights to factors, is largely intuitive and therefore difficult to evaluate or change. The effect of 1. is that the effect of an investment over a range of factors would be difficult to assess, in fact there is no way of doing this within the model. Allocation of investment to different factors would be exogenous to the model. The effect of (2.) is that structural changes which would lead to different growth potential indices could not be calculated.

N7 FACTOR ANALYSIS:

This is a system whereby the basic dimensions of a seemingly complex domain can be identified. This is done by resolving a basic matrix of interrelationships into a small number of hypothetical variates or factors. These factors are made up of two parts - one is the common factor involved in all the variables, the other is the unique factor involved in each variable. The first accounts for the maximum of the variables among 16 factors, second indicates the extent to which correlation with other variables in the set do not account for the total unit variance of the variables. This method is not a magic mechanism tool, but requires a deep understanding of the problem and of the limitations of the input data if the factors are to be identified in a meaningful way. (Henshall in Chorley & Haggett, 1967, p.441). This method recognises that all measurements are not of equal weight but that many of them overlap and tells us the same story about the ways in which a set of regions may vary. (Haggett, 1965, p.223) (Adcock, 1954).

N8 SIMULATION MODELS:

A simulation begins with the development of a custom-made model and continues with its processing or operation in order to determine the behaviour of the system under examination.

The first step in a simulation study, is to study all the factors pertinent to the subsequent construction of the model. The selection of the critical variables form the key to the construction of a realistic model, but it is as important to select the right details to leave out of the model. Consideration of historical data is used to test the validity or otherwise of the model. The accuracy of the simulation is constrained by several factors. The main factors are time, which limits the amount of research that can go into the construction and working of the model; cost, which has the same effect. Experience in the field of study and knowledge of the prototype system are questions which will be mentioned later. Simplicity of the model is a factor that often affects accuracy. The boundaries of the usage of the model will affect the limits of accuracy. It is as well to be aware of the limitations of the simulation model, as it is to be aware of its uses.

The formulation of the problem is probably the most critical stage. It will demand research and understanding of a high order so that the forms and paths of information flows can be accurately traced. At each place where information is received a determination should be made as to what

is done with it, how long it takes to do this and what the capacity of the node is for doing what it does. All the relevant inputs and outputs at each node, as well as the decision making centres, should be identified and located. The operations affecting decisions must be analysed and the rate and capacity of operations at each stage determined. (Ackoff, 1967).

This kind of systems analysis can obviously be costly and time consuming. It is therefore, this stage which demands a full understanding of the nature of urban and regional systems.

It may also be necessary to outline and define objectives of possible courses of action. This can be split into two distinct processes
1) search problems - where the instruments necessary for a better course of action are believed to exist but have to be found, and
2) development problems - where the course of action has to be formulated.

Of the quantitative methods available, the simulation approach has the widest range of applications in that it imposes least restrictions on the problem representations. The only constraint is that the variables have to be quantifiable and the interaction between the variables, defined.

Given a precise mathematization of the situation, there are two ways in which models can be operated:

1) analytic solutions of equations
2) simulation of equations.

The first solution is usually impossible in complex situations where non-linear conditions prevail. Therefore the second approach should be adopted, where known data and trends are used to check the relationships between model and reality, at a series of points in time. When a sufficiently accurate correlation is reached, the model may be used to simulate changes in variables and serves as an experimental device for computing patterns of adjustment corresponding to assumptions about dynamic change.

The advantages of the simulation procedure are:

1) Relative to the size of the prototype system, simulation is a low-cost research tool.
2) Minor changes are easily made which facilitate an iterative approach to research.

3) The models can be non-linear in formulation.
4) The model can deal with many variables.

METHOD:

The basic framework for a research project using a simulation model is as follows:

1) Problem definition
2) Model construction
3) Model simulation
4) Model validation

Definition:
It is important to realize that the model is not an end in itself, but a means to an end. That end might be described in very general terms as an aid to further understanding, or it may be very specific e.g. the effect on a system of a particular input.

