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A REVIEW OF DEVELOPMENTS IN CARTOGRAPHY  
WITH SPECIAL REFERENCE TO CARTOGRAPHIC  
EDUCATION AND TRAINING IN SOUTH AFRICA

BY

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PREFACE

The study presents a review of the history and development of cartography, as it has occurred almost throughout the westernized world, with particular reference to developments in education and training over the last three decades. The intention is to relate these developments to the present state of cartography, cartographic education and training in South Africa. For the purposes of the study, cartography is defined as -

"... the art, science and technology of making maps together with their study as scientific documents and works of art"  
(I.C.A., 1973b p.1).

My interest, specifically in education in cartography, developed when I moved into the academic environment at Rhodes University in 1972. The sudden availability of a bewildering wealth of literature, unknown in my previous working spheres, provided a whole new insight into the developments that had, and still were, taking place in the world of cartography. Although I had been involved in cartography since the late 1940's, it was only from the writings of Robinson, Morrison, Wolter, Grant, Muehrcke, Ormeling, Maling and Birtles, to name but a few, that I began to realize I had entered, trained and worked as a cartographer during possibly one of the most important periods in the history of cartography. These factors, together with the noting in literature of significant increases specifically in education programmes, since the 1950's, has led to a personal concern for education in cartography in South Africa, and consequently to this study.

With regard to the study as a whole, certain points require clarification at the outset.

1. The realization of the importance of the immediate post World War II period, or the 1950's, necessitated a broader historical overview in order to establish the platform from which the growth and developments in cartography over the subsequent three decades could be appreciated. The broadening of the field of study, from about the birth of Christianity to the present day, posed certain problems of arrangement for the material, and justification in the choice of selected aspects of development is based on the sheer breadth and time span of the study.

2. On the other hand, the relatively short period of some 25-30 years which the main thrust of the study covers has meant a heavy reliance on fewer, but often most prolific, authors of research papers and review articles dealing with the more specific aspects of cartography.
3. The problems of definition tend invariably to limit the areas of concern and, for the purpose of the study, every endeavour has been made to define terms in the most appropriate way. Time periods in which growth and development take place cannot be specifically defined, therefore references to such periods as the 1950's, relate to the years falling around that date i.e. about 1950-1960, and a year or two either side.
4. It is not the intention of the study to enter debate in the specific technicalities of how map production takes place, or on course structures or syllabuses, but rather to concentrate on the underlying factors associated with the growth and development of cartography as a whole field of study. Selected syllabuses have, however, been included in the Appendices (A1-9) as examples of degree and certificate course outlines and structures.
5. The use of single inverted commas designates often subjective aspects or references to matters more specifically cartographic in orientation, meaning or content.
6. Finally, all numbers with more than two digits have not been written in words in order to be less cumbersome.

The study then is an attempt to present cartography and cartographic education and training, with particular reference to South Africa, as a response to developments that have occurred almost world-wide, over the last three decades.

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## CHAPTER ONE

### INTRODUCTION

The history of cartography has been characterized by Robinson (1976) as a series of revolutions of either technological innovation, conceptual advances or philosophical shifts. While some have been of major proportions, altering the whole technology or concept of cartography, others of relative minor importance have also contributed no-less to the development of mapping in general. Important technological advances such as the invention of printing, lithography, photography, the advent of plastics and the computer have profoundly revolutionized technological applications in cartography. The concept of cartography has been seen to change fundamentally during both what have been termed progressive and retrogressive periods. Variously it has been regarded as: a record and store of geographical data, a real world model, scripturally symbolic, mathematically precise, a fundamental tool, traditionally inarticulate, and a science of information communication (Thrower, 1972; Tooley and Bricker, 1969; Robinson, 1976; Salichtchev, 1970; Fuson, 1969; Muehrcke, 1972; Kolacny, 1969). These significant technological and conceptual changes or revolutions occurring, singly or in combination, have influenced, not only the whole basis of cartography, but education and training in particular (Grant, 1976).

No revolution however has been of greater consequence than that which apparently commenced during the decade immediately following World War II, and has yet to run its course (Robinson, 1976). Reviewing the twenty five years since 1950, Robinson et al. (1977) consider that in the historical growth and development of cartography, the 1950's constituted a watershed, conceptually, technologically and institutionally. Wolter (1975) also identified the post-World War II period as one of the most important in the history of cartography. Considering the technical, intellectual and philosophical advances which occurred during that period, Wolter (1975) maintains cartography could be identified and designated as an 'emerging discipline'. Muehrcke (1972) and Morrison (1974) both note that the 1950's provided cartography with an identity which changed it from 'map-making' to 'cartography'. It is perhaps Ormeling (1978) who most astutely perceives the magnitude of the changes that have occurred in cartography since World War II, when he states that the post-1950 period is "... one of the most exciting times in the history of cartography, during which the discipline has advanced

theoretically and technically more than in any other period ..." (p.170). Ormeling maintains that the roots of the phenomenal growth and development in cartography lie in the closely inter-related factors of technological innovation, intensified research and the upgrading of cartographic standards by better education and training.

The philosophical bridge between the technology and conceptualization of cartography has been provided by the expanding educational opportunities since the 1950's. Increasing demands for cartographers and cartographic products resulted in the almost world-wide introduction of academic programmes to meet these needs. Such programmes have promoted the basis for literary growth and the establishment of scholarly forum through professional societies, which in turn have provided the impetus for investigation, analysis and rigorous research. However, educational programmes have, together with technological innovations, also widened the dichotomy between education and training (Monmonier, 1975; Grant, 1976; Dahlberg, 1981). Evidence in literature over the past three decades tends to confirm and substantiate the claims to a period immediately post-dating World War II, of revolutionary, exponential growth and development in cartography and concomitant growth in education and training. (Jenks, 1953; Salichtchev, 1962; Maling, 1964; Robinson, 1973, 1976, 1979; Koeman, 1976; Grant, 1976; Robinson, et al., 1977; De Haas, 1980).

Cartography in South Africa, on the other hand, while remaining technologically abreast of world developments since the 1950's, appears to have lagged significantly in the educational training and research fields. That technology and its immediate training requirements are easily importable commodities, probably accounts for this situation. Educational developments in S.A., however, indicate that minimal cartographic education is offered at tertiary level, while research appears not to have progressed beyond the use of cartography as an illustrative aid or a tool in geographical analysis (West, 1979).

The need to look to the introduction and development of academic programmes at university level in South Africa has not gone unchallenged. Watson and van Rensburg (1970) made as their first recommendation for improving the standard of cartography "... the important matter of cartographic education at undergraduate level ..." (p.4). Watson, writing in 1970, contends that most cartographers in

South Africa are basically land surveyors or geographers and it is to these disciplines and university departments that one should look for education and the directing of research in cartography (Watson, 1970). At the S.A. Geographical Society Conference, Bloemfontein, 1976, Watson again challenged the universities on the study of map communication as a field of research (Watson, 1976 p.18).

#### A. OBJECTIVE AND AIMS

The present study is a response to, not only the challenges, but also a concern for, the apparent lack of cartographic education and training programmes in South Africa. As a consequence, the objective of the study is to examine the possible need for more comprehensive cartographic educational programmes, particularly at tertiary level, in South Africa. To achieve this objective, four major aims are proposed for the study:

1. the review of developments in cartography prior to the 1950's, so as to provide the background against which the claim to a revolutionary or watershed period having subsequently occurred, may be established;
2. the review of the growth and development of cartography, as an emerging discipline and scientific field of study in its own right since the 1950's;
3. the review of the nature and growth of education and training in selected countries, since the 1950's, against which the present state of cartographic education and training in South Africa may be compared;
4. the assessment of the possible education and training needs of the South African cartographic community and consideration of a possible place for cartography in the South African university structure.

An explanation of the research framework serves to indicate how the methodology attempts to fulfil the aims.

#### B. THE RESEARCH FRAMEWORK

The selection of a suitable framework in which to review so broad a topic as the history and development of cartography, with particular reference to education and training, initially presented a problem. Although the

scope of the study considers cartography from earliest times to the present decade, claims by Wolter (1975); Robinson (1976); Robinson et al. (1977) and Ormeling (1978) to a watershed period commencing about the 1950's, provide the natural basis for two major periods for study:

1. the period prior to the 1950's, and
2. the following three decades to the 1980's.

As the major thrust of the study is to focus on the development of education and training, however, a more definitive framework embracing these particular aspects needed to be considered. Ormeling's (1978) contention that the growth and development of cartography, since the 1950's, can in part be attributed to 'better education and training', appeared to provide the focus for the review and discussion. The criterion or factor of 'better education and training', however, cannot be seen in isolation from Ormeling's tripartite of closely inter-related criteria or factors which also include 'technological innovation' and 'intensified research'. The study framework is therefore generally based in a chronological framework comprising the period prior to the 1950's, and the following three decades in which the growth and development in technology, research and education and training in cartography are traced, subject to the following provisos:

- a) The terms 'concepts' and 'functions' have, for the purposes of the overview, been used synonymously with 'research', and provide the link and background to the post-1950's research designated developments in cartography. In the context of Ormeling's (1978) factors, research is identified with the conceptual and functional developments leading towards a theoretical structure for cartography. Prior to the 1950's, however, no such area of investigation existed and research in cartography applied primarily to the acquisition and recording of historical data. Although throughout the history of cartography, periods of conceptual and functional change have been noted (Robinson, 1976), these have only been recognized in retrospect.
- b) The term 'education' only became relevant to, and applied in cartography during the 1960's (Moriarty, 1965). All tuition prior to that period has been identified as training in cartography. The

terms 'education' and 'training' have, however, been retained in the overview to provide the link in later discussion.

### C. THE RESEARCH METHODOLOGY

The following methodological approaches have been adopted to achieve the aims of the study.

1. The greater part of the study comprises a review and analysis of literature related to the historical evolution of cartography, through growth and developments in technology, research and education and training. The review material is essentially confined to available English language journals, texts, monographs, occasional and research papers. While this may appear to limit the compass of the study, both Wolter (1975) and Robinson et al. (1977) note that English has become a preferred language in cartographic publication since the 1950's. The review further comprises the examination of university calendars, study information brochures, course outlines and published prospectuses of educational institutions.
2. A questionnaire was framed and distributed to organizations employing cartographers, as an aid to assessing the possible education and training needs of the South African cartographic community. The questionnaire survey was selected as being the only reasonable means of reaching employers of cartographers notwithstanding three possible deficiencies inherent in the technique.
  - a) The questions may not have been detailed enough to determine accurately specific needs or requirements with respect to education or training.
  - b) While every attempt was made to identify all employers of cartographers, some may have been inadvertently overlooked or not reached in the survey.
  - c) The non-participation of employers, or sectors of the cartographic community, in the survey.

Consequently the results of the questionnaire survey cannot be regarded as a definitive study, but rather indicative of trends occurring within the cartographic community. The points a), b) and c) are more fully discussed in Chapter Four of the thesis. An outline of the study as a whole provides an indication of how the research framework attempts to accomplish the aims.

#### D. THE STUDY FRAMEWORK

The study is presented in the following manner:

An overview of the development of cartography, prior to the 1950's, is outlined in Chapter Two. The underlying influence of technological innovation to the whole field of cartography is traced from the invention of printing in the 15th century, while changes in the concepts and functions of cartography, dating from the birth of the Christian era are discussed. Education, or more appropriately the role of training in cartography, from the early 13th century 'schools', and the introduction of apprenticeship, to the situation prevailing in most of the western world immediately prior to the 1950's, completes the historical platform from which the growth and development of cartography, in the third quarter of the 20th century, takes place.

Chapter Three introduces a growth model which constitutes the basis for the discussion reflecting the exponential increases in the number of societies and all aspects of the literature or scholarly bases of cartography. The evolution of a new definition, providing an identity for cartography, is traced and the detailing of technological and research developments, since the 1950's, introduces the bases for cartography as a scientific field of study.

The major thrust of the study is presented in Chapter Four where developments in education and training, since the 1950's, are discussed. Against the background of international developments relating to education and training in cartography, three specific case studies are presented in which differing patterns of educational development can be identified. The current situation, in terms of cartographic education and training opportunity in South Africa, is examined with a view to providing a comparison as to the adequacy of cartographic education in relation to that presented in the case studies.

Chapter Five includes an attempt to assess the needs or requirements of the South African cartographic community, in terms of education and training. An evaluation and analysis of data from the survey questionnaire and annual reports is presented and related to the essential differences between education and training. Finally, the consideration of a place for cartography in the South African university structure is discussed.

The final chapter presents an appraisal of the study in terms of the aims and objective, suggestions are made for the improvement of the study and directions for future research in additional aspects of education and training in cartography are indicated.

CHAPTER TWO

OVERVIEW OF THE DEVELOPMENT OF CARTOGRAPHY  
PRIOR TO THE 1950'S

INTRODUCTION

Cartography, like art, is presumed to pre-date writing, and, like architecture, has both scientific and artistic attributes (Thrower, 1972). Since ancient times, the development of cartography kept pace with the steady growth in geographical science and knowledge, from which concepts such as the spherical earth, map projections, latitude, longitude and compass bearings all came into being (Robinson, 1976). The recording of data on hand-drawn manuscript maps and charts was a blending of the scientific and artistic attributes of the map-maker or copyist. At the time of the rediscovery in Western Europe of Ptolomey's Geographia during the 15th century, important developments were taking place which would affect the progress of cartography. The most important of these were the invention of printing and the commencement of the voyages of discovery (Thrower, 1972).

The printing of the first map in 1472 was a noteworthy event in the history of cartography. The capability of producing, for the first time, exact duplicate copies was to revolutionize the field of cartography for ever. To the age-old art and science of map-making, a new and tremendously significant technological element had been added (Robinson, 1975a). Developments that were most significantly to affect cartography for almost the next 500 years, took place in the technical map reproduction field.

As knowledge of the known world expanded with each new discovery and, especially after the 15th century, the nature and function of cartography also changed. The basic sea chart depicting sailing directions and coastlines no longer adequately served as a base for the recording of new geographical discoveries and information. A new form, the geographical map, came into being, constituting in nature and function, a storehouse of geographical knowledge. Similar functional changes have occurred throughout the history of cartography (Robinson, 1976). The investigation of some of the notable periods of change can provide an insight into more recent functional changes and research developments in cartography.

Major technological advances and periods of functional change which have influenced cartography up to the 1950's are considered in Sections A and B of the overview. With these factors, Ormeling (1978), assessing developments in cartography, has identified a further factor, viz. education and training. Where skills, either learning or manual, are to be acquired, education and training occurs. This overview also considers training in the cartographic skills from the 13th century to the mid 20th century (Section C).

## A. TECHNOLOGY

Technologically, the media of cartography have run the whole gamut from pre-historic clay tablets to the high resolution multi-colour earth satellite photography of the 1970's (Prestwich, 1973). Evidence in literature suggests that the three major technological inventions which most profoundly influenced cartography up to the 1950's were printing, photography and plastics. The nature of the inventions is summarized below.

### 1. Printing

- a) The woodcut technique of the 15th and 16th centuries.
- b) Copperplate engraving from the late 16th to the 19th century.
- c) Lithography<sup>1</sup> in the late 18th and 19th centuries.

### 2. Photography

- a) Process photography and photo-lithography in the late 19th and early 20th centuries.
- b) Aerial photography in the 1930's and 1940's.

### 3.

- a) The incorporation of dimensionally stable polyester based plastic materials in the 1940's and 1950's.
- b) Scribing and preprinted materials also in the 1940's and 1950's.

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<sup>1</sup> Although the invention of the lithographic process is an invention in its own right, it has been included under Printing for convenience.

## 1. Printing

The first known printed map in the Western world came from a German press in 1472 (Tooley and Bricker, 1969). It was a simple woodcut print of a diagrammatic T-O style map of the world, a form in use since Roman times (Fig. 2.1).



Figure 2.1: The first printed map dated 1472. A symbolic 'T-O' map inherited from the Dark Ages of Christian geographical theory (Tooley and Bricker, 1969).

The map therefore achieves prominence more from being the first one printed rather than for its content (Brown, 1960). The woodcut technique involved cutting away the unwanted woodblock background, leaving in relief, a reverse or negative image for printing (Woodward, 1975). The success in replacing laboriously hand-copied replicas with exact printed duplicates was the tentative start of a technological revolution that would eventually enable maps of unvarying quality to be produced in unlimited quantities (Tooley and Bricker, 1969). As the requirements of the map-maker became more demanding and detailed, the limitations of the woodcut technique, in terms of size and quality of woodblock, and more particularly in the intricacy of cutting, became apparent. These limitations, together with the invention of 'roller printing', led to the experimentation in metal plate techniques. Although the woodcut continued to be used it was effectively superseded by the new method of copperplate engraving in the 16th century (Woodward, 1975).

In copperplate, map-makers and a growing body of engravers found the medium which suited all their requirements (Robinson, 1975a). The size

of metal plates was larger than those obtainable from woodblocks. Copper was soft enough to be engraved with the finest lines and yet sufficiently hard not to blur under printing pressure, a flexibility which enabled the quality of image to be preserved. The relative ease with which copperplate could be altered encouraged the introduction of amendments and prolonged the useful printing life of the plates (Verner, 1974). Polished copperplates were thinly coated with wax which hardened sufficiently to receive an image. The manuscript map was laid face down on the plate, varnished so that the drawing would show through and then traced or transferred as a reverse image on to the wax. When complete, the drawing was removed to serve as a guide to the engraver. The image was then cut, with special engraving tools, through the wax into the surface of the plate (Verner, 1975). The production by copperplate engraving of some of the finest maps in the history of cartography, bears tribute to the skill and control of the engraver (Tooley and Bricker, 1969). Combined with the new roller printing process, the copperplate technique became the preferred map printing method for nearly three centuries (Robinson, 1975a).