Construction:
What to model is a question that is bound up directly with the formulation of the problem. The first stage will elucidate many of the variables which can be included or left out. The analysis of feedback loops is of prime importance.

The level of aggregation or grain of the model is a factor that will materially affect its usefulness. In a small problem a fine grain analysis is possible, but when dealing with problems on a regional level for example, a coarser grain analysis is necessary in order to expedite calculation time. The kind of aggregates used also depends on the questions being asked. For example, in an urban study it may be possible to consider housing stock in terms of DU's as a simple aggregate for one purpose, but for another this figure may have to be split into types, size and costs per unit to answer another question.

Equation writing:
Writing the equations on which the model is based can be split into three sections:

1) Statistical analysis of data
2) Formalizing this analysis in mathematical terms
3) Translation of these mathematical equations into a language to suit the computer programme being used.

These stages are technical processes and are beyond the scope of this thesis. They do, however, form the core of the simulation process.

Simulation:
Simulations may be used individually as projections or in groups as sensitivity indexes. The relationship of policy decisions to the model results should be carefully controlled. The testing of the effect of different policy decisions is a difficult process, but the use of sensitivity analysis to define the important parameters during the construction of the model can aid the research and lead to a fuller understanding of the prototype system. A well designed study will use the policy-decision of interest within the overall projection model, and will employ sensitivity analysis to evaluate a range of policies under different conditions.

Validation:
Testing of the model for reliability is often a subjective matter. The main tests are questions of an empirical nature:
Is the microstructure reasonable? That is, have the appropriate variables been included, and their relationships defined sensibly?
Has the data been sufficiently carefully processed to yield sensitive parameters?
Is the behaviour of the model realistic; does it reproduce historical trends accurately; is there unusual bias in results that indicates a weakness in the formulation?

Thus, trust in, and effectiveness of the model, rests squarely on professional ethics. As stated before, mathematical formalization is no guarantee of a perfect model, and inadequate data cannot be substituted by mathematical equations.

The essence ofthis procedure is the realization that it is difficult to forecast the extent of a research project, or the type of data required for the project at its inception. Thus the entire process is broken down into stages at which the amount of work done, the amount of work to be done, as well as the additional or unforeseen work needed, can be reviewed. At each review stage it is accepted that the directions, scope or nature of the research project may change, depending on the information available. This method is applicable to all research. It is specially relevant to research into complex planning problems where adequate information or empirical work is not always available, and where time and financial resources are invariably limited. It is specifically relevant to simulation studies, where the checking and validation of the model is essential to the value of results obtained from the model.

N9 DATA BANKS:

The problem inherent in many projects of a large scale is the mechanical one of data storage and retrieval. It might be worthwhile here to mention some points regarding the idea of data banks. These pieces of 'software' are becoming essential as the scale of projects increases and the scope of Planning widens. Even on a small scale some knowledge of the operation of a data bank would be beneficial in the collection, storage and processing of data.

A data bank is a system for storing relevant and useful information in such a way that it is readily accessible, easily manipulated and capable of constant review. (Brundell, 1969). The following remarks relate specifically to electronic data processing, but the principle can also apply to manual methods. (Lee, 1971) The main functions can be summarised as follows:

1) To provide selected information on request.
2) To communicate information (ideally between research and/or administrative centres).
3) To provide a base for survey and analysis.
4) As a framework for planning research with models and simulation.

The last point can be expanded so that information could be made available for day to day management as well as for research.

There are two basic approaches to storage:

1) An omnibus file - this involves long records, long access and is difficult to update.
2) Separate files with cross references - this is preferable but involves a cataloguing and classification problem.

Taking 2. further, there are certain classification rules that should be observed:-

1) Each piece of information should have a location reference.
2) The smallest possible unique areal units should be used as the information grid.
3) Quantitative information must be filed in a raw state (i.e. not in classes, groups or ratios, but purely nominal data).

4) Qualitative information must be filed according to a pre-established set of 'pure' themes. That is, activities should not be confused with places - 'government land' for example, is nonsense. Land is land, and government represents ownership. These two facets would be separately filed and cross indexed.