The invention in the 18th century of the lithographic process, which combined speed of production with quality of image, presented the only serious challenge to copperplate printing (Mumford, 1972). The rising price of copper had gradually led to the adoption of polished soft stone bases for engraving. Further experimentation with the action of acid on the stone, and later zinc sheet bases, resulted in the introduction of the first chemically produced or planographic printing method (Robinson 1975a). Manuscript images, drawn on specially prepared paper in a slightly greasy lithographic ink were either transferred or directly drawn with pen and ink on to the stone or metal surface. The plate was then washed with a weak solution of nitric acid which accentuated the inked image by etching and increasing the porosity of the uninked background. Although the image was barely raised above the background it was sufficient to accept ink from the printing roller while the moistened porous areas of the plate rejected the ink (Ristow, 1975). The lithographic process which permitted, for the first time, the practicality of colour-separation in map printing, rapidly gained favour with map-maker, engraver, and printer in the early 19th century (Goodrick, 1957). However, ease of alteration and the cost of replacing existing plates ensured the continued use of copperplates for map printing throughout the 19th century (Harris, 1975).

While the significance of the lithographic process in map printing was cartographically profound it did little to alter the relationship between the map-maker, or now designated cartographer, the engraver and the printer (Ristow, 1975). The apparent skill of map-making still lay, not with the cartographer as map author, but with the engraver/printer in a 'client-architect' relationship in which the engravers permitted themselves many changes in 'improving' the original work (Robinson, 1975a). The invention of photography and the introduction of the reprographic or process camera in the 1880's was however to alter the cartographer/engraver relationship dramatically.

## 2. Photography

Initially, photographic duplication was considered an alternative to map printing for certain maps which required only a very limited number of copies. However, the photographic process, coupled with the invention of the chemically developed chromium-gum printing plate in 1901 and the high speed offset printing process in 1904, gave rise to a further revolution in map printing technology (Koeman, 1975). The facility of photo-lithography, as it became known about the turn of the century, provided a production sequence of original drawing to printing plate through a photographic negative and at last allowed the cartographer to bypass the interpretive craftsman engraver, wood, copper or litho entirely (Robinson, 1975a).

In sharp contrast to the technical perfection achieved by these inventions the quality of cartographic drawing deteriorated noticeably (Koeman, 1975). Photo-lithography heralded the demise of the engraver and opened the floodgates to a new generation of amateur cartographic draughtsmen. Generally unskilled, untrained and lacking in true cartographic tradition, "... for neither the newly emancipated cartographer-turned-draughtsman nor the printer-turned-copier had the background to carry on the cartographic tradition..." (Robinson, 1975a, p22), as pen, ink and photography replaced the traditional engraving methods of cartography. The introduction of the dimensionally unstable, transparent acetate-based draughting films did little to improve standards. The coarse-grained surfaces did not easily accept ink, were difficult to draw on, even more difficult to amend and stretched or shrank at every change in temperature (Koeman, 1975).

The development of aerial photography and photogrammetry as cartographic data sources between the First and Second World Wars, together with an increasing world-wide demand for maps, severely taxed the resources of map producers (Robinson, 1973; Morrison, 1974; Grant, 1976). Speed of data acquisition, available through aerial photography, had to be matched with faster production. Again cartographic quality was to suffer for, notwithstanding the high standards achieved by the late 1940's on acetate, the graphic fineness of the engraved map could not be equalled (Koeman, 1975). Cartographic draughtsmen were still forced to waste their skill by drawing on surfaces generally hostile to the acceptance of ink. It seems likely that by comparison with earlier periods, the first part of the 20th century will be considered a retrogressive period in the history of cartography (Robinson, 1975a).

### 3. Plastics

As printing and photography characterized the first two major revolutions in cartography, the introduction of dimensionally stable polyester-based plastic sheets was to characterize the third. The new polyester-based films were transparent, tough, durable yet flexible and were relatively unaffected by temperature and moisture changes (Braund, 1980). Coated with a soft actinically opaque layer to which the map image was chemically transferred, the film enabled map production to revert to a form of engraving process again (Keats, 1973). The new technique, scribing, probably the only technological invention specifically designed for cartographic work, was only perfected and widely adopted after World War II. The ease with which the new technique could be mastered, shorter training and production times, together with a result that could match former engraving methods, was sufficient to convince most map producing organizations of the acceptability of scribing (Koeman, 1975). Based on the use of plastics, scribing encouraged a whole new set of developments particularly in pre-printed, pressure sensitive stick-on symbols and lettering (Muehrcke, 1972). Whereas previous technological advances in printing and photography had largely dictated changes in cartographic practice, by the 1950's a specific and adaptable technology in scribing had been developed which would enable cartography to keep pace with current data acquisition sources and the increasing demand for maps.

### B. CONCEPTS AND FUNCTIONS

In the context of Ormeling's (1978) factors, research is identified with the theoretical, conceptual and functional developments in cartography.

Historically, research in cartography applied primarily to the acquisition and recording of geographical data (Brown, 1949; Thrower, 1972). The nature of cartography has however been dictated by the prevailing concepts and functions of cartography through time. Robinson (1976) identified some of the most important periods as the early associations with geography, the Middle Ages, the geometrical renaissance and the development of topo-geographical cartography. Reviewing these periods of conceptual and functional change provides the background against which Ormeling's (1978) consideration of 'intensified research', in all aspects of cartography since the 1950's, may be understood.

The common associations of geography and cartography have been widely identified in the works of Erestosthenes (276 BC), Strabo (63 BC) and Ptolemy (127 AD). The essence of early cartographic work was the acquisition of geographical knowledge and its depiction as accurately as possible (Brown, 1949, 1960; Bagrow, 1964; Crone, 1971; Wilford, 1981). The accuracy of geographical presentation by these early geocartographers was however suppressed by the changing attitudes to cartography during the Middle Ages (Robinson, 1976). This was a period during which religious attitudes dominated and cartographic representation was characterized by the advent of extraordinarily inaccurate and functionless T-O hemispherical world maps. Cartographic portrayal was based on scriptural perfection and symbolization rather than on the realities of geographical discovery and understanding. The world was moulded into specific shapes, which had Biblical sanction (Robinson, 1976), such as circular or oval, and usually divided into three parts by a T-shaped partition, a T within an O (Fig. 2.1). The known geography of the Mediterranean area, orientated with East at the top, symbolically represented Asia, Europe and Africa (Brown, 1960). These forms and their variations were to dominate until the 13th century when cartography shed the scripturally aesthetic for a geometrical function and developed as an applied art.

According to Robinson (1976) the first of the modern functional revolutions in cartography began with the introduction of the Portolan sea charts about the end of the 13th century. Based on compass bearings, coastlines and sailing directions were accurately plotted within a geometrical system of wind or compass roses. The charts were produced by navigators and map-makers based mainly in Genoa, Venice, Majorca and Barcelona (Lock, 1975). The charts, completely different from the

medieval T-O mapping, heralded a transformation in which the map was conceived of as a reduced image of the the real world, drawn within a geometrical framework as accurately as science would allow (Robinson, 1976). With each new real world discovery the range and functions of the charts were extended by the incorporation of new information. By the end of the 15th century, Portolan type sea charts covered all the coasts of the Mediterranean area, northern Europe and north-western Africa, and were to become the basic navigational aid for the early voyages of discovery (Wilford, 1981). The function of the Portolan chart as a navigational aid was only superseded when Mercator published his projection in 1569. The Mercator projection gave mariners, for the first time, a map on which direction or bearings remained unchanged (Brown, 1960).

The function of acquiring and recording geographical knowledge certainly prevailed throughout the voyages of discovery and colonization periods from the 15th to the 19th centuries (Wilford, 1981). In many instances it was the explorer who was both surveyor and map-maker and who independently compiled and supplied manuscript maps for publication (Bagrow, 1964; Thrower, 1972). Commencing with the rediscovery of Strabo's and Ptolemy's work towards the end of the 15th century the production of geographical maps gained momentum as a commercial enterprise and was pioneered by men like Mercator, Ortelius, Jode and Sanson in the 16th century (Wilford, 1981). The feedback of a great wealth of geographical data over the next two centuries saw the rise of some of the now famous specialist cartographic institutions of the 18th and 19th centuries such as Perthes, Hondius, Philip, Bartholomew and Son, Peterman, Johnson, Blaeu and Arrowsmith in Europe and Rand McNally in America (Brown, 1960; Tooley, 1979) as well as the establishment of national mapping institutions such as Ordnance Survey in Great Britain (Woodward, 1978) and Institut Géographique National in France (Koeman, 1975). Cartography in the 19th century is perhaps epitomised in the meticulously drawn geographical atlases and overloaded military topographical maps which pay tribute to the skill and technique of cartographer, engraver, and printer. (Koeman, 1975).

As geography moved towards becoming a science and academic field in its own right during the early 20th century, the cartographic component was

relegated to being "... a tool of expression only and not an end in itself ..." (Briault and Hubbard, 1957, p.18). As a consequence of the change in emphasis by geographers, the mathematical basis of projection calculation, triangulation, geodetic and survey measurement shifted into the realm of the engineer, geodesist, land surveyor or mathematician who became the accepted scientific researchers in cartography (Grant, 1976). Salichtchev (1970) identified the early 20th century as one of geometric-mathematical cartography, a claim which is supported by the many subsequent English language publications of the 1930's and 1940's which concentrated primarily on the survey, projection and geodetic aspects, with cartographic representation being seen as a tool only in geographical analysis (Vide Hinks, 1933; Deetz and Adams, 1934; Bygott, 1934; Garnet, 1935; Debenham, 1937; Mainwaring, 1942; Chamberlin, 1947). Salichtchev (1970) also contends that the advent of mathematical cartography stunted the study of the essence of maps and hindered research into the very nature of cartography. While geographers, surveyors, geodesists and engineers took an interest in cartography, they tended to regard it as a less intellectual component of the broader fields in which they worked. In consequence there were few professional societies or journals for cartographers and research papers were published through survey or geographical journals (Robinson et al., 1977). In many respects the movement of the geometric-mathematical components of cartography into the university environment and the academic neglect of the rest of the cartographic field, which by now had become identified with technical draughtmanship, proved to be crucial in the evolution of cartography (Robinson, 1979). The division is still apparent in the continuing education/training dichotomy in cartography today (Grant, 1976).

The increased demand for maps of all types, generated by the growing air-photo data source of the 1930's and the mapping needs of World War II, (Morrison, 1974; Grant, 1976) left little time for research and experimentation other than towards faster map production through technological innovation (Robinson et al., 1977). With the lack of research opportunity, the consequence of these pressures resulted only in more selective content criteria in the still traditionally acceptable geographical map, all too often intuitively produced maintains Muehrcke (1972), to historical standards and norms. Robinson (1979) claims that prior to the 1950's there was a complete lack of a formalized research tradition in North America. Both the Royal Society (1965) and Koeman

(1976) have noted the lack of organized research programmes in cartography in Great Britain and Europe, prior to the 1950's.

In the immediate post-war developments of cartography a new trend emerged. Out of the conditions generated by World War II, an awareness of the growing importance of thematic cartography became apparent. Not generally associated with the mainstream topo-geographical cartography (Robinson et al., 1977) the need for more specific functionally orientated cartographic products was promoted by post-war world developments. Agricultural, demographic, health, social, economic and development programmes were but a few aspects to which the specialist needs of thematic cartography could be applied (Morrison, 1974). These specialist needs formed the basis of a change in attitude towards the whole nature and function of cartography and, for the first time, incorporated the potential of a specific research field in cartography.

### C. EDUCATION AND TRAINING

From earliest times to the end of the 18th century, maps and charts more often than not, were the by-product of the research, occupation or general interests of a great number of individuals from many differing backgrounds (Wallis, 1979). The terms cartography and cartographer, according to Wolter (1975), only came into existence in the middle of the 19th century. Cartographers were preceded by innumerable individual map-makers, chorographers and cosmographers or whatever they chose to call themselves (Tooley, 1979). It is therefore often difficult to separate the specifically trained map-maker or cartographer from geographers, astronomers, mathematicians, explorers, historians, surveyors, engravers, publishers, soldiers, sailors or priests (Brown, 1960; Tooley, 1979). Nevertheless the existence of 'schools' of trained map-makers, apprenticeship, technical and university training programmes in cartography are all evident in literature. Tracing some of the developments in training from manuscript mapping in the early 13th century through to the mid 20th century, provides a background against which 'better education and training', as noted by Ormeling (1978), may be compared.

Before the invention of printing, maps and charts existed in manuscript form only. Consequently there were relatively few maps and, more particularly, few copies of any specific map (Robinson, 1975a). While

copying was not unknown, it was not usual for two reasons. Firstly, the contents of manuscripts were often closely guarded secrets as when pertaining to profitable trade routes and, secondly, there was always the doubt that the manuscript map accurately reflected the work of the original map-maker rather than merely the independent impression or carelessness of the copyist (Robinson, 1975a).

The first reference to collective groups or 'schools' of trained manuscript makers and copyists is noted by Tooley and Bricker (1969) as occurring with the development of the Portolan sea chart about the 13th century. The sea chart became the combined product of merchants and mariners trading out of the Mediterranean seaports (Lock, 1975). New information on trading routes, landfalls and harbours was brought back to the merchant houses by ships captains, navigators and pilots in their employ, and was transcribed or copied in the merchants own specially constituted 'schools' of chart-making. Evidence from charts of the period suggests a well developed expertise in manuscript preparation based on the experience of generations of trained chart-makers (Tooley and Bricker, 1969).

With the invention of printing in the 15th century, map production was given a whole new emphasis and impetus. Printing technology introduced profound long term changes to the established practices of the manuscript map-maker (Robinson, 1975a). Initially, in search of printing copy, printers rediscovered many early manuscripts e.g. those of Strabo and Ptolomey, in the monasteries and church libraries of Europe. The first printed maps therefore reflected the work and the extent of the geographical knowledge of second century map-makers, rather than the extensions to that knowledge provided by the sea chart era. The use of these early manuscripts as printing copy also meant little immediate demand by printers on map-makers to supply printable manuscripts (Brown, 1960). With each new territorial discovery however, maps of the known world needed to be updated and map-makers began to supply original copy to the printing establishments. In trading the freedom of manuscript copy delineation for the facility of mechanical reproduction by printing, map-makers relinquished the autographic control in the processes of map production to a new interpretive craftsman, the engraver (Robinson, 1975a). Initially many map-makers, attempting to retain the accuracy of their work, became engravers and even printers (Verner, 1975). However, with a long tradition of apprenticeship training through the Craft

Guilds, engravers readily adapted to map production and soon became the link between map-makers and printer (Brown, 1960). Craft Guilds, which had emerged as early as the 13th century in Europe, incorporated a system of indentured apprenticeship training and with the movement of the trained art, metal and jewellery engravers into map engraving, created the basis of an apprenticeship training system in map engraving (Brown, 1960).

With the rise of map publishing as a commercial enterprise during the 17th and 18th centuries, map production constituted the combination of a series of highly specialized skills performed by the map-maker, engraver and printer (Robinson, 1975a). By 1700 there were 18 major map publishing centres in Europe, of which Amsterdam was the most important. Apprenticeship, the only accepted form of training, was offered in the associated map production skills of platemaking, transfer draughting, engraving, printing and map colour artistry (Brown, 1960). Map publication, by virtue of the printing processes, became the prerogative of the members of the Booksellers Guild, which often included family publishing enterprises such as those of Blaeu, Sanson, Cassini and Arrowsmith. While family enterprises usually offered all the processes required in the mapping process, from manuscript preparation to printing and publishing, in general a specialization of roles occurred and engravers, printers and colour artists, often set-up as, and became completely independent establishments (Verner, 1975).

Map-makers or cartographers on the other hand, appear to have retained a measure of independence in the supplying of manuscript maps for printing. Throughout the 18th and early 19th centuries maps were prepared for publication by a great number of individuals of many differing interests and occupations and included explorer, engineer, surveyor, sailor and soldier (Wallis, 1979). Inevitably, however, specialization in the role of cartographer took place, not only in the large publishing enterprises but also in smaller 'schools' of specialist map and chart-makers such as the Drapers' or Thames School (Smith, 1978). As in the other associated map production skills, apprenticeship training, usually over seven years, became the recognized form of training for cartographers. Woodward (1978) notes that the records of up to seven generations of apprentice cartographers can be traced in some of the map producing establishments of the period. The preparation of maps from many different types of information, from travellers tales to military surveys, often spread over lengthy time periods, provided by

many varied sources and suppliers, represented the real challenge of the cartographers art (Robinson, 1975a). In preparing the original manuscript, it was the cartographer alone who had the responsibility of assembling, creatively interpreting and depicting the data of the day and on whom the integrity of the product rested (Ristow, 1975; Verner, 1975). Nevertheless, the work of map-makers or cartographers was still subject to the influences and vagaries of the engraver in correctly depicting that detail. Robinson (1975a) speculates that much of the balance, decorative cartouche, design and technical excellence of many maps of the period can probably be directly attributed to the engravers, who were apprentice trained and skilled in the craft, rather than to the original map-maker.