5) The range of themes should represent the requirements of all types of users of the data banks. For instance, geologists would require different information in a given unit of area from a planner.

6) The inclusion of irrelevant information wastes time and space, therefore the principles of economics apply to data banks too.

To expand on point 1. - location identification is the major hurdle in the formation of a data bank. Suggestions are: postal addresses, administrative areas and their subdivisions, or preferably true topographic location related to some form of National grid. The requirements of location data is that the absolute and relative location of each piece of information should be established, and this information itself should be suitable for data processing. (In that case topographic location - a set of x and y co-ordinates, would be ideal).

The following remarks on areal units are equally cogent for the following note on quadrat analysis (N10):

Areal units should be identical if information is to be truly comparable without distortion. A national grid system as used in Britain is ideal. Administrative units have the disadvantage of unequal area and a tendency to change shape over time. The concept of a national grid in South Africa is not far-fetched if one takes into account the sophisticated work of the Trigonometrical Survey Department; because of their work, virtually the whole of the country is covered by a co-ordinated grid to which most physical features are related. An areal unit based on the national grid has a short term disadvantage because existing data is not allocated to that grid, but the long term advantages are so great that it warrants adaption. A further refinement of this system is that different scales of areal aggregation could be used depending on the type of analysis required (e.g. 100, 10 or 1 km sq. units).

The management and effectuation problems of a data bank are not to be minimised, but discussion of these is beyond the scope of the thesis.

N10 QUADRAT ANALYSIS:

Given a national grid for which data is collected, based on some unit of area (say 10 km square), it becomes possible to use quadrat sampling in the analysis of spatial distribution of activity. Quadrat sampling is a method used to determine the frequency distribution of a phenomenon. The observed frequency distribution may then be compared with a theoretical probability distribution generated by a known set of processes. A completely random distribution would resemble a Poisson frequency distribution; variations from the Poisson distribution can lead to postulates about the degree of determinism of the pattern (Harvey in Chorley & Haggett, 1967, p.572). A neutral grid is also useful for carrying out experiments using a Monte Carlo method of placing probability fields to simulate diffusion processes. (Morrill, 1965). A further use on an urban scale of quadrat analysis is indicated by a study by Dickens (1969) where the use of different quadrat sizes to 'catch' information about nodes, networks and surfaces is illustrated. For research purposes a neutral grid would be a useful tool. The ideal situation would be to apply it on a national scale to collect and locate national statistics within the grid.

CHAPTER FIVE: conclusions

Logically speaking, there can be no conclusion to this thesis, because it is intended to be an exploration in method, and the effectiveness of the methods proposed can only be tested in action from which conclusions could be drawn. In that case, the statements here should be regarded as interim conclusions which should be compared with the results when the propositions of the thesis are actually put into practice.

The basic objective of the thesis was to investigate methods of analysing urban/regional systems so that predictions could be made about the location of investment decisions. This led to the identification of some general concepts which could prove useful in two ways: firstly, as a way of synthesising some of the work in the planning field itself and secondly, as a means of recognising the structure and interaction of urban and regional systems.

The concepts can be very simply stated, and although they appear in the precis of the thesis as well, they are repeated here since they are actually the conclusions of the thesis:

1) Planning is a science since a logical and critical approach is needed to solve the problems posed by the system it studies, and to provide a solid grounding of theory on which to base continuing research.

2) The concept of system is a useful construct which allows the complex behaviour and interaction patterns of human communities to be analysed and understood.

3) Spatial analysis does not depend on a heterogenous collection of devices but can be considered as a structural way of breaking down a complex system into meaningful sections in such a way that the components, connections and the domain within which they exist, can be described and explained.

4) An understanding of the historical development of disciplines associated with planning can give the researcher an essential insight into the weaknesses which exist in these disciplines. It also affords an idea of the connections between different theory systems. This insight is important in the application of theory, where uncritical use of a theory can distort the results of research work. In this respect the behavioural content of the disciplines studied in the thesis is found lacking, and very strong assumptions are made to retain the logic of theory; this limits the general application of theory.

In addition, the origin and nature of the disciplines themselves call into question their general validity in different parts of the world and in relation to the values of different societies.

5) The history of a prototype system is considered to be another important aspect that could assist with the formation of models of that system. A historical review of South Africa reveals the large role played by the natural barriers of the country. Politics seems to play a far more important role in the structure of the system than is commonly accepted even in a politically conscious country. The forces of urbanisation and their dependence on the transport network are also brought out by the review. An important aspect of this is the artificial nature of the urban structure of the country. These qualities could provide an indication of the emphasis to be placed on different approaches to the analysis of the national space-economy.

A few limiting factors must be pointed out here. Because a great deal of the analytical work in regional science and geography at present is expressed in mathematical terms, the author's field of inquiry is severely limited. General verbal statements of what could be expressed accurately and concisely in mathematical terms, are set down in this thesis. Much of the recent and very relevant work in the analytic field was beyond the author's comprehension because of this. The underlying structure to these methods should not vitiate the conclusion of the thesis, but where specific examples are quoted, it may well be that better ones exist.

In looking at the S.G.P.M., it becomes apparent that had some attention been paid to a methodical approach at an early stage of that project, the results would have been significantly more reliable. The point to be learned from this is that a problem-solution attitude to research is not sufficient, and must be replaced by a solid background of theory and analytic method in order to achieve a meaningful result. This can be regarded as the main conclusion of the thesis. It is certainly not startling, but the author felt it could not have been made without making some proposals about what that background of theory and method should consist of.

At certain stages in the argument there may be an impression that all one has to do in many cases is to use the right formula to get the right results, or that analysis is just a matter of selecting and using the right tools at the right time. To a certain extent this is true, just as a watchmaker or an artist works according to certain principles and

uses the right tools. Beyond that the implacable rules of creativity, intuition and ethics are as important as in any other field of activity. These devices merely structure creativity in such a way that, unlike the artist, there is a chance of repeating the creations so that they may be refined and made more useful at every iteration.

APPENDICES

A.1 SPATIAL GROWTH PROBABILITY MODEL - general. 1.1 Program. 1.2 Summary. 1.3 Factor analysis; summary. 1.4 The model. 1.5 Table of index numbers.

A.2 SELECTIVE BIBLIOGRAPHY OF PLANNING IN SOUTH AFRICA 2.1 Description and purpose. 2.2 Method. 2.3 Bibliography. 3.1 Growth and Development, analysis and research. 3.2 Spatial Distribution of Activity. 3.3 Urbanisation & Cities. 3.4 Policy, Strategy and Planning. 3.5 Planning, general topics and research.

A.1 A SPATIAL GROWTH PROBABILITY MODEL FOR THE REPUBLIC OF SOUTH AFRICA

A summary of this project and the model itself is included here since the discussion in the thesis hinges on this model. It is necessary to include such a summary for the reader's convenience and quick reference. The summary has picked out the main structural factors in the approach to the problem, and in the building of the model. Much of the background discussion is omitted which may make some of the statements appear rather bald and arbitrary. A section in the original on ciritcal analysis is omitted since the equivalent section in the main text of this thesis replaces it.

A.1.1 THE S.G.P.M. PROGRAM

PROJECT: 1969/2/1

A study of differential growth potential factors in the Republic of South Africa and their synthesis in a spatial growth probability model.

FRAMEWORK:

1) The purpose of the project is to progress towards the rational formulation of a national growth policy in terms of the spatial allocation of national financial resources in developing the inherent and derived resources of the Republic of South Africa.

2) Definitions: "Inherent resources" means natural resources.

"Derived resources" - those resources which have become "inherent" by a process of development.

3) The Scope of the study is necessarily broad, but will be largely confined to selected indices which can be measured, if not precisely, then approximately. Quantification must be used wherever possible. Assumptions which will be clearly and rationally stated will be used only when other avenues have been tested and found to be blocked.