About the middle of the 19th century changes which would alter the whole function of the cartographer were already taking place. Advances in methods of astronomical observation, survey mathematics and instrument making facilitated the development of national surveying and mapping programmes and the establishment of national cartographic institutions such as Ordnance Survey in Great Britain and the Institut Géographique National in France (Woodward, 1978; Koeman, 1975). The adoption of national mapping programmes had three noticeable effects on cartography in the long term. Firstly, the contribution of the independent cartographer was virtually eliminated as the national organizations employed only 'in-house' staff, cartographers compiling the work of the field surveyors in preparation for engraving, litho-etching and printing (Robinson, 1975a). Secondly, the introduction of series sheet mapping, based on field surveys, meant the gradual demise of many private map producing establishments who could no longer remain competitive without the means of acquiring, or having access to, the original field data. Thirdly, in that apprentice training in the mapping processes shifted into the realm of, and became the prerogative of, the national institutions.

By the early 20th century the compounding of these changes affected the whole field of cartography. The introduction of the field or topographical surveyor and the incorporation of photography into the mapping and printing processes heralded the decline of the cartographer as data supplier, the engraver as interpretive craftsman and the introduction of the cartographic draughtsman. Whereas apprentice training programmes for the cartographer/draughtsman were adapted to meet

the new methods and materials, the skills of the engraver were no longer required as pen, ink, and photography replaced the traditional methods of map production (Koeman, 1975). The field surveyor, engineer and later the photogrammetrist became the suppliers of data to the now burgeoning technical division of cartographic draughtsmen (Grant, 1976). The incorporation of photography in the map printing procedure effectively divorced all the map reproduction processes from the realm of the cartographer, many of whom doubled as engravers or litho-draughtsmen. A further factor in the eroding of the cartographers role was a growing awareness of, and demand for, maps generated particularly by the First and Second World wars. Although the increased demand led to the expansion of mapping programmes, map preparation required no more than a skilled draughting workforce to maintain the now established traditional sheet map format (Grant, 1976). Academic basis for entry into the field of cartography was no more than a 'good general education' with some ability to draw (Robinson, 1979). Apprenticeship remained the only recognized form of training and, while difficulty was experienced in obtaining apprentices particularly after World War I, greater difficulty was found in retaining them for the full five year 'contract'; as a consequence labour turnover was high. With the exception of a few private cartographic enterprises in Europe (Bartholomew, Philip and Perthes) still following the engraving traditions (Koeman, 1975), most of those engaged in map-making in public or private organizations well into the decade of the 1940's were field surveyors, photogrammetrists and cartographic draughtsmen. The latter did the "...routine drawing and had at best a high school education ... their supervisors had the same background, having risen from the ranks by virtue of experience. They could draw but knew nothing of geography or cartography ..." (Robinson, 1979, p.99).

The first movements towards an academic awakening and interest in higher cartographic education took place during the late 1920's in the Soviet Union and in America and Europe about a decade later. Advanced cartographic training as part of an engineering education, was available as early as the 1930's in the Soviet Union and in the Geography departments of the universities of Moscow and Leningrad by 1938. Course and teaching orientation was toward map study, analysis, history and mapping sources (Salichtchev, 1970). In America, education in cartography by the late 1930's comprised only one course at post-graduate level at the universities of Berkeley (Leighly, 1979), Chicago (Harris,

1979), Clark (Prunty, 1979), Ohio and Wisconsin (Robinson, 1979). The express purpose was to equip geographers to illustrate research studies rather than the development of cartography as an academic pursuit. Robinson (1979) asserts that generally in America "... nothing really got started before World War II. Probably the most notable academic event prior to that was the publication of Raisz's General Cartography in 1938 - a small beginning for an academic programme ...". (p.97)

In Europe, prior to the 1950's, there was no established or recognized qualification in cartography although a chair in cartography had been established in an engineering faculty in Switzerland and some technical universities offered cartography as a part course in the degree of geodetic engineering (Koeman, 1976). A similar lack of educational programmes in cartography seemed to exist in Great Britain. Maling (1964) notes that an editorial published in 1944 considering cartography in the universities, recommended that there were undoubted grounds for the improvement of cartographic education and in view of the probable post-war need for specialist cartographers it was desirable that not only the standard of teaching be raised but also that advanced courses be created at selected universities (Balchin and Pye, 1944). In 1965, or some twenty one years later, the Cartography Sub-committee of the Royal Society's British National Committee for Geography reporting on Education in Cartography stated that "... there seemed to be little complete cartographic training let alone education ... there are two post-graduate diploma courses but numbers are small and departments broadly speaking ... without adequate facilities..." (p.18). Maling (1964) finds it remarkable that twenty-one years should have elapsed between the recommendation and the actual investigation into the need for training and education and that so little had been accomplished in Great Britain.

No formal cartographic training or educational programmes had been developed by the 1950's in Canada, Australia or New Zealand where mapping responsibility constituted a function of either the state, federal, or national government. Cartographic traditions and practices were largely derived from, and relied on, immigrant professional cartographers (Barnard, 1964; Birtles, 1976; Grant, 1976). In-house apprenticeship training as draughtsmen/technicians in government departments or agencies was the only form of cartographic training available and seniority was a function of experience (McCormack, 1980).

Government responsibility for a national mapping programme also pertained to the development of cartography in South Africa. Watson, (1962) records 1932 as the year when a section in the Surveyor-Generals office was created to undertake cartographic work distinct from that normally associated with cadastral survey. In 1934 the section became a separate Mapping Section "... concentrating on the art of map-making ... and establishing the nucleus of a Central Mapping Office ... the functions of which will be the co-ordination of all the mapping work ... of the Union" (p.45). However, with neither field staff nor printing facilities, amalgamation with the newly formed and rapidly growing field mapping strength of the Trigonometrical Survey appeared a logical development. The Central Mapping Office was transferred to the control of the Trigonometrical Survey Office (T.S.O) in 1936 (Watson, 1962). By the 1950's no formal training in cartography was available or required by entrants to the T.S.O. and an in-house, on-the-job draughtsman training only was offered. The 'professional identity' of cartography was maintained by the appointment of survey graduates to the directorate posts.

Changing technological, functional and training influences had all contributed to the changing role of cartography and of the cartographer. Cartography by the 1950's had become traditionally identified with the production of topographical maps and the role of the cartographer, one of specialist draughtsman and there was no indication that either existed other than as a function of topographical map production (Grant, 1976). Developments during and after the Second World War were to alter the cartographic 'status quo' dramatically. Not only did the war create an unprecedented demand for many different types of maps, it provided a body of skilled map users and draughting technicians (Robinson, 1953, 1979; Watson, 1970; Grant, 1976). Innumerable individuals, both military and civilian had been trained to read, use, analyze and draw maps. As a consequence, many new mapping agencies came into being employing hundreds of prospective cartographers who demanded education and training, which in turn demanded scholars, teachers and structured curriculae (Robinson et al., 1977). In 1948, Raisz noted in the preface to his second edition of General Cartography, that "World shaking events have taken place since the original First Edition was published in 1938. In response to increased demands, a new school of cartography is developing with great promise for a renaissance of this art" (Raisz, 1948 p.vii). Developments in the renaissance and growth of cartography as an emerging scholarly and scientific field of study (Wolter, 1975) are reviewed in Chapter Three.

## SUMMARY

Major aspects in the history and development of cartography up to the 1950's have been presented in the overview. The underlying influence of technology, since the invention of printing in the 15th century, the development of photography and the advent of plastics has been briefly traced. Historical changes in the nature and function of cartography, from religious sanctification through the geometrical, geographical to the developing interest in thematic cartography have been identified. The effects of developments in survey, institutional and national mapping programmes which led to the gradual erosion of the role of the generally independent cartographer and the general lack of formal educational programmes at either technical or academic level have also been discussed.

The overview presents a background of developments in cartography up to the mid 20th century against which Ormeling's claim in 1978, of improved technology, research, education and training may now be considered.

CHAPTER THREE

REVIEW OF LITERATURE RELATED TO DEVELOPMENTS  
IN CARTOGRAPHY SINCE THE 1950's

INTRODUCTION

The evolution of a field of study can be viewed in terms of the growth and development of the underlying scientific and scholarly bases related to that field (Wolter, 1975). A recognized need plus an adaptable technology and a growing number of participants together constitute the basis for the development of a scientific field (Robinson et al., 1977). The basis for a scholarly field of study comprises a basic literature, exclusive societies and journals, opportunities for research and increased educational and training programmes (Morrison, 1974; Wolter, 1975). When exponential growth occurs in all these aspects within a specific field, an identifiable scientific field of study may be said to have come into existence (Robinson et al., 1977). The purpose of the chapter is to review developments in cartography since the 1950's in relation to a general growth model applied to cartography (Section A) and the bases which relate to the emergence of cartography as a scientific field of study (Section B). The new definition and concept of cartography will be considered in Section C and technological and research developments in Sections D and E. Developments in educational and training programmes are considered separately in Chapter Four.

A. A GROWTH MODEL

Holton's model of the sigmoid or logistic curve (Fig. 3.1) as a realistic function of exponential growth has been developed and used as the characteristic growth pattern of scientific, technological and scholarly fields (Price, 1963; Crane, 1972; Starr and Rudman, 1973 and Wolter, 1975). Price (1963) develops the model to explain and define periods of growth and their doubling rates in science. Crane (1972) uses the curve to elaborate the characteristics of scientific and social communities, while technological growth has been demonstrated by Starr and Rudman (1973) to exhibit similar growth patterns. For his investigation into the development of cartography as an identifiable field of study, Wolter (1975) adopts the same logistic curve model as a basic foundation.

The curve of scientific growth can be divided into four distinct stages according to Price (1963).

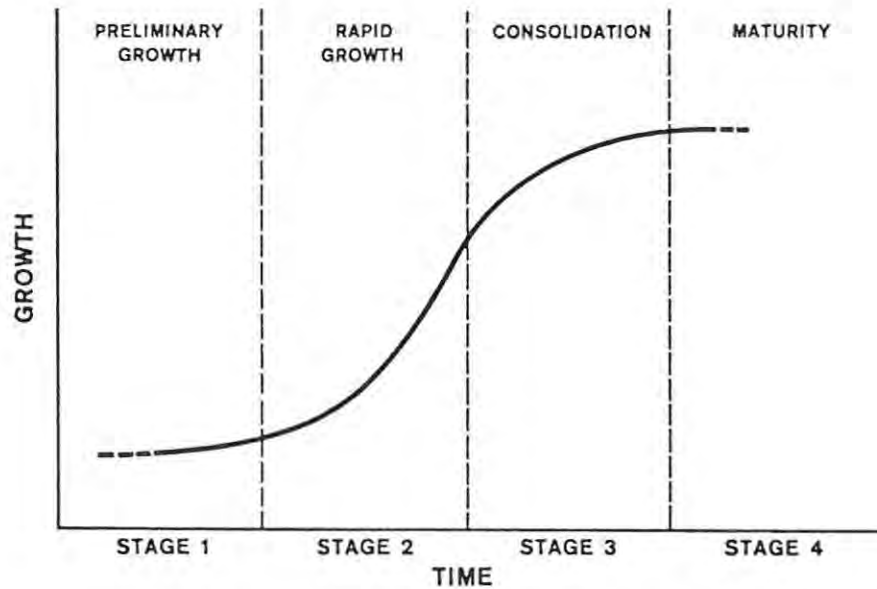


Figure 3.1: The logistic curve characteristic of the growth of scientific fields, divided into stages (after Price, 1963).

Stage 1: Preliminary growth period with small absolute increments of literature.

Stage 2: Period of exponential growth when the number of publications doubles at regular intervals.

Stage 3: Period when rate of growth begins to decline but annual increments remain constant.

Stage 4: Final period when the rate of growth approaches zero.

An important feature in the growth of science, maintains Price (1963), is that the empirical law of exponential growth (Stage 2) holds true however measured. In the case of scientific journals, abstracts and institutes, the doubling rate has been found to be in the order of 15 years. If however very stringent definitions are applied it may be drawn out to approach 20 years (Price, 1963). The study by Starr and Rudman (1973) includes illustrations of growth curves for types of illumination, computer trends, power output of machines, aviation and broadcast frequency trends. They note that when performance is plotted against

time, it follows a sigmoid curve. It has also been noted by both Price (1963) and Starr and Rudman (1973) that overall growth is composed of a series of sigmoid curves with each curve building on the performance level of the previous generation so that extinction (Stage 4) rarely takes place.

The characteristics of scientific and social communities during each of the comparable stages are described as follows by Crane (1972).

Stage 1: Little or no social organization.

Stage 2: Groups of collaborators and the existence of 'invisible colleges'.

Stage 3: Increasing specialization and increasing controversy.

Stage 4: Decline in membership of collaborators and colleges.

Building on the hypotheses of Price (1963) and Crane (1972) in a study embracing literature and literary output, research definition, organizational and institutional developments and the influence of automation, Wolter (1975) concludes that cartography as a field appears to have followed a similar growth pattern since the 1950's (Fig. 3.2). Varied evidence supports this view. Although the period prior to the 1950's can be characterized as one reflecting only nominal growth with few journals, societies and little basic literature, formal education and training, it did end with strong bases for the development of an identifiable field of study (Wolter, 1975).

The bases for an identifiable field of study according to Robinson et al. (1977) are summarized below.

1. A generally recognized and accepted need.
2. An existing, up-to-date, and adaptable technology to meet that need.
3. A growing number of participants within the field.
4. An initial development of basic literature outlining the subject.
5. Scholarly forum for the stating, debating and testing of basic conceptual and theoretical structures for the field.
6. Continuing technological development and research within the field.
7. Educational programmes with structured curriculae.

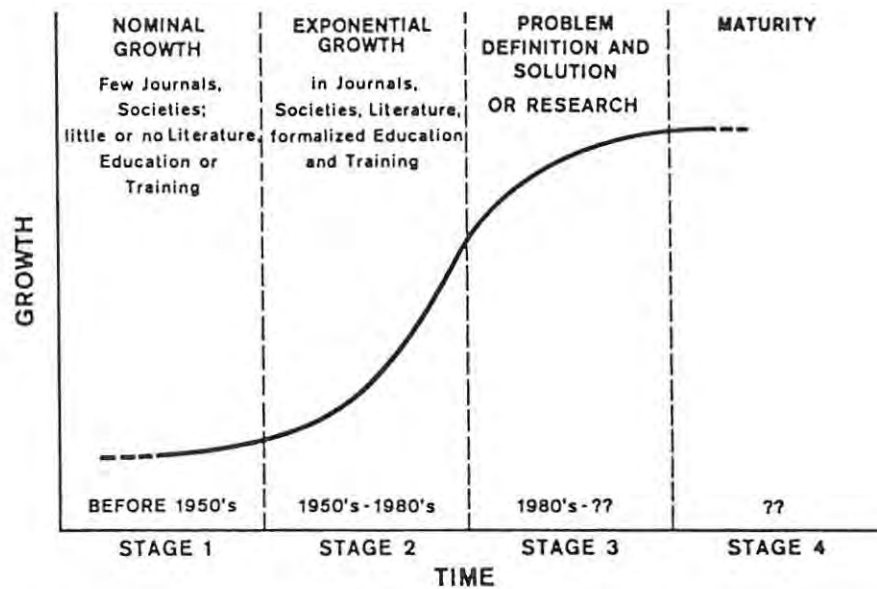


Figure 3.2: The growth of cartography as an identifiable scientific field of study.

According to Robinson et al., (1977) when all these conditions are met an identifiable scientific field may be said to exist.

By the 1950's some of the bases identified had already developed. There was a generally recognized need for cartographic products that had been generated during and after World War II, an existing and adaptable technology in scribing methods and procedures and a growing number of semi-trained personnel were evident in the field. The next three decades were to see the growth of the other bases from which cartography could develop as an identifiable scientific field.

#### B. AN EMERGING SCIENTIFIC FIELD OF STUDY

The increased interest in, and identification of the emergence of cartography as a field of study, first became evident in the rapid growth of all components of the subject literature and in the founding of professional societies for cartographers. In a study considering literary output, the growth of societies and an analysis of developments in education and training in cartography by 1975, contends Wolter, all these bases exhibited exponential growth patterns comparable with those of other scientific and technical disciplines.

The initial response in the English language literary field after World War II was the publication of texts attempting to explain the complexity

of maps and their use to the interested layman or would-be cartographers (Greenhood, 1944; Tooley, 1949; Birch, 1949; Drury, 1952; Robinson, 1952; Crone, 1953 and Lynham, 1953). Secondly, as an obvious response to the needs of trainers and teachers, the publication of reference sources or manuals of basic cartographic principles and techniques made their appearance (Raisz, 1948; Monkhouse and Wilkinson, 1952; Bygott, 1952; Robinson, 1953). Since 1953, Raisz has published one more volume, Monkhouse two, and Robinson three new editions (Robinson et al., 1977). These have been further supplemented by texts dealing in depth with specific aspects of the cartographic discipline (Dickinson, 1969; Hodgkiss, 1970; Keats, 1973; Robinson and Petchenik, 1976; Kretschmer, 1977; Muehrcke, 1978; Lawrence, 1979; Schmid and Schmid, 1979 and Loxton, 1980). With the development of computer-graphics, edited texts orientated towards computer-assisted cartography began to make their appearance during the 1970's as hard- and soft-ware became available and cartographic computer programmes were developed (E.C.U., 1971; Davis and McCullagh, 1975; Wilford-Brickwood et al, 1975; I.C.A., 1973a; I.G.U., 1977; Taylor, 1981; Monmonier, 1982). The common thread to all these publications has been the increasing interest in cartography, the rapidly changing technology of cartography and more recently the changes in points of view regarding the discipline by researchers in cartography (Robinson et al., 1977).