4) The Study Area is defined as: The geographical confines of the Republic of South Africa, together with those entities physically or functionally linked to it.

Policy decisions having a spatial content will be confined by the Administrative boundaries of the Republic of South Africa.

A.1.2 SUMMARY

APPROACH:

Where information was not available assumptions were made in order to proceed with the model.

Lack of precedent meant that the form of the project developed in an ad hoc way as data was collected and as the model began to take shape.

THEORETICAL FRAMEWORK:

The theory of 'cumulative advantage' was used where the rate and form of the growth of cities and regions is determined by the relative advantages of each. Relative advantage was taken to define depressed and growing regions, and as an explanation of locational factors.

Non-economic and economic factors were analysed to determine relative advantages. The standard Economic Regions were used as a predefined set of regions for data collection purposes. (This was recognised as a weakness at the time, also the interdependence of regions was mentioned).

METHOD OF DATA COLLECTION AND ANALYSIS:

The factors relevant to the study were decided on as follows:

1) Population

2) Industry
3) Tourism
4) Agriculture
5) Minerals
6) Social capital
7) Water for agriculture (WA)
8) Water for power generation, urban and industrial use (WIUP)

Electrical power was taken to be ubiquitous because of the national grid. Political power proved too difficult to analyse and was not included.

An atlas of maps was compiled (scale 1:4.000.000) for: Mineral distribution, Relief, Railways, Vegetation, Distribution of corps, Main roads and air routes.

A systematically organised body of data containing the raw data and basic tabulations for each factor was compiled as an addendum. Each factor was analysed and related to growth potential weighting factors (see below) and expressed as a common scale for comparison.

A.1.3 FACTOR ANALYSIS

POPULATION:

The 1960 census figures were used with estimates for 1967. Urban and rural figures were obtained per region.

1) The 1960-67 growth expressed as a percentage of the total national population was used as an indicator for the activity in and attraction of a region.

2) The population of a region as a percentage of the T.N.P. indicated relative quantity of resources available and therefore a growth potential factor.

3) Regional urban population as a percentage of the regional total indicated level of communication, level of skill education and entrpreneurship and also as an activity indicator.

4) Density figures were calculated to indicate communication, activity.

5) Economically active persons as a percentage of regional population indicated availability of labour.

6) White economically active as a percentage of regional population was used as a crude indicator of education levels and skill levels.

Data Analysis:

Factor 2 was unweighted and was multiplied by the other 5 factor weights in turn to give an overall weighting. The weights were then expressed as percentages of the highest figures to give a comparable set of figures and expressed as a proportion of 1000.

Method:

Weighting tables for population:-

Arithmetic ratings:

Weighting	% Growth 1960-67	Density (p.p.s.m.)	Total ec. active
1	1-9	1-19	1-26
2	10,11,12	20-49	27-31
3	13,14	50-99	32-34
4	15-19	100-999	34-39
5	20+	1000-	40+
Range	6-51	2-4610	21.45 - 66.59

Logarithmic ratings:

Weighting	% Urban population	% Whites ec. active
1	1-20	1-8
2	21-40	9-16
4	41-60	17-24
8	61-80	25-32
16	81-100	33-40
Range	1.31-100	1.11 - 39.85

INDUSTRY:

The following elements were considered important as measures of growth potential:

1) Each region should concentrate on those areas where it has a comparative advantage.

2) Secondary industry is most important for growth, and is weighted heaviest as a factor of industrial growth potential.

3) There is an unequal distribution of industrial groups amongst regions; the smaller economic regions having a much smaller range than the major regions, on which they depend for consumer goods. Service industries are not represented in the majority of the economic regions.

4) The nature of an industry must be considered in relation to its location.

Data Analysis:

The following data was used to compile indices:

1) Average output per industry group for 1962-63

2) Average gross industrial output for the Republic 1962-63

3) Average output per industrial group as percentage of total gross output of all industry

4) No. of industries in major groups per region

5) Gross output per group per region as percentage of total gross output

6) Percentage increase of that output per major industrial group 1956-67.

Method:-

Index A: Quantitative Index:

$$\frac{\text{Average gross output per group ('62-'63)}}{\text{Average gross output of Rep. ('62-'63)}} \times \frac{\text{output of industrial group ('61-'62)} \times 100}{\text{gross output of Rep. ('61-'62)}} \times \text{No. of industries per group per region.}$$

This figure was then expressed as a proportion of 1000, the highest figure set = 1000.

Index B: Growth Index:

$$\frac{\text{Total \% increase per group ('57-'67)}}{\text{Total \% increase for all industries ('57-'67)}} \times \frac{\text{Output of industrial group per region ('61-'62)}}{\text{Total output per region ('61-'62)}} \times 100$$

This figure was then expressed as a proportion of 1000, the highest figure set = 1000.

Final index for industry: $\frac{A + B}{2}$

The productivity of labour, capital and labour intensity, linkages and raw material orientation were not accounted for because of lack of comparable data.

TOURISM:

Tourism can be regarded as an important growth factor in the economy of the country at present since it is relatively unexploited and large returns can be had for relatively small investments. Relative to world growth of the tourist industry this factor becomes even more important.

Data Analysis:

Maps and tourist guides of the AA, Rondalia, and Dept. of Tourism and publicity guides were compared and collated to identify types, location and number of tourist attractions: these were then defined and weighted as follows:

Number of hotel beds (as a crude assessment of facilities per region)	unweighted
Tourist resort (all facilities)	x 10
National Park	x 8
Bodies of water	x 5
Game and nature park (below national status)	x 3
Scenic areas	x 2
Single features	x 1

Method:

The weighted figures were added for each region and multiplied by the number of hotel beds. This index was then reduced to a 1000 scale with the best endowed region taken as 1000.

AGRICULTURE:

Detailed agricultural statistics were available per magisterial district, but compilation time made it necessary to seek out simple ways of quantifying this factor.

Data on forestry was not used.

Comparative studies are complicated by the heterogeneity of topography, produce and climatic regions. It is assumed that farm size is related to value and productivity of agricultural land.

Fishing was not considered since it affected only 3 regions and its growth potential was considered marginal.

Data Analysis:

Each region was assumed to be agriculturally homogeneous.

A random sample of magisterial districts was taken for each region and from that was calculated an average agricultural production figure for each region. This method proved to be reasonably realistic. Average total wages per region was used as a second index of costs.

Method:

Each column of figures was ranked from highest to lowest. The highest figure was set = 1000 and the remainder weighted in relation to this

i.e. $\frac{\text{figure in column}}{\text{highest figure}} \times 1000$

The two indices thus obtained were added and divided by 2 and again expressed as a proportion of 1000.

TRANSPORT:

Data Analysis:

Population density was used as an indicator of connectivity. Small regions were given a weight of 1.5 to account for closer networks.

Interregional:

Roads entering the region are classified and weighted.
Rail routes entering the region are classified and weighted.
Shipping routes are included in harbour weights.
Airports are classified and weighted (landing strips omitted).

International:

International transport modes are classified and weighted per region according to intensity of use. Border crossing roads and rail links are classified and weighted according to region.

Method:

Factors:	Points:
Untarred National	1.00
Tarred National roads	1.5
Main line -single track	3
Main line - double track	4
Branch line	2
Fishing harbours	unaccounted for
Minor harbours	2
Major harbours	5 + 1.5 per million tons handled annually, and 1/3 of this for relative growth potential.
International Airports	8 for each economic region benefitting directly from an international airport. 5-6 for economic regions within 75 miles of an international airport.
Major airports	3-4 depending on volume of traffic handled.

Factors:	Points:
Minor airports	1-2 depending on volume of traffic handled.
Interregional transport network	Points were allocated to regions based on % of population of the region relative to total population multiplied by 1.5
Growth potential value added to region by virtue of proximity to regions with heavily weighted internal transportation network.	1/3 of points allocated to heavily weighted regions bordering on these regions, and 1/6 to regions from 75 to 100 miles distant.
Loss of relative advantage due to distance via shortest road or rail route from the national centre of gravity at Winburg.	1 point deducted per 100 miles.