While texts have provided the foundation for the subject, it is the journals which have assumed the leading role in the communication and dissemination of cartographic research and views. Wolter (1975) contends that the exponential rate of increase in the number of journals established over the past 30 years is approximately the same as that for science and technology as a whole. A doubling rate of about 14 or 15 years has been noted for cartographic literature, which compares with fifteen years determined for science and technology (Price, 1963). The period from 1951 to 1966 saw the establishment of 33 cartographic journals (Robinson et al., 1977) with at least 10 new English language journals making their appearance after 1960, the latest in the field being in South Africa in 1982. At the present count, a total of some 46 cartographic journals exist, most of which are the literary organs of viable cartographic societies or associations. Cartographic journals have all but superseded the leading geographical and survey journals as outlets for research papers dealing with most aspects of cartography. The more affluent societies have instituted resource, monograph and

occasional paper series as additional outlets for research communication in cartography. Papers and articles reviewing the state of more specific aspects in cartography have also been compiled and published (Keats, 1977; Petrie, 1977; Rhind, 1977).

The exceptional growth in literature appears to have created a language barrier in cartography (Wolter, 1975). For many years German was the language of cartographic scholarship, but now English, Russian and Polish are becoming of increasing importance. Almost every study indicates the necessity for bilingualism or the initiation of an international abstract translation service for the cartographic community to keep abreast of important research developments and trends. Major reference bibliographies and abstract works are being published, notably by the International Cartographic Association (Meynen, 1975) and the German Society for Cartography which includes over 11 000 references contributed by some 35 countries (Zögner, 1975). The University of East Anglia has added a section on cartography to their Geo-abstracts series and bibliographies have begun to appear on such specific areas as automation (Bzdega, 1975; Peucker, 1972), cartographic communication (Board, 1976) and education in cartography (I.C.A., 1970b).

The founding of cartographic societies is for the most part a 20th century and more particularly a post 1950's phenomenon. Since the establishment of the Swedish cartographic Society in 1908 some 28 societies have come into being of which 23 have been formed since 1950 (Wolter, 1975). Ten were established in Europe, seven in Asia, two each in North and South America and one each in Australia and New Zealand (Robinson et al., 1977). The founding of the International Cartographic Association (I.C.A.) in 1960 with 56 member nations has provided cartography with a regular and recognised international forum, for the debate, discussion, stating and testing of all aspects relating to cartography as a field of study. Proceedings and papers are published and freely available. The I.C.A. has established at least 11 commissions and working groups to investigate and report on such diverse areas related to cartography as education, automation, communication, technology, history, oceanography, natural resources, thematic and environmental cartography (Gutsell, 1979). The I.C.A. has also undertaken the sponsoring of dictionaries, bibliographies, atlases and produced syllabuses for education in cartography. International conferences are held every two years in conjunction with the

International Geophysical Union (I.G.U.) and leading contributions are published in the International Yearbook of Cartography.

The increases in literature, journals and societies, since the 1950's, have all exhibited exponential growth patterns. In terms of the growth model proposed, cartography may be placed in Stage 2, approaching Stage 3 (Wolter, 1975; Robinson et al., 1977). These developments have also served to create some of the bases Robinson et al. (1977) considered essential in establishing an identity for cartography. A new identity however, requires a new definition and concept of the broader field of cartography.

### C. THE NEW DEFINITION AND CONCEPT OF CARTOGRAPHY

The initial impetus towards framing a new definition of cartography was created by the establishment of an international forum such as the United Nations and more particularly the International Cartographic Association (I.C.A.) which brought together, for the first time, cartographers with different viewpoints from many different countries. Tracing the attempts by various societies and individuals to frame an internationally acceptable definition for cartography can provide an indication of the fundamental problem which faced cartographers in the post 1950's, which was, the ability to reach consensus and place within a definitive framework, the changing nature, status, function and concept of cartography.

What had for centuries been the art and craft of chorographers, cosmographers, map-makers, surveyors, explorers and geographers, was given formal recognition and an identity by the Royal Society in 1843 as cartography (Wolter, 1975). Although no real attempt was made to define the field, there is little doubt that prior to the 20th century, cartography was considered essentially an art form only (Raisz, 1948). Commenting on a late 19th century treatise which commenced "... the art of drawing maps is called cartography..", Eckert (1908) argues that while conceding the art form, cartography is in essence "... not merely a technical art ... but an applied art ... governed and determined by scientific laws..." (p.3). Eckert's argument probably represents the first attempt to place cartography within the realm of a science.

The unprecedented demand for and widespread interest in maps generated by World War II, together with the motivation of a world mapping scale

initiated by the United Nations Organization (Grant, 1976), led to the first attempt to define cartography. The United Nations Report by the Committee of Experts in Cartography (U.N. 1949), produced the first widely used and internationally accepted definition of cartography -

"... the science of preparing all types of maps, and includes every operation from original surveys to final printing of copies. The types of maps and charts included are:

- i) topographic maps;
  - ii) geologic maps, soils maps, vegetation maps, cadastral maps, hydrologic maps, hydrographic charts and aeronautical charts, all of which are prepared upon a topographic map base; and
  - iii) office-compiled maps showing the location, extent and character of physical, economic and social phenomena..."
- (United Nations, 1949, p.7).

In spite of its acceptance, this first definition was severely criticized on the grounds that it is not clear whether it was intended as a general definition or merely an attempt to define the scope of the word (Leppan, 1966) in that it assumes cartography to be a science yet indicates nothing of its content, methods or tasks (Grant, 1976). Further, it embraced both original data collection (survey, geodesy) as well as final map printing, thereby constituting a basic conflict in the content of cartography. These functions had not been considered part of the cartographers field of activities since the late 19th century (Robinson, 1975a). Salichtchev (1970) contends the definition only reflects the practical conception of cartography that prevailed in the United States at that time.

By 1952 the American Congress on Surveying and Mapping (A.C.S.M.) accepted a definition which restricted both data collection (particularly survey) and the printing activities (Lock, 1975) and conceptualized cartography as the -

"...compilation of essentially new maps from existing basic data, the processing of maps in general through drafting and photo processing stages preparatory to reproduction (this does not include the production of original data from aerial photography and field surveys)" (A.C.S.M., 1952, p.49).

While the A.C.S.M. definition is probably closer to the generally accepted concept of cartography (Leppan, 1966) and provides realistic measures to the practical limits of the subject in most English speaking countries (Maling, 1964) it has also been criticized in several respects. Grant (1976) maintains it is an incomplete assessment of cartography's content, methods and tasks and does not represent the complete field of study. Although that most important component, compilation, itself defined as a science (Maling, 1964), is included, methods are restricted to applications and techniques of map production only, thereby perpetuating the technological view while ignoring the art/science relationship.

Conceptual trends in cartography followed a similar pattern in the Soviet Union. According to Salichtchev (1970), up to the early 1930's cartography was considered either a subdivision of geodesy or its scientific interests were limited to specific and relatively narrow mathematical problems. The practical demands of a diverse thematic mapping programme introduced in the 1930's led to advanced cartographic training being introduced at tertiary level by 1938. Under these influences cartography became the discipline -

"... that studies and devises the scientific - technical methods and processes of map compilation and reproduction: (Salichtchev, 1970, p.77).

Criticism that the technical aspects of cartography only were being emphasised led to the revised version in the late 1930's of -

"... the science that studies geographical maps and the methods and processes of their compilation and reproduction" (Salichtchev 1970, p.77).

Although defining cartography in the nebulous terms of geographical maps it did orientate cartography towards a science, but neglected the map user whom cartography should equip with methods and modes of rational map use (Salichtchev, 1970). Map use as an effective means of learning and as a practical activity provided the basis for Salichtchev's own, now classic 1954 definition of cartography as -

"... the science of geographical maps and a special method of representing reality, including in its tasks, together with the comprehensive study of geographical maps the devising of methods and processes of their making and use" (Salichtchev, 1970, p.78).

Although not generally accepted outside the Soviet Union, Salichtchev's 1954 definition does at least attempt to outline the content, methods and tasks of cartography for the first time.

The Cartography Sub-committee of the Royal Society's British National Committee for Geography, in its 1965 report on Education in Cartography, held that the subject ranged from -

"... the study of information collected by 'surveyors' - using that word in its widest observational sense - to the final reproduction of maps, and charts at any scale, on any subject and by any means" (p.18).

The criticism of this definition was in that it neglected to distinguish between cartographic science and production, included printing, ignored map users and was obviously biased towards creating a platform for education (Salichtchev, 1970; Grant, 1976). Meanwhile the newly formed British Cartographic Society (B.C.S.) formulated an English language definition in 1964 which was the most broadly based definition to date. Attempting to bring together the diverse nature and widely ranging concepts in cartography, the definition identified cartography as -

"The art, science and technology of making maps together with their study as scientific documents and works of art. In this context maps may be regarded as including all types of maps, plans, charts and sections, three dimensional models and globes representing the earth or any celestial body at any scale."  
(B.C.S., 1964, p.17).

It was the first definition to acknowledge the seemingly incompatible co-existence of art, science and technology as equals (Grant, 1976), a fact which had both exercised and intrigued Eckhert (1908) almost fifty years earlier. Although further addenda were added by the B.C.S. (1964) and the Royal Society (1965) they only served to either increase the range of map products or to specify the excluded fields more explicitly. The B.C.S. definition was to be widely accepted and acknowledged at international level when adopted as the English language definition by the International Cartographic Association (I.C.A.) in 1967.

Of the other attempts at framing or re-framing definitions for cartography about that time (Australian Institute of Cartographers, 1969; Petrie and Keats, 1968; Klawe, 1970; Salichtchev, 1970; Ontario Institute of Chartered Cartographers, 1973) only that of the French Cartographic Committee, 1965, was recognized to any extent. Cartography was defined as the -

"aggregate of scientific, artistic and technical studies and operations carried out, on the basis of the results of direct observations or from exploitation of documentation, for the elaboration and preparation of maps (charts), plans, and other modes of expression as well as for the utilization of the latter" (I.C.A., 1970a, p.6).

Grant (1976) maintains that the French definition is much broader in outlook and by including 'studies' and 'operations', introduces a much needed research component. While it explicitly excludes the techniques for basic mapping (survey, geodesy) the B.C.S. definition tacitly avoids the issue.

It is interesting to note that even the various Commissions appointed by the I.C.A. found it necessary to re-define cartography so that it would more clearly reflect the specific activities and purposes required (Grant, 1976). The I.C.A. Commission I, Education in Cartography, elected to adopt the French Cartographic Committee (1965) definition for working purposes whereas the official report of Commission I (1967) makes reference only to the adopted 1964 B.C.S. definition. In view of this, Grant (1976) considers that there should be a closer association between the practice of cartography as suggested by the 1964 B.C.S. definition and the pedagogic approach as indicated by the 1965 French definition for it is "... inconceivable to provide cartographic education and training for one set of skills and expertise, while the practice of cartography requires another set ..." (Grant, 1976, p.28).

South Africa, an accredited founder member of the I.C.A. has not ventured into the field of attempting to define cartography for its own specific needs. However, the view has been expressed that the B.C.S. (1964) definition is probably closest to present day thinking on this matter (Watson, 1970).

With the publication of the Multilingual Dictionary of Technical Terms in Cartography (1973b) by Commission II of the I.C.A., the issue seemed to have been settled with the English language definition being officially accepted as formulated by the B.C.S. (1964) and adopted by the I.C.A. in 1967. However at the opening of the IXth I.C.A. International Conference on Cartography in 1978, the President presented a new designation for cartography which he claimed, had the consensus of all member countries. The new designation proposed that -

"Cartography is the totality of scientific, technical, and artistic activities aiming at the production of maps and related presentations on the basis of direct measurements in the field or on aerial photographs or of source material of a different origin" (Ormeling, 1978, p.170).

In this designation, cartography is limited to cartography 'proper', i.e. to data presentation up to the reproduction and printing of maps and charts. It will be understood that in the practical application of this designation, the gathering of primary data, field surveying, and photogrammetry are excluded as are surveys carried out by other disciplines such as geology, statistics and zoology. A noticeable omission is however the phrase, 'their study as scientific documents and works of art' which was retained in the 1973 (I.C.A) definition at the insistence of the original commission (de Brommer, 1969).

A definition inevitably results in limiting the extent of concern of a subject. Tracing the background to the various definitions of cartography has not been with the intention of limiting the extent of concern of cartography or cartographers. Rather it has been to indicate the attempts by cartographers to crystallize the thinking and conceptualization of the content, methods and tasks of cartography. Although a variety of opinions of cartography are evident, all are indicative of a new concept of cartography as a field of study. Advances in technology, research, education and training lend support to the new identity of cartography as an emerging discipline and scientific field of study.

#### D. TECHNOLOGICAL DEVELOPMENTS

Viewed in retrospect, Ormeling's (1978) assessment of the importance of technological innovations is not without merit (see p.2). Technological advances in the areas of data capture and handling, image creation or generation, modification and multiplication since the 1950's have had a profound impact on cartography. As has been noted in the previous section, areas of original data collection by field surveying or photogrammetry, together with map reproduction or printing are excluded by definition from the activities of the cartographer. Nevertheless, to achieve the most accurate and desirable representation of information in any cartographic form or context, it is essential that cartographers have a more than adequate knowledge of the methods, applications, limitations and standards of the equipment needed to obtain that information or reproduce the end cartographic product. Discussion of technological developments must therefore include these areas of concern.

Primary ground and aerial survey techniques and procedures have changed significantly as a result of developments in optics and electronics. The introduction of sonic, electromagnetic and electronic measuring devices in photogrammetric and ground survey techniques has reduced overall geodetic and survey data acquisition time. Whereas conventional black and white (visible-light) air photograph cover was the primary data source by the mid 20th century, the development of special films, filters and camera equipment has broadened this data capability to include the invisible-light portion of the spectrum. New techniques in remote sensing, as it has become known, include true-colour, false-colour, infra-red photography, thermal infra-red imagery, side-scanning radar and gamma-ray spectrometry. When these techniques are combined with multi-bank cameras and optical scanners in conventional, rocket, satellite or spacecraft technology, raw data capture can match almost any requirement. (Muehrcke, 1970, 1972; Robinson et al., 1977; Petrie, 1977; McCormack, 1981).

In data capture from secondary sources such as line maps, photography or numerical data sources, the value of new technical developments is virtually unlimited due to the application of digitiser devices. Essentially designed for the statistical-mathematical manipulation of numerical data prior to the creation of the map image, digitisers now range in complexity from the manually operated to the fully automated

optical-mechanical scanner. Multiple access data banks for the storage of vast amounts of environmental data have been developed and are continually up-dated by such information handling sources as the National Cartographic Information Centre, U.S.A. (Robinson et al., 1977; Muehrcke, 1970, 1972; Linders, 1973).

The advent, during the late 1950's, of the high speed digital main frame computers and later mini-computers provided the basis for modern electronic data manipulation, processing and handling. The first successful attempts, according to Rhind (1977), at producing computer graphics were made by the middle of the decade on the now standard out-put device, the line printer. Cathode ray tube (C.R.T.) displays followed and the screen displayed 'temporary map' developed to suit specific user needs. Hard copy converters have subsequently been developed and range from simple line printers to highly automated and sophisticated line, drum and flat-bed plotters utilizing ink, light or scribing modes, linked to electrostatic, photo and micro-photo printers (Muehrcke, 1972; Robinson et al., 1977; Rhind, 1977).

Computer developments in the 1960's tended to follow two courses for cartography. One course was related to the involvement of researchers (geographers, botanists, geologists, geophysists and other earth scientists) primarily in the portrayal of data distributions while the other course tended towards computer-aided digitised productions of existing topographic maps (Rhind, 1977). Within ten years cartographic mapping programmes had been developed and incorporated into more than 300 universities, which made available automated mapping facilities to academics and researchers. By 1975, most national survey and cartographic organizations in Europe and North America had carried out experiments with automated mapping techniques. Computer-aided digitised mapping and computer controlled laser-assisted atlases have subsequently been produced and published (Royal Society, 1981). Certainly the potential of computer-aided cartography is not yet fully realized (Linders, 1973), even though the technology currently available "...probably far exceeds the associated level of conceptualization and theory essential to guide future developments.." (Robinson et al., 1977, p.9).

The graphic arts industry is, as a whole, a very large one and plays an important role in the communication of information in any modern society. From a technological point of view, however, map publication forms only a very small part of the industry. The main consequence is that special developments for specific cartographic purposes are rare and costs in research and developments are high in relation to the relatively small map production field (Keats, 1977). Most developments therefore tend to be derived as special applications from the graphic arts, printing and publishing field as a whole. The most notable exception to this model was probably the development of the plastics - associated equipment, procedures and techniques specifically designed for cartographic image creation and portrayal.