The final weighted index was then expressed as a proportion of 1000.

MINERALS:

Untapped mineral resources were not taken into account since no comparative data was available.

Data Analysis:

The 53 mineral types listed in the Statistics of South Africa yearbook, are located according to economic regions. The gross sales for 1968 were worked out for each mineral, then a percentage of that figure was allocated to each region containing the mineral. The total mineral production was then summed for each region and expressed as a proportion of 1000 (the highest scoring region = 1000).

SOCIAL CAPITAL:

This was defined as service factors such as communication, local administration, education, health services, capital (buildings). Economic base was not regarded as important in this factor, but social infrastructure existing in areas of unexploited resources were taken to indicate growth potential.

Data on commercial activity is not available for economic regions.

Data Analysis:

The municipal yearbook records of law and property values were collated into regional figures. This figure was converted to a per capita index to assess comparative total urban welfare. Municipal establishments were summed per region (smallest unit = village board). This was related to population density to give and index of service area.

Where economic regions coincide with administrative regions (the five urban regions) the scores are equally allocated.

Method:

Index = Rateable value per region as % of country total x per capital valuation x density.

This is then expressed as a proportion of 1000 (5 metro regions = 1000).

WATER:

Water (for agricultural use) A

Water (for use in industry, urban areas and power generation) IUP

Data Analysis:

The following factors were analysed:

1) Water resources of drainage region, and whether tapped or untapped.
2) Flow characteristics of this water in terms of seasonal fluctuation and reliability.
3) Water presently and potentially led in from outside sources.
4) Presence of existing dams and potential dam sites.
5) Quality of the water.

In addition A used:

6) The amount of irrigated and irrigable soils

and IUP recognised:

7) Existing capital expenditure on water supply installations (assumed to be a function of urban population in the area).

A.1.4 THE MODEL

Description:

A table of ER's x factor was drawn up using the factor indices described above. Three activity factors were isolated: Agriculture, Industry, Tourism, and the value of each other factor was weighted in terms of these three with regard to growth potential as follows:

Factor	Activity		
	Industry	Agriculture	Tourism
Population	6	3	3
Industry	10	2	5
Agriculture	5	10	4
Minerals	4	1	1
Transport	4	5	5
Social Capital	4	2	1
Tourism	0	0	10
Water A	0	10	1
Water IUP	6	0	3

The factors (columns) in the basic table of index numbers (A. 1.5) were then multiplied in turn by their ratings to give 3 separate index tables weighted for Industrial, agricultural and Tourism growth potential respectively. In each of these tables the rows were totalled to yield a growth potential index for that activity in each region. (Note: The primary index table only is included here).

Conclusion:

The activity growth potential indices were mapped to illustrate in a graphic way the differences in potentials between the regions. (These maps are not included here since they do not form an integral part of the model). These maps correspond reasonably well with an intuitive assessment of the system.

Capital/Multiplier:

An arbitrary capital multiplier was assumed for each activity as follows:

Industry = 6

Agriculture = 3

Tourism = 4

These multipliers were then applied to the activity growth potential indices to estimate the relative value of capital inputs in a given factor in a given region. From this it was possible to estimate the most profitable way of investing in any particular region.