The development of the scribing technique, for both manual and mechanical operations in either negative or positive image creation, has resulted in a diversity of means of production for the cartographer (Baldock). Hand operated mechanical scribers have considerably speeded up repetitive symbol representation and double line (road casing) symbols have successfully been obtained from single line scribing through photographic procedures (Keats, 1977). Colour proofing of scribed originals has become a photographic rather than printing process and allows greater control to be exercised by the cartographer during map production. Scribing in turn has spawned a whole new set of almost exclusive cartographic instruments and procedures, resulting in substantial reductions in time, materials and costs. It has virtually replaced traditional pen and ink methods in all but the smaller cartographic establishments (Muehrcke, 1970, 1972; Robinson et al., 1977; Robinson et al., 1978).

Possibly the most obvious labour saving change is in the large variety of preprinted, pressure sensitive materials (lettering and symbols) which have become commercially available. These have permitted less skilled personnel to produce consistently higher quality cartographic presentations than was possible using traditional drawing methods (Muehrcke, 1972; Robinson et al., 1977). The development of photo- and computer-assisted type-setting machines, strip films and adhesive non-photographic waxes have ensured precision 'stick-on' lettering and symbols tailored to the individual cartographic requirement (Fry, 1979). Laboratory or in-house pre-sensitized peelcoat materials have simplified the preparation of colour-separation masks and together with specially developed chemicals and punch-registered systems have facilitated the

introduction of non-printing daylight colour-proofing techniques (Keats, 1973).

Photography and photographic materials for image modification processes have all benefited by technological advances. Precision process cameras and lenses specifically designed for graphic work have been developed and the replacement of the carbon arc lamp by quartz-halogen or pulsed xenon tubes ensures an even distribution of light (Keats, 1973). Plastic base materials enable the employment of the transparency and reversal processes, again giving alternate methods of production. Special films, chemicals and quick drying resin-coated papers are continually being researched and marketed. Technological advances in image multiplication are no less startling with the development of photocopying, electrostatic printing, paper and pre-sensitized printing plates, automatic plate processors, high speed multicolour printing presses and 35mm photo 'chip' originals enlarged to scale and printed electrostatically on demand (Keats 1973, 1977; Robinson et al., 1977).

One of the most significant developments new technology has brought to cartography is in the concept and form of the map itself, in which both photographic and conventional cartographic imagery are represented as a photomap (Van Zuylen, 1969, 1974; Robinson et al., 1977; Petrie, 1977). Although aerial photography and photo-mosaics have been freely available for several decades, the addition of line detail served only to enhance analysis and interpretation. Serious inherent flying, linear and relief distortions in the photography could only be controlled and corrected photogrammetrically. Experiments in pictomapping, a process combining different density phototone images lithographically to depict specific features such as vegetation, resulted in the first overall photographic background to a map (van Zuylen, 1969; Welch, 1972). However even with elaborate techniques, the production of pictomaps was not always satisfactory in terms of quality of the final image (Petrie, 1977). The breakthrough came when instrumentation and methods were developed which permitted the photographic geometry to be rectified to true photometric image. The rectified or orthophoto allowed the photographic image to be combined accurately with the conventional map image without the serious distortion errors of the original photography (van Zuylen, 1969; Petrie, 1977).

A completely new technology has become available since the 1950's and according to Robinson et al., (1977), even if no new technological innovation occurred by the year 2000 the field would be taxed to utilize current technology to the full. Technology alone however, does not promote unity in a field (Grant, 1976) but rather tends to isolate, divide or fragment tasks. Fragmentation not only leads to revised and simplified training programmes and shorter training times, but to the ready application of mechanical skills to fragmented tasks. For cartography in the third quarter of the century, these developments were to have a profound effect. As data acquisition and handling capabilities increased, the tendency was to pressure cartographers to produce:

1. Less expensive cartographic products.
2. Shorter cartographic production times.
3. New map forms.
4. New types of cartographic data (Muehrcke, 1972).

The adoption of or adaptation to new technological developments provided the means to alleviate some of these pressures. However it also resulted in the fragmentation and mechanisation of some of the cartographers previously valuable skills which had been acquired through training and experience alone. Whereas cartographic emphasis in both training and practice had been all too readily placed on the largely technical processes of map-making, a new trend became evident. The shift in thinking, and the growing academic interest, promoted notably by geographers (Wolter, 1975), was directed at formalizing the science underlying the art and technology of cartography (Muehrcke, 1972). For the first time a scientific framework for cartography as an identifiable field was being consciously researched and developed. In an environment where both technology and practice are undergoing change, the development of a definitive framework could provide the link which would bind the cartographic community together.

#### E. RESEARCH DEVELOPMENTS

The nature of research and the development of a research field in cartography, can be attributed to changes in the prevailing attitude to the concept and function of cartography since the 1950's. The growth of thematic cartography fostered a new approach to the study of the role of

the map and the map user in the cartographic communication process (Morrison, 1974; Robinson et al., 1977). This in turn led to the formulation of a conceptual structure and theoretical framework in which cartography, both as a field of research and a science in its own right, may develop.

It is difficult to identify the point when the change occurred which affected the perception of the function of cartography (Grant, 1976). It is equally difficult to determine where such changes originated. However the realization during the 1950's, that data capture capabilities far exceeded the capability of presentation, led to a growing awareness and acceptance of functional design orientated towards map use and the user, as the basis for creative cartographic effort (Robinson, 1952). The cartographic community was compelled to re-assess established and accepted design conventions and presentations in the communication of data and information. The movement away from the technological, engineering and survey concepts and procedures, prevalent prior to the 1950's, towards those of graphic content and presentation (Grant, 1976) notably by academics, was to have marked consequences in the development of research fields for cartography.

Research aspects of the 1950's tended towards such matters as the choice or method for the determination of class intervals for choropleth maps (Mackay, 1954), relief portrayal (Robinson and Thrower, 1957) or the selection of the correct projection for a specific map (Philbrick, 1953). Ironically these problems have yet to be finally resolved (Watts, 1970; Evans, 1977; Peterson, 1979; Snyder, 1979; Henoch and Croizet, 1976). The ongoing field of cartographic research normally includes accuracy, generalization, projections, scales, relief portrayal and the historical roots and methods of cartography.

It is possibly in the realm of thematic cartography, with the accent on map use and map user, that the greatest developments have taken place (Robinson et al., 1977). Although it can be argued that all cartography is thematic by nature, cartographic application even well into the 20th century required little more than the ability to accurately depict places, rivers, coasts, mountains, communication routes and boundaries or where the major geographical features were located. Consequently the concept of 'the map' was largely one of a topographic, hydrographic or navigational nature, the acme of geodetic accuracy and usually the

preserve of the large national survey or military organizations (Robinson et al., 1978). While early specific examples of thematic mapping existed, such as Snow's map of cholera deaths in London in 1848 (Monmonier, 1977) and Halley's work on magnetic theory and declination in the 18th century, (Thrower, 1978), they were not generally considered as part of traditional mainstream topographical cartography. By the mid 20th century, however, with the broadening of scientific enquiry and the branching out of science into separate fields, 'the map' became the medium for the communication of specific concepts or themes regarding the character of particular distributions. Using as a base the work of the national agencies, thematic cartography became concerned with communicating the work of earth, life and social scientists. The concept of 'the map' became one of densities, relative magnitudes, gradients, spatial relationships, movements and the many inter-relationships generated by these phenomena and data. Specific subject matter was drawn from such areas as history, geography, economics, urban planning, sociology, psychology, geology, hydrology and many of the other physical, life and social sciences. Of prime importance however was the concern for a properly designed, clear, legible graphic communication to assist the understanding, interpretation and analysis of the complexity of the spatial distribution of the earth's surface and resources (Robinson et al., 1978).

The changing concept of the map reflected the changing concept of the whole nature of cartography. The increased concern for the map as a medium of information communication, rather than as a storage medium for spatial data, provided the basis for a new concept with the central theme - the cartographic communication process. The sequences related to information flow linkages between a 'source' and a 'destination', concepts established in information and communication theory, were found to be easily adaptable to the field of cartographic practice (Jolliffe, 1974; Monmonier, 1977). The printed map, including the technical processes of production, as a transmitter of information is but one concern in a sequence of actions which begins with the concept (source) of the image to be conveyed and culminates with the intellectual or physical responses of the map user (destination). The concept of the cartographic communication process has probably created more research areas than any other to date (Robinson et al., 1977). Some of the more specific areas that have and are being researched in cartography are detailed below.

1. Value assessment studies relating to perception and symbolization.

These studies relate to the use of dot and shading patterns, their influence on the perception of value judgement in iso- and choropleth maps; the perception of areas, grey-tones, graduated circles, squares, and over-lapping circles as cartographic symbols; design modification and symbol identification and their effects in map reading, analysis and training; perception and estimation of dot maps, numerousis and the use of screens and scaling factors to enhance readability (Castner and Robinson, 1969; Meihoefer, 1969, 1973; Crawford, 1971, 1973; Flannery, 1971; Keats, 1972; Head, 1972; Williams, 1972a; Lo, 1973; Muehrcke, 1973; James, 1975; Olson, 1972, 1976; Provin, 1977; Balogun, 1978; Lloyd and Steinke, 1976, 1977; Hsu and Robinson, 1970; Barnes, 1978, Jensen, 1978; Muller, 1979). Many additional aspects of this type of research are listed by Morrison (1974) and Board (1976).

2. Psychological and psychophysical studies in map reading, use, search tasks, and related areas.

Areas of research include the determination, tracking and recording of eye movement parameters and patterns in map reading tasks, random search techniques and typographic legibility, type design, style, character, size and visual impact as an integral function of map design; the legibility of monochrome and colour relief maps; the design and production of fluorescent, orientation and embossed maps for night blindness, pilot performance and the visually handicapped (Eckman and Junge, 1960; Eckman et al., 1961; Bartz, 1970a, 1970b; Crandall, 1973; Gill, 1974; Pearson et al., 1974; Copland, 1974; Phillips et al., 1974; Amachree et al., 1977; Dobson, 1977; Phillips et al., 1977, 1978; Shimron, 1978).

3. The use of colour and colour perception in map production.

Research related to the effects of colour as it influences interpretation, analysis, user preferences and planning in cartography. These in turn affect design, legibility effectiveness and visual impact as well as photography, registration, proofing and costs in map production (Morrison, 1971; Cuff, 1972, 1973a, 1973b, 1974; Stolle, 1972; Feeken, 1972; Fischer, 1975; Harley, 1980).

Much of this research has been incorporated in current texts such as Keats (1974) and Robinson et al., (1978).

4. Graphic and cartographic design and presentation.

These research studies include investigating the principles of design theory and information display as applied to map layout, format, structure, content, symbolization and other graphic characteristics (Balchin and Coleman, 1966; Wood, 1968, 1972; Watson and van Rensburg, 1970; McGrath and Castner, 1972; McCullagh and Sampson, 1972; Jenks, 1976; Keats, 1973; Watson, 1976; Board and Taylor, 1977; Robinson, 1977; Bertin, 1978; Guelke, 1979; Monmonier, 1980). Research methods in cartographic design have been extensively discussed and summarized by Robinson (1977) and chapters on cartographic design are now standard inclusions in all major cartographic text books.

5. Automated or computer-assisted cartography.

The extensive development of soft-ware programmes to undertake almost all known cartographic data manipulation and tasks (O'Callaghan and Stanton, 1971; Peucker, 1972; Linders, 1973; Fryer et al., 1974; Stutz, 1975; Davis and McCullagh, 1975; Bzdega, 1975; Schofer, 1975; Wilford-Brickwood et al, 1975; Lock, 1975 with a most comprehensive review of the state of the art by Rhind, 1977) is now well documented in comprehensive edited texts and bibliographies, the latest of which are Monmonier (1982) and Taylor (1981).

6. Exploratory investigations into the development of cartographic theory and a structure for the discipline of cartography.

These studies relate to the concept of the map as a means of information communication; the application of information, communication and modelling theory and the adaptation of these theories to cartographic communication theory forming the basis of a philosophical and theoretical approach to the field of cartography. The changing emphasis towards cartography primarily as a science and not an art or technology; its historical associations with fostering disciplines (engineering, geography, survey) are all being subjected to research and debate. The development of a theoretical framework,

through communication theory, for cartography notably by Kolacny (1971) and Ratajski (1973) has been extensively reviewed and developed by Grant (1976) towards forming the essential structural and theoretical base of a pedagogic identity for cartography. (Imhof, 1963; Board, 1967, 1978; Kolacny, 1969, 1971; Balasubramanyan, 1971; Koeman, 1971; Ratajski, 1970, 1973, 1974, 1977; Salichtchev, 1970, 1973, 1978; Jolliffe, 1974; Morrison, 1974, 1976; Robinson and Petchenik, 1975, 1976; Grant, 1976; Guelke, 1976, 1977; Freitag, 1978, 1980; Kretschmer, 1978). The I.C.A., Commission V (Board, 1976) has published a provisional bibliography listing nearly 900 references to research work undertaken in the area of cartographic communication.

The diverse character, rigorous nature and exponential increase in research, evident in the continuing flow of journal publications since the 1950's (to which this brief summary can hardly do justice) fully substantiates and justifies Ormeling's (1978) claim to 'intensified research' in all aspects of cartography. Research, particularly academic research, of this order pre-supposes either the development of comprehensive educational, rather than training programmes or the substantial influx of academic researchers other than cartographers to the research field. In the next chapter the study reviews the development claimed by Ormeling (1978) of 'better education and training' while the identification of the growing body of academic researchers in cartography is considered in Chapter Five.

#### SUMMARY

A general growth model relevant to cartography as a developing field of study has been outlined. The bases of an identifiable scholarly field exhibiting exponential growth in professional societies and all components of the subject literature has been established and the evolution of a new definition of cartography examined. The continuing technological advances have been reviewed and some of the research developments promoted by the new concept of cartography as a communication process and emerging scientific field of study have been detailed.

CHAPTER FOUR

THE GROWTH AND NATURE OF EDUCATION AND TRAINING  
IN CARTOGRAPHY - SELECTED CASES SINCE THE 1950's

INTRODUCTION

Prior to the 1950's cartography in one form or another had been offered at various institutions of higher learning in the U.S.A., U.S.S.R, and some countries of Western Europe. Course orientation was, however, primarily directed towards cartography as map study, an analytical tool or for illustrative purposes. World War II and the decade that followed saw the generation of an unprecedented demand for a greater variety of cartographic products and consequently cartographic expertise (Robinson, 1963; Grant, 1976). These demands brought about the expansion of established map-making facilities, the creation of new mapping agencies and the involvement of a greater number of practitioners (Robinson et al., 1977). Career opportunities developed and the interest in education and training increased. This expanding activity posed many problems for the cartographic community, not the least of which was that additional personnel had to be trained (Jenks, 1953). The most important development however, was the acceptance of cartography as a field of study, worthy of intellectual and academic interest (Kish, 1950; Robinson, 1951; Bieshlag, 1951; Jenks, 1953; Maling 1957, 1958, 1959, 1964; Salichtchev, 1962).

Consequently, the content and structure of courses began to be more specifically considered, especially in North America and Western Europe. Since the 1950's, educational and training programmes are noted in literature to have been developed in Australia, Austria, Canada, Czechoslovakia, China, East Germany, France, Great Britain, India, Indonesia, Iran, Italy, Japan, Netherlands, New Zealand, Papua New Guinea, Poland, Spain, Switzerland, South Africa, West Germany, the U.S.A. and U.S.S.R. According to the differing emphasis placed on the cartographic needs or requirements, the levels and methods of introduction have varied in each country (Table 4.1). For example, Canadian cartographic education and training reflects a fair balance between university degree and college training programmes. Under-graduate or Bachelor degree courses in cartography are offered at 34 universities and two or three-year cartographic technician courses are available at 11

TABLE 4.1: LEVELS OF CARTOGRAPHY COURSES OFFERED IN SELECTED COUNTRIES.

COUNTRY	TECHNICAL		ACADEMIC				SOURCE	
	CERTIFICATE 2-YEAR	DIPLOMA 3-YEAR	BA/BSc. 3-YEAR	4-YEAR	POST- GRADUATE DIPLOMA	MA/MSc.		Ph.D.
Australia	X	X	X		X			Birtles, 1974; 1976.
Austria	X	X	X	X				Kretschmer, 1982.
Belgium	X	X	X					Depuydt, 1982.
Canada	X	X	X	X		X	X	Grant, 1976.
E. Germany	X	X	X	X		X	X	Ogrissek, 1982.
France	X	X	X	X		X	X	Carré, 1982.
Great Britain	X	X	X	X	X	X	X	Anson, 1982.
Hungary	X	X	X	X				Klinghammer, 1982.
India	X	X						Khosla and Datta, 1978.
Indonesia	X	X						Bos, 1978.
Iran				X				N.G.O., 1977.
Japan						X		Kananzwa, 1973.
Netherlands	X	X		X	X	X	X	Ormeling, 1982.
New Zealand	X	X						McCormack, 1980.
Papua N. Guinea	X	X						Braund, 1979.
Poland	X	X	X	X		X	X	Grygorenko, 1982.
South Africa	X	X						Noble, 1983.
Sweden	X	X						Palm, 1982.
Switzerland	X	X	X	X				Ficker, 1982.
U.S.A.	X	X	X	X		X	X	Dahlberg, 1977; 1981.
U.S.S.R.	X	X	X	X		X	X	Evteev, 1982.
West Germany	X	X	X	X				Haase et al., 1973.
Yugoslavia			X	X	X			Lovric, 1982.

colleges (Grant, 1976; Coulson, 1981). Selected syllabuses are given in Appendices A1 and A2. Cartographic education and training in the U.S.S.R. is offered at four different levels of expertise. Education at the universities of Moscow, Leningrad and Kiev for geographer-cartographers, through geography faculties concentrate on specialization and research in the application of thematic cartography to the earth, life and social sciences. Courses at the second level, engineer-cartographer, are offered at the Institutes of Geodesy, Aerial Survey and Cartography, through cartography faculties. Programmes are directed at the technological aspects of cartographic production, particularly the mass-production of popular, general or atlas type maps. Technical training at both the higher level, in compilation and design, and lower level, in draughtsmanship, is offered at the technical colleges of the State Cartographic Service or within cartographic organizations (Bolshakov, 1970; Evteev, 1982). The International Institute for Aerial Study and Earth Sciences (I.T.C.) in the Netherlands initially introduced courses for technicians and technologists in cartography. With the subsequent addition of correspondence courses, a two-year post-graduate diploma and a degree course to master's level, the I.T.C. now provides one of the most comprehensive cartographic instructional systems in Western Europe (Appendix A3).

In order to investigate more closely the implementation of educational and training programmes in cartography, three systems, as found in the U.S.A., Great Britain and Australia, have been selected as case studies. The selection is based on the availability of English language literature and differing educational systems, levels and methods. From the literature available, it would appear that in the U.S.A., the accent was placed on the introduction of cartography programmes in the universities with little attention paid to the development of technician training in cartography. A better balance between education and training seems to have been achieved in Great Britain with degree courses confined to fewer universities and well designed technical training programmes integrated into the national educational structure. In Australia, however, the initial emphasis was on the introduction of technician training programmes in cartography at all state technical institutes or colleges. The subsequent introduction of degree courses has been at two institutions only. These case studies therefore provide general models against which cartographic education and training in South Africa may be reviewed. However as much of the impetus in education and training can be attributed to the influence of the I.C.A., international developments

also need to be considered. Reviews of the selected cases are presented as detailed below.

- A. International Developments.
- B. The United States of America.
- C. Great Britain.
- D. Australia.
- E. South Africa.

Before proceeding with the reviews, two major aspects need to be clarified. Firstly, early cartographic teaching programmes in universities in both North America and Europe are referred to as 'training' programmes. It was not until the mid 1960's that the term 'education' appears to have been adopted with particular reference to university courses (Moriarty, 1965; Royal Society, 1965). Accepting the distinction, for the purposes of this study the term education refers to graduate and post-graduate university degree programmes. The term training refers to certificate or diploma courses offered primarily by technical colleges or institutions. Secondly, 'cartography as a specialization', occurs frequently in the literature and indicates that in a specific degree programme, courses in cartography form the major study component within host disciplines such as geography, surveying, geodesy or engineering (Anson, 1980; Dahlberg, 1981).

#### A. INTERNATIONAL DEVELOPMENTS

As the International Cartographic Association (I.C.A.) became the principal forum for cartographic debate, the appointment of Commission I, 'Education in Cartography' in 1964, may indeed have influenced thinking and terminology with regard to education and training. The 1970 report of Commission I identified three areas of cartographic activity (W, V and Z), provided a set of typical or ideal syllabuses for the education and instruction of cartographers (I.C.A., 1970a), (Appendix A4), and a working bibliography for education and training in cartography (I.C.A., 1970b).

The areas of activity were defined as:-

W: Essentially cartographic activities of persons who, due to education or position held, devoted 75 - 100% of their time to cartography.

- V: Activities affected by cartography, which while not representing the essential feature of a training, nevertheless constitutes an important part of the education (geographers, geologists, engineers, topographers, map custodians, surveyors, military personnel etc.).
- Z: Related activities where cartography represents a slight part of the instruction (publishers, archivists, printing and graphic art technicians etc.) (I.C.A., 1970a).

The following categories of cartographers were identified:-

- W1: Scientific or academic cartographers, geographical cartographers and scientific or academic cartographical engineers.
- W2: Engineers in cartographic work, university graduates in cartography, chief cartographers.
- W3: Confirmed (authorized) cartographers.
- W4: Cartographic draughtsmen or assistants (I.C.A., 1970a).

The functions, activities and levels of expertise of each category of cartographer are detailed in Table 4.2. The V and Z categories were not considered by Commission I and are not considered in this study.

The approach of the Commission was necessarily idealistic but the significance of the classification was in the identification of progressive categories of cartographic personnel and expertise. Ranging from purely technical to scientific-academic, each required a very different type of education or training (Grant, 1976). Setting out the general principles of the syllabuses, the Commission stressed that they ideally cover both the whole range of knowledge and the subjects considered essential to cartographic instruction. The particular needs, functions and tasks envisaged, as well as levels of education previously reached, should be taken into consideration by each individual user when introducing or developing the syllabuses (I.C.A., 1970a).

While generally accepted as a basis for a curriculum in cartography (Grant, 1976) there is little evidence in the literature of the syllabuses being implemented. Kanazawa (1973) considers the equating of

TABLE 4.2: CARTOGRAPHIC EXPERTISE AND ACTIVITIES (AFTER I.C.A., 1970a).

CATEGORIES	SUGGESTED EDUCATION LEVEL OR ENTRY EQUIVALENTS	FUNCTIONS (TASKS)
Essentially cartographic activities designated W, of persons who due to education or position held, devote 75 to 100% of time to cartography.		
W1 Scientific or academic cartographers: geographical cartographers and scientific or academic cartographical engineers.	W1 (Doctorate or Professorial status).	W1 Scientific Research and/or the Organization of Faculties or Departments of Cartography.
W2 Engineers in cartographic work, university graduates in cartography, chief cartographers.	W2 Higher instruction, at universities or engineering schools. (Post-graduate degree).	W2 a) Documentation, studies, research, design (conception); b) Teaching; c) Organization and direction of work, planning.
W3 Confirmed (authorized) cartographers.	W3 Secondary or technical instruction. (Bachelor degree or three year technologist diploma).	W3 a) Checking, supervision; b) Elaboration of originals (compilation, preparation, generalization); c) Execution of works involving an important part (amount) of interpretation; d) Techniques requiring special qualifications.
W4 Cartographic draughtsmen, or assistants.	W4 Primary, elementary or professional (on-the-job) training. (One or two year, technician certificate or diploma).	W4 a) Duties essentially of production involving only a minimum of interpretation, current productive work of a routine kind (line drawing, lettering, colour washing, etc.) using various processes.

the syllabuses with actual training, the selection of suitable subjects and finding suitably trained personnel to undertake teaching to be the major problems associated with the introduction of cartographic education in Japan. In Canada, Klawe (1970) has presented a cartographic syllabus, based on the concepts of the I.C.A.'s syllabus, while making use of existing courses at the University of Alberta (Appendix A1). The proposed B.Sc. programme, in association with the department of geography, allows for the development of a special curriculum, and is a realistic attempt to integrate the I.C.A. syllabus into an existing Canadian university structure (Grant, 1976). It would appear that in most countries, education and training programmes in cartography are being developed in and through the existing educational systems according to national and commercial demands rather than in terms of the I.C.A. recommendations (Meine, 1973). The very existence, however, of a set of 'typical or ideal' syllabuses does provide a basis from which to evaluate education and training needs, the selection of suitable subjects at all levels and an indication of the training or teaching personnel required. Developments in selected countries since the 1950's, are examined against this background.

## B. THE UNITED STATES OF AMERICA

Cartographic instruction in the U.S.A. has developed predominantly in the universities and state colleges through under- and post-graduate degree programmes. Cartography in the community colleges offering a two year credit programme for either university or college entrance or technician diploma purposes, does not appear to have been developed to the same extent.

Journal literature provides little information on the content of cartographic programmes in the U.S.A. Articles and papers indicate rather the number of courses offered, the objectives of training and the fundamental aspects that should be included in any teaching programme (Robinson, 1951; Kish, 1950; Jenks, 1953). The increasing recognition of cartographic specializations (Bieshlag, 1951) led to the first real attempt to determine the extent and content of cartographic teaching in the U.S.A. and Canada. Reporting on the preliminary survey conducted by Raisz, Kish (1950) identified 62 universities (against 29 in 1948) offering one or two, 14 offering three or more courses in cartography and seven universities which offered graduate work in cartography. All

courses, however, were primarily orientated to the use of cartography in geographical analysis or as an illustrative aid to research work (Leighly, 1979).

By the early 1950's some North American academics, notably geographers, were beginning to express interest in cartography as a field of study. Bieslag (1951) recommended the training of student cartographers at university level to provide the teachers of the future while Robinson (1951) entered a plea for university training for government cartographers. Jenks (1953) pointed to the repeated attention training problems had received in professional literature indicating that the American Association of Geographers (A.A.G.) had devoted 'several meetings' to the problem of cartographic training. Bachelor degree courses with a cartography specialization are noted by Randall (1959) as having been introduced in the early 1950's at two state universities, Ohio and George Washington. Although by 1953, well over 100 institutions offered training in cartography (Jenks, 1953), the increasing numbers did not solve the problem of poorly trained map-makers. Both Salichtchev (1962) and Tobler (1976) concurred with this point of view. Salichtchev noted that of the 200 courses offered in the 1960-61 academic year only 118 could be termed 'cartography proper'; the balance lacked specific cartographic content or were not offered regularly. Tobler contended that the production of graduates with cartography as a specialization was insufficient to fill all available teaching positions. As a consequence, the newest or youngest staff member was often assigned the cartography course, in which they may not have had a great deal of training or commensurate interest (Tobler, 1976). Jenks (1953) did however set the responsibility for cartographic teaching firmly within the university framework. He also made significant proposals with regard to a curriculum based on recommendations by personnel in government and commercial mapping organisations. Of major consequence was his rejection of 'super' departments of cartography on selected campuses as proposed to the A.A.G. as early as 1950. Jenks (1953), supported later by Robinson (1969), recommended a broadening of the scope of university geography departments to accept responsibility for cartographic training - a recommendation, the implications of which are still very much apparent in American cartography today (Dahlberg, 1977). Reviewing the state of cartography in American universities, Salichtchev (1962) observed that in the period 1952-1962, enrolments, a basic indicator of growth, had nearly doubled to some 3 600 students, and that four universities offered a 'thorough training' to master's or doctoral level in cartography as a

specialization. Considering the 1960-61 academic year in particular he noted that undergraduate programmes in cartography, provided primarily through geography departments, were heavily biased towards the acquisition of the technical skills of elementary draughtsmanship.

By the late 1960's a new approach to the teaching of cartography could be identified which decreased the emphasis on the practical skills and the tendency to produce university educated technicians (Moriarty, 1965; Robinson, 1965). Although the inclination was still to maintain the cartographer as the skilled craftsman, American cartographic leadership on the other hand was becoming more concerned with understanding the academic concepts of cartographic communication and the information communication process (McCleary, 1972; Robinson, 1973; Steward, 1975).

The shift in objectives highlighted the dichotomy between education and training (Moriarty, 1965). Whereas the primary objectives of cartographic programmes had been towards the development of the skills and expertise required in all aspects of map-making, these were replaced by programmes reflecting the new conceptual, quantitative and technological advances of cartography as a science. Graphic communication, design, symbol research and user perception, together with computer-assisted data manipulation in projection construction, statistical and thematic mapping techniques became the key objectives. As the general application of technological developments had reduced the actual map-making techniques to a series of mechanical and photographic techniques they were considered as no longer of serious academic interest. The concept of a cartographic training at university was replaced by one which adopted a more academic approach or offered an 'education' in cartography at university level (Moriarty, 1965). Typical of the syllabuses is the degree programme at Wisconsin (Appendix A5).

Cartographic education nevertheless continued to grow in all aspects. Increased numbers of institutions offered increased numbers of courses to increased numbers of students (Table 4.3). Although the data available in literature are neither complete or comprehensive enough to be of statistical value they do indicate the trends. From a scant 29 institutions offering cartography prior to the 1950's, within three decades the number had increased by almost 900% to over 250. Exponential increases in the number of courses offered and student enrolments also

TABLE 4.3: NUMBER OF INSTITUTIONS OFFERING CARTOGRAPHY, COURSES AND STUDENT ENROLMENTS IN THE U.S.A.

YEAR	NO. OF UNIVERSITIES/ STATE COLLEGES	NO. OF COURSES OFFERED	STUDENT ENROLMENT
1948	29	Not Stated	Not Stated
1960	138	118-200	3 600
1972	264	466*	11 700
1975	258	470	10 000

\*Includes cartography related courses. Sources: Kish (1950); Salichtchev (1962); Wolter (1975); Dahlberg (1977).

TABLE 4.4: DEGREE PROGRAMMES WITH CARTOGRAPHY AS A SPECIALIZATION IN THE U.S.A.

YEAR	NO. OF DEGREE AWARDING INSTITUTIONS	NO. OF DEGREE PROGRAMMES		
		BA/BS	MA/MS	Ph.D
1951	7*	-	-	-
1975	18	Not stated	18	7
1981	27	27	20	10

\*One course post-graduate work through Geography. Sources: Kish (1950); Dahlberg (1977, 1981).

TABLE 4.5: DEGREE PROGRAMMES IN CARTOGRAPHY IN THE U.S.A.

YEAR	NO. OF DEGREE AWARDING INSTITUTIONS	NO. OF DEGREE PROGRAMMES		
		BA/BS	MA/MS	Ph.D
1975	4	3	1	-
1981	5	3	2	-

Sources: Dahlberg (1977, 1981).

demonstrate the acceptance of cartography, not only as an academic subject, but one in its own right (Monmonier, 1978). In his two most comprehensive studies on cartographic education in the U.S.A., Dahlberg (1977, 1981) indicates that differing criteria of tuition in institutions, course frequency, content, duration and enrolments make meaningful statistical analysis most difficult. However further indications of the development of education in cartography can be found in the growth of institutions offering post-graduate courses (Tables 4.4 and 4.5) and higher degree awards (Table 4.6).

Three interesting facts emerge from these data. Firstly, the almost four-fold increase in the number of degree programmes in geography, geodesy and engineering which offer cartography as an independent specialization (Table 4.4). Secondly, there are at least five universities offering degrees, two to master's level, in cartography as a discipline in its own right. However, as yet there are no full Ph.D. programmes in cartography (Table 4.5). Thirdly, the number of doctorates awarded with a cartography specialization (Table 4.6) is of interest because of the key role these specialists play in future educational programmes (Dahlberg, 1977). Specialization in cartography has occurred most frequently through geography and the availability of specialist cartographic personnel has led not only to the extension of programmes in geography departments but also the upgrading of existing courses and the development of research opportunity (Dahlberg, 1981). The growth of doctorates awarded during the decade 1965-1974 is especially pronounced, representing 28 degrees or 76% of the overall 30-year total 1945-1974. Only nine degrees, or 24%, were awarded in the 20-year period 1945-1964.

In sharp contrast to the academic development in cartography, the training establishments did not respond to the need to train cartographic technicians. The expected development of technologist and technician training programmes in the Community (two-year) Colleges did not take place (Dahlberg, 1977, 1981). Community Colleges numbered over 1 200 in 1974, yet by 1981, only six offered training in cartography and only four, training to technologist level (Dahlberg, 1981). The lack of training programmes offered may well be attributed to the lack of recognition by the Colleges, of the shift in emphasis from the more technical to more academic courses in the universities. College courses also often serve as entrance qualifications to university and it is possible that aspirant cartographers proceeded to university to acquire

TABLE 4.6: Ph.D. DEGREES WITH CARTOGRAPHIC SPECIALIZATION AWARDED BY U.S. INSTITUTIONS BY FIVE-YEAR PERIODS, 1945-1974.

FIVE-YEAR PERIODS	Ph.D. DEGREES NO.	CUMULATIVE TOTALS NO.
1945-1949	1	1
1950-1954	1	2
1955-1959	3	5
1960-1964	4	9
1965-1969	13	22
1970-1974	<u>15</u>	37
	TOTAL	37

Source: Dahlberg, 1977.

TABLE 4.7: PRIVATE CARTOGRAPHIC ORGANIZATIONS IN THE U.S.A., BY SIZE AND EMPLOYMENT CLASSES, 1974, (AFTER LEVERENZ, 1974).

FIRMS		CARTOGRAPHIC CLASSES		
CATEGORY	NO. OF CARTOGRAPHIC PERSONNEL EMPLOYED	MAPPRODUCTION (TECHNICIANS)	COMPILATION/ DESIGN (TECHNOLOGIST/ GRADUATE)	RESEARCH/ EDITORIAL (GRADUATE/ P-GRADUATE)
Small	Less than 8	90%	10%	-
Medium	8-15	75%	20%	5%
Large	Over 30	65%	25%	10%

degree status rather than directly into employment. However, with an estimated enrolment of some 3,5 million students on which to draw, Dahlberg (1977) considers the promotion and introduction of comprehensive

training courses in cartography at the Community Colleges to be of primary importance.

The outworking of the emphasis on the academic approach, coupled with the lack of development of adequate training programmes has seriously affected employment opportunities, particularly in private commercial cartographic organizations. Considering conditions in private organizations during 1974, Leverenz (1974) indicates that many smaller cartographic firms were unable to afford the more highly educated cartographer. The study by Leverenz (1974), the only one to date, categorized the private commercial firms in the U.S.A. according to the number of personnel employed. Relating the various work functions to qualifications, he noted that the research, design and the compilation functions were being performed by personnel at the technical level (Table 4.7). While there was a small but consistent demand for people to fill the professional function (Wasserman, 1972), larger organizations also have a greater need for technicians. The same situation may equally well apply to employment opportunity with non-profit or government organizations, which are, by far, the employers of the greatest numbers of cartographic personnel (Leverenz, 1974). A recent survey cited by Leverenz indicated too few universities and colleges have broad enough academic and technical curriculae to allow graduates to enter the field with sufficient knowledge and the basic skills. Dahlberg (1981) contends that institutions rely on employers to teach the basic technical skills while firms have expected the universities to provide this foundation. The ability of the potential cartographer to obtain employment in cartographic organizations is therefore often hampered by this gap in course structure (Leverenz, 1974).