A.1.5 TABLE OF BASIC INDEX NUMBERS

Economic Regions	Ind.	Agr.	Tour.	Pop.	Min.	Trans	Soc. Cap.	W (IUP)	W (Agr.)
01 CT	537	150	1000	1000	4	562	1000	113	32
02 S.W.	189	760	265	75	5	330	224	625	464
03 M	47	275	8	1	4	183	5	97	397
04	29	366	8	1	1	241	33	180	464
05	19	193	25	3	1	219	22	26	86
06	2	117	11	1	1	146	1	8	86
07	17	86	1	1	1	211	5	17	148
08 P.E.	97	65	8	97	1	534	556	30	18
09	11	185	1	1	1	213	6	8	121
10	2	57	1	1	1	261	1	8	130
11	28	415	11	1	1	548	6	425	1000
12	13	273	1	1	1	299	1	55	445
13	7	58	16	1	1	321	2	35	250
14	20	166	11	1	470	139	1	48	167
15	6	94	7	1	10	246	1	16	185
16	42	558	1	1	7	431	1	12	185
17 Kim.	48	175	16	1	28	348	7	81	232
18 E.L.	87	85	164	77	1	285	439	148	60
19	37	450	13	1	1	357	5	276	397
20	18	9	10	1	1	171	4	154	360
21 TRA	17	77	10	1	1	91	1	108	297
30 DU	511	45	333	428	1	813	1000	379	24
31	26	186	42	1	1	151	25	97	93
32	20	400	58	1	1	182	1	52	46
33	8	364	1	1	1	106	1	24	67
34	61	225	83	1	1	289	15	885	278

cont./

Economic Regions	Ind.	Agr.	Tour.	Pop.	Min.	Trans.	Soc. Cap.	W (IUP)	W (Agr.)
35	7	96	6	1	1	148	1	32	93
36	37	741	47	1	1	300	4	805	740
37	60	150	32	2	368	326	2	288	334
38	3	36	16	1	1	155	1	20	185
39	14	267	8	1	1	73	1	132	223
40 Jhb.	1000	56	278	707	944	1000	1000	139	19
41 B	591	108	5	218	954	667	1000	91	47
42 Kr.	72	117	52	96	998	509	604	89	47
43 Pre.	171	77	22	437	946	542	1000	160	47
44 Ver.	189	64	8	97	1000	428	405	93	47
45 Kl.	73	1000	5	2	1	479	35	378	241
46	29	390	65	1	19	332	1	61	167
47	58	467	151	1	390	405	1	255	464
48	43	231	16	1	4	418	1	310	232
49	64	423	18	3	536	479	8	430	167
50	39	254	65	1	7	470	4	500	325
51	39	665	306	1	690	327	1	1000	740
60	1	81	4	1	1	318	2	91	398
61	12	131	1	1	16	305	1	30	276
62 Bl.	93	296	36	34	1	623	81	545	398
63 Wel.	22	32	1	29	853	248	490	55	37
64	90	688	32	1	853	598	30	306	398
65 Sas.	7	11	1	5	1	400	45	19	46
66	31	199	18	1	1	305	6	120	121
67	25	144	27	4	1	306	4	53	61

Note: This table permits vertical comparison but no horizontal comparison can be made.

A.2 SELECTIVE BIBLIOGRAPHY OF PLANNING IN SOUTH AFRICA

A.2.1 DESCRIPTION & PURPOSE

This bibliography is not a definitive list of all material relating to aspects of Planning in South Africa, but it does attempt to give some idea of the scope and scale of recent professional work in the field in this country. It is intended as a source of material for use by future students of the School, since a reference of this nature would have been of great assistance to the work done on a project such as the S.G.P.M.

A.2.2 METHOD

1 The bibliography was compiled by scanning at least the 1960 volumes of those professional journals which were felt to be the most likely to contain relevant material. The journals to which the majority of articles refer, are listed below with the abbreviations used.

2 References are limited to those which are available in the University Libraries (J.W. Jagger Main Library and Architectural Library).

3 Selection of material was based on its relevance to the subject. In order to guide this selection, certain terms (or their variations) covering aspects of the topic, were chosen (growth, regionalism, urbanisation, spatial dispersion, policy).

4 The bibliography has been divided into 5 sections dealing with these different aspects of Planning in South Africa. It must be stressed, though, that this has been done to help the searcher to use the bibliography and articles may cover more than the section in which they appear.

5 Periodicals cited:

South African Journal of Economics	S.A.J.E.
South African Geographical Journal	S.A.G.E.
South African Journal of Science	S.A.J.S.
Saipa; South African Journal of Public Administration	S.A.I.P.A.
Agrekon	Agr.
Plan (Formerly: Plan S.A.)	Plan
South African Architectural Record	S.A.A.R.

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