Recognizing the need to bridge the lack of training in cartographic skills, several universities, notably Michigan State and Syracuse, re-introduced a greater technical map production component into their undergraduate programmes. Prompted by the inability often to obtain employment (Monmonier, 1975), the pragmatic approach of students towards course selection has shown the desire to develop specific marketable job skills (Williams, 1975). In order to overcome the near-absence of technician training, Dahlberg (1981) proposed that knowledge-skill matrices be devised for each individual course offered in cartography at university level, so that at least the basic technical skills pertaining to each course are acquired by students.

Exponential increases in the number of institutions offering cartography, courses and student enrolments have characterized the academic development of cartography in the U.S.A. since the 1950's. The neglect of training programmes has also become apparent and of growing concern to both the private and government cartographic organizations where the greater need is for trained technical personnel. A better balance between education and training appears to have been achieved in Great Britain since the 1950's. A review of these developments, as noted in the literature, forms the basis of the second case study.

### C. GREAT BRITAIN

Post-war cartographic education and training in Great Britain appears to have developed at a more conservative rate than in the U.S.A. Literary evidence suggests that the prevailing technical concept of cartography, and the still accepted system of apprenticeship, together with the staffing policies of major employers, may have been responsible for this later development (Wiggins, 1958; Mumford, 1968). Despite the advances which had been made in map-production during the war and the post-war increase in the demand for and use of maps, no university, by the mid-1950's, offered graduate training for cartographers in Great Britain (Maling, 1957). Since cartography as a subject was seldom taught beyond a very elementary level through geography at universities, even an honours degree in geography was of little value to either employers or prospective cartographers (Wiggins, 1957; Maling, 1958). There were only two criteria by which the proficiency of cartographers was gauged. The first was to have been trained at the School of Military Survey (S.M.S.) or the Royal Engineers (R.E.) and the second was to have served an accredited apprenticeship in cartography gaining the necessary experience in one of the private commercial mapping establishments (Mumford, 1968).

It is notable that the first graduate course in cartography, since the publication of the report 'Cartography in the Universities' (Balchin and Pye, 1944), was introduced at Swansea University College under Professor Balchin in 1957 (Balchin, 1957). Following a year of investigation into the needs of both government and private cartographic organizations, a fourth year honours level, specialist cartography course was developed and offered to graduate geography students (Maling, 1957; 1964).

By 1960, course changes to include cartography as a specialization were also being implemented in the department of Geography at the University of Glasgow (Petrie and Keats, 1968). Originally, courses in surveying and cartography were given within the curriculum of the degree of Geography. With an increasing number of students wishing to specialize in these subjects and with the development of teaching and research programmes, quite separate qualifications were instituted within the department. A post-graduate Diploma in Cartography was introduced in 1963 and the B.Sc. Honours degree in Topographic Science, with Cartography and Surveying or Photogrammetry as majors, in 1966 (Petrie and Keats, 1968).

Initial reaction to these courses by the survey establishments was generally, however, one of non-acceptance of the graduate status which commanded no interest as a qualification for employment by either Ordnance Survey (O.S.) or the Directorate of Overseas Surveys (D.O.S.) (Mumford, 1968). Employment by O.S. and D.O.S. was still the sole preserve of officers and trainees of the S.M.S. or R.E. The situation, perpetuated by the military, was considered an essential function of military peacetime activity (Mumford, 1968). The effect of this attitude on education in cartography was of great importance. The non-acceptance of external graduate qualifications by O.S. and D.O.S., by far the largest employers of cartographers, mitigated against the general recognition of a university education for cartographers. Petrie and Keats (1968) note that of the 24 post-graduate diplomas for cartography awarded by 1968, none of the holders had obtained employment at either O.S. or D.O.S. Graduate cartographers from Swansea and Glasgow, the only two offering cartography, found employment in commercial air survey organizations, teaching or in other government departments with limited promotional horizons (Mumford, 1968). Nevertheless cartography continued to be introduced at universities both as a specialization or as full optional courses. By 1971, the University of Edinburgh had introduced degree courses in cartography at fourth year honours level for Arts, Science and Social Science students with nearly 1 000 students taking the various degree examinations in cartography that year (MacGregor, 1972). By 1973, cartography as a full optional course at second or third year level was also offered, primarily through Geography, at a further five universities in Great Britain (Maling, 1973).

Meanwhile cartography as a subject had been introduced at four Polytechnics or Colleges of Higher Education in the early 1970's (Beard and Cooper, 1972; Anson, 1974, 1978). Initially designated as a two year technical qualification, the gradual upgrading of courses led to an investigation into the equivalence of academic qualifications in cartography by the Council for National Academic Awards (C.N.A.A.). The Council was formed specifically to consider equivalence in course structure and content as offered by the various institutions of higher education, and by 1979, five Polytechnics and one College of Higher Education were awarded degree status for their under-graduate courses in cartography (Royal Society, 1981). Post-graduate opportunity also continued to expand as the Department of Topographic Science at Glasgow introduced the Master of Applied Science (M. App. Sci.) degree in cartography, surveying or photogrammetry in 1976 (Appendix A6). In addition opportunities were made available to undertake research in cartography with a view to the award of an M.Sc. or Ph.D. degree (Petrie, 1979). Anson (1980) reported the state of cartographic education in Great Britain as indicated in Table 4.8.

The conservative approach to the introduction of university programmes in Great Britain, as compared to that of the U.S.A., is not only evident from the data in Table 4.8, but also in the post-graduate enrolments or awards of the two leading universities offering cartography, Swansea and Glasgow. Post-graduate enrolment figures for Swansea reflect some 10 Diplomas in Cartography awarded between 1958-1963 with an increase to 'about six per year thereafter' (Maling, 1979). Post-graduate diplomas and research degrees awarded by the University of Glasgow between 1965-1979, comprised seven B.Sc. with cartography as a specialization, 106 Diplomas in Cartography and two each M.App.Sc. and M.Sc. degrees (Petrie, 1979).

TABLE 4.8: DEGREE PROGRAMMES IN CARTOGRAPHY OR WITH CARTOGRAPHY AS A MAJOR SPECIALIZATION IN GREAT BRITAIN, 1981.

NO. OF DEGREE AWARDING INSTITUTIONS	NO OF DEGREE PROGRAMMES					
	2-YEAR SPECIALIZATION WITHIN BA; BSc.	BA: 3-YEAR DEGREE	B.Sc. 4-YEAR DEGREE	POST-GRADUATE DIPLOMA	MA/MSc	Ph.D
13	9	4	4	2	2	1

Technical training, on the other hand, and the question of qualifications had been a subject of discussion by numerous bodies throughout the 1950's and early 1960's. According to Mumford (1968) several factors mitigated against the adoption of an overall policy towards the training of technicians in cartography.

1. Individual apprenticeship training programmes were still favoured by both government survey and commercial employers even though difficulty was experienced in obtaining suitable entrants.
2. The lack of recognition of any external qualification particularly as the general technical 'trade or engineering drawing' courses had little application to, and therefore market value in, cartographic work.
3. The lack of advancement opportunity in government organisations such as O.S., D.O.S. and the Hydrographic Survey Department for non-military trained cartographers.
4. The creation of single classes of employees in essentially similar occupations by the Civil Service resulted in all grades of draughting technicians being designated draughtsmen. Consequent common recruitment standards recognized no differences between the cartographer and any other type of draughtsman.
5. The systems of apprenticeship, learnership, in-house training and the influence of craft and trade unions put an effective limit on the acquisition of skills and experiences for professional and administrative management advancement which countered the sense of equality of opportunity, particularly in the education field.

The 1965 report of the Royal Society's Cartography Sub-committee of the British National Committee for Geography found that training varied from institution to institution. Most training courses treated cartography as synonymous with draughtsmanship and there seemed to be little specific cartographic training. The report also proposed guidelines for syllabuses and recommended that training should lead either to a Diploma in Cartography from a College of Technology or a M.Sc. in cartography from an advanced degree course at a university. As the recommendations were not generally recognized or accepted, Mumford (1968) considered they

had initially been set at too high a standard. During subsequent years a more realistic separation of the academic from the technical levels in relation to the occupational fields led to a more realistic approach to the problem of training.

Under the aegis of the Royal Society, a conference was organized in 1968 to consider all aspects of education and training in cartography (Wiggins, 1970). Representation included the Department of Education and Science, (D.E.S.), the universities and the major government survey and commercial employers of cartographers. Items discussed included international developments in cartographic education and the role of the universities, the existing training requirements of O.S. and D.O.S. and the commercial mapping agencies as well as training facilities available for aspirant cartographers. As university courses were already established, the primary focus of the conference turned to the training of cartographers. Taking advantage of the presence of representatives of the D.E.S., who were ultimately responsible for education and training in Britain, the following resolution was framed, presented and adopted: "This Conference, recognising the need in government, academic, and commercial spheres for adequate levels of technical education in the fields of cartography, photogrammetry, and surveying, urges the Department of Education and Science and the Scottish Education Department to take immediate steps to set up a Joint Committee for the formulation of requirements for qualifications in these subjects at Ordinary and Higher National Certificate levels" (Mumford, 1968 p.90).

The conference was the first occasion on which the various parties interested in the training of cartographers were brought together. Previously each had been trying to negotiate separately with the D.E.S. for some formal recognition of their own training programmes (Mumford, 1968). The decisive factors, considered Wiggins (1970), in the formal acceptance of the proposal, was not only the combined representation but the backing of the influential Royal Society. A Joint Committee under the direction of the D.E.S. was formed to consider the introduction of training courses in cartography. Cartography alone, however, was thought unlikely to be viable as a one course offering. A growing need for surveying and planning qualifications, which had also been noted by the Joint Committee, if coupled with cartography would provide the best overall basis for introductory courses (Wiggins, 1970). Consequently draft outline syllabuses in cartography, surveying and planning were

prepared with common first year core subjects which allowed for specialization in the second year. Entry level was set at four years secondary education or O level. Ordinary National Certificate (O.N.C) two year courses were introduced at technical colleges in both England and Scotland in 1971. Higher National Certificate (H.N.C.) courses, requiring a further two year training period, were introduced a year later. By the academic year 1972-73, student enrolment had increased to almost 500 for the O.N.C., and 60 for the H.N.C. courses offered (Maling, 1973).

Of greater importance than the growth in full-time enrolments was the effect that the introduction of these courses had on the government cartographic organizations. Although continuing to offer initial training to school leavers as learner cartographic technicians, D.O.S., O.S. and the Hydrographic Survey now required trainees to attend at least O.N.C. level courses as an integral part of their training (Maling, 1973; Anson, 1980). Trainees were, moreover, encouraged to proceed to the H.N.C. level and the acceptance of recognized external qualifications represented a major breakthrough in the development of training in cartography in Great Britain (Maling, 1973). Further, the introduction of approved courses through the D.E.S., provided for cartographic technician and technologist training to be developed within the existing technical educational system in support of the more specialized academic programmes instituted by the universities and polytechnic colleges.

In spite of the recognition of training courses, benefits for cartographers were slow to accrue. Boud (1974), in a study of 56 government and commercial organizations, employing 860 cartographers, found a significant lack of interest by employers in technical training qualifications in cartography. He suggested that two possibilities existed for this attitude. The first was that employers were not yet familiar with the O.N.C. and H.N.C. qualifications which had only been introduced some five years earlier. Second, the lack of interest possibly signified a certain alienation between employers and cartographic instructors with regard to the value of the qualifications. Many employers still favoured apprenticeship as the only acceptable form of training, and considered college instruction incapable of providing the essential day-to-day technical training required. In terms of employers' requirements, Boud (1974) determined rating values for factors by which applicants for cartographic posts could be assessed. Employer

rankings of 'very important', 'important' and 'not important' for nine factors, were scored at three, two and one mark each respectively and an overall rating value for each determined (Table 4.9).

TABLE 4.9: FACTORS LOOKED FOR BY EMPLOYERS WHEN ASSESSING APPLICANTS FOR CARTOGRAPHIC POSTS IN GREAT BRITAIN (BOUD, 1974).

ASSESSMENT FACTOR	OVERALL RATING
Quality of cartographic work	125
Cartographic experience	118
Imagination of flexibility	117
Variety of cartographic work	105
Personality	102
Education (General)	87
Education (Professional)	75
Age	73
Sex	57

The ratings reflect a measure of the overall importance of each attribute to the employers of cartographic personnel. With the lack of interest in technical training qualifications, it is not surprising that, when recruiting, more emphasis was placed on skills, ability and experience than on education and training. Consequently over two-thirds of all employers had experienced difficulty in filling vacant posts (Boud, 1974). It was also established by Boud's survey that military personnel continued to maintain control of the higher posts in the larger government mapping organizations. Commercial mapping enterprises had found it equally difficult to replace the jealously guarded apprenticeship entry system with diploma applicants in the face of craft and trade unionism (Boud, 1974).

The early 1970's is noted by Anson (1982) as a period of substantial change in the approach to technical training. In an attempt to rationalize the diverse provision of technician training programmes that existed for all areas of employment, with over a quarter of a million students in more than 500 Colleges, two Councils were formed in 1973. In

response to the recommendations of the government sponsored Hazlegrave Committee on Technician Courses and Examinations, which reported in 1969, the Technician Education Council (T.E.C.) and the Scottish Technical Education Council (S.C.O.T.E.C.) assumed responsibility for technical education and training, course arrangements, standards and awards in 1974. Cartography was linked with Surveying, Planning, Land Use and Hydrography and courses were developed for each area to Certificate level. The last full intake to both O.N.C. and H.N.C. courses took place in 1976, and although the Joint Committee was formally disbanded in 1978, its training schemes continued to operate under the T.E.C. and S.C.O.T.E.C. until 1980. During the period 1971-1980, O.N.C. and H.N.C. courses in cartography were offered at 25 Colleges and some 1 150 awards were made. The new T.E.C. and S.C.O.T.E.C. Certificate and Higher Certificate programmes were comparable with the O.N.C. and H.N.C. qualifications and standards and by 1981, 24 Colleges were operating T.E.C. or S.C.O.T.E.C. Certificate programmes in cartography. Higher Certificate programmes based on existing H.N.C. courses in cartography, were offered at four Colleges (Anson, 1982).

Anson (1980) notes that while significant developments had occurred since 1975 within the field of education and training in cartography, far reaching technological and economic changes have influenced all mapping and related fields. Post-graduate university courses are being increasingly orientated toward computer-assisted cartography. As demand for this type of specialization, however, remains small, graduates are experiencing difficulty in obtaining employment. In the bleak financial climate of the early 1980's, non-replacement and post-freezing policies also affected technician employment in the cartographic fields as in all other sectors of the economy (Anson, 1980).

Looking to the future development of cartography in Great Britain, a firm basis has been established for, and a balance achieved between, university and technical training programmes. In contrast to developments in the U.S.A. and Great Britain, a third pattern in the evolution of education and training in cartography since the 1950's has taken place in Australia. A review of Australian cartographic education and training constitutes the third case study.

#### D. AUSTRALIA

The consequences of World War II had a widespread impact on Australian cartographic education and more particularly training during the 1950's. Developments can be summarized from Birtles (1976) in the following manner. The concerted war effort to create a more effective mapping cover of Australia, challenged most of the accepted norms of cartographic practice. New forms of maps and mapping techniques were advised and new technologies imported and introduced to map production. The Royal Australian Survey Corps (R.A.S.C.), which had assumed the war-time responsibility for map production, increased its staff to nearly 2 000 personnel, and included many of the trained staff from survey and cartographic organizations. The immediate shortage of manpower created by this recruitment, forced the acceptance and interim training of temporary personnel, mostly female, for the first time. At the end of the war, the subsequent return to civilian duties of the large complement of military personnel, trained in map work and map production, who wished to remain in cartographic employment, created a new demand for advanced training and education. In addition, temporary staff now also demanded improved training to secure permanent appointments (Birtles, 1976).

The 1950's also constituted a period of many substantial public works programmes. A result was the considerable increase in demand for new maps. New cartographic tasks were linked to uranium ore and oil exploration and to the engineering activities of the Snowy Mountains Authority. The national mapping policy of making available photomaps, preparatory to the issue of the more detailed topographic maps, was a particularly valuable cartographic contribution of the period. Although the incoming groups of European emigrants included a number who possessed talents in cartography and associated fields, the demand for increased number of cartographic staff could not be met quickly. Also, the existing apprenticeship training schemes were found to possess many shortcomings, principally in the length of service time required, unfavourable conditions, lack of adequate additional formal training and low rates of pay. Some improvements in employment conditions were made by replacing apprenticeship schemes with new terms of 'cadetship' or learnership, which offered permanent appointment, better service conditions, salaries and fringe benefits, particularly in government service (Birtles, 1976). More important, a new attitude was engendered in that cartography was no longer considered the exclusive preserve of

the surveying profession. Although this attitude was strongly contested by Leppan (1966), who maintained that the courses offered through survey degree programmes at universities provided sufficient background for prospective cartographers, a range of essentially technical cartographic skills was recognized. As a result, the part-time, engineering orientated technical drawing programmes were modified and updated to include cartography and cadets during the first two years of service were required to attend formal daytime courses at technical colleges (Birtles, 1976). Course syllabuses were broadened to include the mathematics required for surveying and general map and plan drawing. Post-cadetship courses in printing and lithographic technology provided a better overall knowledge of map production techniques.

As early as 1953, the Australian Institute of Cartographers (A.I.C.) was formed with the intention of establishing cartography as a profession. The need for long term planning was seen and the A.I.C. endeavoured to provide opportunities for better communication between cartographers. Within three years the membership exceeded 600 persons. One important task which received immediate attention was the upgrading of cartographic training. Commenting on training, the A.I.C. noted that in the past, the training of cartographers had been left mainly to employers who conducted training courses essentially for their own staff. Alternatively, those technical schools which provided courses did so in subjects mainly taken from other established courses such as engineering. The courses were necessarily restricted in scope, being largely formulated to suit the minimum requirements of the more particular employers, rather than providing a comprehensive training in cartography. It was considered essential that a uniform course of high standard, framed to provide a thorough training in cartography, should be established in all states (Williams, 1972). These courses, by providing a comprehensive basic training, and by teaching modern techniques and standardized methods, would fit all students for employment with the various map-making bodies. Very little further training would be necessary to satisfy the requirements of any particular department or firm. The completion of courses would aim to give a qualification of high standing to cartographers, resulting in benefits to both the profession and its members (A.I.C., 1954).

To meet this aim, a part-time certificate course in cartography was inaugurated in 1955 at the Royal Melbourne Institute of Technology

(R.M.I.T.). The syllabus was constructed so as to provide technical students with a good working knowledge of mapping skills, including scribing and elements of map design. Basic physics, particularly in the fields of optics, light and colour, was considered essential preparation, and practical techniques included the transfer of data from aerial photographs. Attention was also given to aspects of map reproduction and printing. By the late 1960's, the A.I.C. had been instrumental in the promotion of 10 similar certificate or diploma courses through at least one Technical College or Institute of Technology in each of the six States. National student enrolment increased from 300 in 1960 to over 1 000 by 1973.

During the 1970's, significant efforts were made to improve the quality of cartographic training (Birtles, 1976). Major restructuring of the aims and form of courses, essentially in an effort to increase the value and practical purpose of existing syllabuses, was undertaken (Appendix A7). Entry standards both into cartographic training institutions and cartographic employment were raised. Certificate courses were augmented by more professional associated diploma courses. There was also heavy expenditure on buildings, teaching staff and specialized equipment (Birtles, 1976). Despite the growth of technician training, no degree course existed in cartography prior to 1974.

Cartography at university level constituted an important element of both academic geography and surveying courses. The approach was, however, to present cartography as an accessory service component only (Spitzer, 1974). While surveying had a longer tradition of interest in map-making, geographers had tended to give greater stress to the use of maps and their applications in geographical analysis. In response to representations by A.I.C., a cartography major was implemented in 1974 as part of a bachelor degree award in applied geography and computing studies at the Canberra College of Advanced Education (Birtles, 1974). The main emphasis of the programme was the provision of specific skills in thematic cartography and computer mapping (Appendix A8). Substantial attention was also given to photogrammetric application. All incoming students were required to possess a sound background in mathematics and obliged to incorporate some studies in calculus and computer programming. The achievement of incorporating cartography within the degree programme offered at Canberra, led to the suggestion that scope and opportunities existed for other degree programmes in cartography. In 1976, R.M.I.T.

replaced its associate diplomas programme with a more comprehensive three-year full-time course leading to the award of a diploma of applied science in cartography. Subsequently, R.M.I.T. has introduced a post-graduate course in automated cartography. There is as yet no post-graduate research programme of a nature similar to the experimental cartographic work of European or North American universities (Birtles, 1976).

The increase in cartographic education and training is related to the boom in cartographic activity and employment since the 1950's. Although efforts were made by employers to attract personnel from overseas, the immigrant flow did not meet local demands. The result of the almost complete dependence on an intake of school leavers entering directly into employment is that Australia possesses a very young cartographic staff. A survey conducted by the A.I.C. in 1973 revealed more than two-thirds of the workforce was aged less than thirty years. The same survey showed however that the private sector gives only a minimum of employer interest to cartographic education. Staff in private firms tend to be appointed on the basis of practical experience rather than a formal qualification. A much more positive attitude prevailed in government circles which encouraged staff to complete academic and professional studies.

The active participation in and encouragement of educational programmes in Australia by the A.I.C. is also seen in the sponsoring of conferences on education in cartography in 1974, 1976 and 1977. The A.I.C. have further amended the rules of membership to take account of educational developments. Associate and full membership of the Institute now requires, as a minimum, a three-year qualification in cartography in addition to an appropriate period of experience in the field (A.I.C., 1980). The new entrance qualifications have served to promote a professional identity for cartographers and cartography. For employers, claim to membership of the A.I.C. ensures, of prospective employees, a minimum, standardized training and qualification in cartography.

With the emphasis on the development of recognized technical training programmes, cartographic organizations in Australia are now assured of a well qualified technician workforce, capable of handling all aspects of map production. University programmes, on the other hand, have been introduced to provide the possible personal requirements for the future

development of thematic and growing field of computer-assisted cartography.

#### E. SOUTH AFRICA

Prior to the mid-1950's, training in cartographic draughtmanship was available only in government departments through on-the-job training schemes. In response to requests by the South African Institute of Draughtsmen (S.A.I.D.) training courses in draughtsmanship were introduced at the Cape and Pretoria Technical Colleges in 1958. The diploma course for survey and cartographic technicians consisted of a three-semester part-time study programme. The first semester of study covered general draughting techniques such as cartography, survey, geology and hydrography to participate and acquire the basic common draughting skills and techniques. Thereafter two semesters of specialization together with a minimum 2 year in-service training period was required in one of the specific fields for the technician diplomas award (Noble, 1983). As there were no other specifically cartographic organizations from which to draw two and three semester specialist students, specialization in cartographic work was limited almost entirely to employees of the Trigonometrical Survey Office (T.S.O.) in either Cape Town or Pretoria (Watson, 1970). The two semester specialization period was only offered as in-house tuition by senior members of the Pretoria staff during working hours. The Cape Town college offered the first two semesters of study in cartographic draughtsmanship only, all students being obliged to transfer to Pretoria for the third semester. The course was therefore largely directed towards the basic training of technician cartographic draughtsmen in the Civil Service and more particularly the T.S.O. (Watson, 1970). It is interesting to note that, although the diploma course was instituted in 1958, the Pretoria Technikon records the first diplomas being awarded in 1974, some 16 years later. Inquiry as to possible reasons for the lack of awards prior to 1974, only prompted the comment that no records existed of any diplomas being awarded. The Pretoria Technikon also advised that no information was available for student enrolments other than that all third or final semester students received diplomas in the year of enrolment (Table 4.10). The final semester was also only offered when a sufficient number of students had 'accumulated' to constitute a class, which accounts for the lack of awards during some years (Noble, 1983).

The reconstitution of the various government survey organizations, under a single directorship in 1972 led to changes in the training offered for cartographic technicians. The new structure combined the four provincial cadastral survey offices of the Surveyors General with the geodetic, topographical and cartographic functions of the T.S.O. under the Director- General of Surveys (D-GS) in Cape Town. The Cartographic Office, the only Pretoria-based component of the T.S.O. was eventually transferred to Cape Town at the end of 1979 (D-GS, 79/80).

TABLE 4.10: NATIONAL DIPLOMA (CARTOGRAPHIC DRAUGHTSMANSHIP) S.A., AWARDS AND STUDENT ENROLMENT, 1974-1982 (NOBLE, 1983).

YEAR	NO. OF DIPLOMAS AWARDED	NO. OF STUDENTS ENROLLED		
		SEMESTER 1	SEMESTER 2	SEMESTER 3
1974	7			7
1975	0			-
1976	4			4
1977	7			7
1978	0			-
1979	8			8
1980	0			-
1981	0			-
1982	3	11	12	3
TOTAL:	29	11	12	29

An immediate effect of the transfer of the Cartographic Office was the withdrawal of the third semester component of the diploma course at the Pretoria Technikon in 1979 following the transfer on retirement of the officers responsible for training. The diploma course was subsequently discontinued in Pretoria in 1980 and reconstituted at the Cape Technikon in 1981 "... so as to be near the Cartographic Office who (sic) had moved to Mowbray" (Noble, 1983 pers. com.).

The National Diploma (Cartographic Draughtsmanship) is currently only available at the Cape Technikon. The study programme comprises a three-year 'sandwich' course of three full time semesters with equal periods of 'appropriate in-service' training, again primarily available only in the Cartographic Office of the now designated Chief Director of Surveys and Mapping (D.S.M.). The course is therefore still directed towards the basic training of technicians in the Civil Service and more particularly the D.S.M. Details of the current course outline appear in Appendix A9, which is included to provide an insight into the nature and content of the Diploma, as it is the only available technician qualification in cartography in South Africa.

Traditionally, at South African universities, both the discipline of Land Surveying and Geography have claimed to include tuition in cartography (Watson, 1970). Land Surveying courses have tended to concentrate to a greater degree on the mathematical aspects of map construction, geodetic survey and map projections. Graduate surveyors have also assumed, by appointment, the 'professional' identity in cartography in both government and private cartographic organizations. Geographers, on the other hand, have placed greater stress on the use of maps as tools in geographical analysis. To substantiate these statements a review of South African literature was undertaken. In the absence of a specific cartographic journal publication in South Africa, the S.A. Survey Journal, S.A. Geographical Journal and the S.A. Geographer were examined for papers relating to education and training in cartography. However, of the 616 papers published in these journals between 1968 and 1982 only one paper related to the teaching of cartography at university level, two to the use of cartography in geographical analysis and three to technical aspects of map production.

In order then to determine the nature and content of cartographic tuition as well as possible differences in tuition programmes as offered by Land Surveying and Geography departments, the following investigations were undertaken:-

1. University calendar entries for Land Surveying and Geography Departments between 1950 and 1979 were inspected with reference to entries relating to tuition of courses offered in cartography.
2. Questionnaires were sent to Land Surveying and Geography Departments requesting information on cartography courses and tuition.

3. Calendar entries for 1982 were inspected as an update for any significant changes in entry relating to cartography courses offered.

The selection of the calendar years 1950-1979 and the subsequent use of a questionnaire was made with a view to providing a basis for the comparison of data, selected from a research study conducted by Dahlberg (1981) in the U.S.A. While it is appreciated that calendar entries do not normally provide detailed course or syllabus information, the intention was to identify cartography as a specific field or area of study.

1. In the examination of the calendars, it was noted that neither Land Surveying or Geography Departments used the term cartography, nor offered specific courses in cartographic work. In fact the term 'cartography' only came into popular use in the S.A. university calendars during the early 1970's. Prior to that all cartography related work was designated under the broad title of 'practical work', which included such aspects as survey drawing, geometric drawing, map reading, map projections, scales and penmanship. The subsequent change to the term 'cartography' served only to include topographical, statistical or thematic mapping as additional areas of consideration. No indication however was given as to the nature, form or content of the courses offered.
2. The lack of specific information in the calendars invited further investigation. A questionnaire was prepared and sent to 17 Geography and four Land Surveying university departments in South Africa in 1979 (Appendix B1). The primary aim of the questionnaire was to determine the nature, form and content of cartography courses. It was also hoped to ascertain whether the change in designation from practical work to cartography, as noted in the calendar entries, represented a change in the concept of cartography to one of a possible field of study in its own right. From the 100% response received the extremely diverse nature of the tuition offered by the individual university departments can only be summarized in the following manner.
  - a) There were no specialist courses offered in cartography at undergraduate or fourth year level by either Land Surveying or Geography departments.

- b) Cartographic tuition formed an integral, but relatively minor part of the practical course work in 19 of the 21 departments. Two, both geography, claimed to offer no tuition in cartography at all.
- c) One geography department offered differentiated practical work for B.A. and B.Sc. degree courses and two departments provided separate or special practical course work for students of other disciplines.
- d) The duration of course work in cartography varied from only 12 hours in three years to almost 100 hours over four years.
- e) Cartographic 'theory' appeared to constitute only that directly related to practical work, viz. map projections, scales and statistical calculations and did not include the theoretical structure of cartography as a science or field of study.
- f) Cartographic techniques required by course work consisted of basic penmanship and stencil lettering and their application to the production of simple monochrome statistical, thematic, survey or topographic maps, plans or diagrams.
- g) An evaluation of practical course work was required in all departments, although this varied from formal examinations to the completion of only 'some' practical work to a prescribed standard.
- h) Advanced techniques in fair drawing, scribing, colour separation, photographic and printing processes were taught in two departments. In one however, it was offered as a lecture course only, with no related practical work.
- i) Tuition in computer-assisted or automated cartography was not available at any of the universities.
- j) There were no post-graduate research degrees with cartography as a specialization through either Geography or Land Surveying in any of the universities.

In essence there appeared little change in the accepted content emphasis of cartographic courses in either department. In Land Surveying, the emphasis remained on the survey, projection mathematics and air photography components, primarily of cadastral and topographical map construction, while Geography departments continued to stress the use of cartographic techniques in statistical and thematic mapping as aids in geographical analysis. In terms of relating the data obtained from calendar entries and the questionnaire, the absence of specific courses offered, and therefore enrolment figures in cartography in South Africa, precluded any form of comparison other than between the number of institutions from which information was obtained.

3. Examination of the 1982 calendar entries and course outlines for Land Surveying and Geography departments indicated very little substantial change in respect of tuition in cartography since 1979. Although differing course credit structure and evaluation in the individual universities make comparison difficult, the following summaries are indicative of the current state of cartography courses as given in the university calendars.

Cartography as offered by Land Surveying departments constituted only 4% of the total degree credit rating (Table 4.11). On average the cartography component comprised 26 lectures and six practicals in the four-year degree programme. Geography departments, however, still regard cartography at undergraduate level as synonymous with practical course work in terms of tuition (Table 4.12). There are still no post-graduate, research or computer-assisted cartography related courses offered at any of the universities. While exceptional development in cartographic education and research opportunity has taken place almost world-wide since the 1950's, little advance, interest or awareness in cartography as a field of study, appears to have been generated in South African universities during the past three decades.

The apparent lack of academic interest has not, however, remained unchallenged. In a paper presented to the 4th South African National Survey Conference, Watson and van Rensburg (1970) made the consideration and introduction of graduate level tuition, their first recommendation for improving the standard of cartography in South Africa. The significance of the recommendation lies in the fact that the authors

TABLE 4.11: S.A. UNIVERSITY LAND SURVEYING DEPARTMENTS : SUMMARY OF FOUR-YEAR DEGREE PROGRAMMES, 1982.

NO. OF DEPTS.	NO. LISTING TUITION IN CARTOGRAPHY	AVERAGE NO. OF CREDITS REQUIRED FOR DEGREE AWARD	AVERAGE NO. OF CREDITS RELATING TO CARTOGRAPHY	CARTOGRAPHY AS A PERCENT OF DEGREE PROGRAMME	RESEARCH OR P/G COURSES OFFERED IN CARTOGRAPHY
4	4	144	6	4	Nil

TABLE 4.12: S.A. UNIVERSITY GEOGRAPHY DEPARTMENTS : SUMMARY OF THREE- AND FOUR-YEAR DEGREE PROGRAMMES 1982.

NO. OF DEPTS.	NO. DESIGNATING PRACTICAL COURSE WORK	NO. SPECIFICALLY LISTING TERM CARTOGRAPHY	NO. IN WHICH CARTOGRAPHY RELATES ESSENTIALLY TO PRACTICAL COURSE WORK	NO. LISTING CARTOGRAPHY AS FULL COURSE CREDIT	RESEARCH OR P/G COURSES OFFERED IN CARTOGRAPHY
17	10	7	7	Nil	Nil

were, at the time, Assistant Director and Chief Cartographer respectively, of the Trigonometrical Survey Office, which, in turn, was not only the leading government cartographic organization but possibly the largest employer of cartographers in South Africa. Watson (1970), contends that most cartographers in South Africa are land surveyors or geographers and it is to these disciplines and university departments that one should look for education and the directing of research in cartography. At the South African Geographical Society Conference, Bloemfontein, 1976, Watson again challenged the universities on the study of map communication and use as viable fields of academic research

(Watson, 1976). That these challenges have not been taken up is evident in the university curriculae and tuition offered in cartography.

The prevailing perception of cartography at all levels of education and training in South Africa today would appear to be epitomised in the current career description issued by the Cape Technikon. Cartographers, it claims "... are concerned with the compilation and production of maps. To begin with they are engaged in simple drawing, tracing, lettering and inking of maps and later advance to drawing maps" (Cape Technikon 1983, p.i).

The description presents no information to suggest that cartography is a field of study or discipline and no indication that it exists other than as a draughting function, primarily in topographical map production.

#### SUMMARY

The chapter has generally reviewed developments in education and training in cartography. The influence of the I.C.A. through the appointment of Commission I, Education and Training in Cartography, and the publication of ideal syllabuses which provide a basis for the introduction of cartographic education and training, has been noted. The current state of cartographic education and training in South Africa has been reviewed in relation to developments in the U.S.A., Great Britain and Australia since the 1950's. Three major developmental patterns in education and training have emerged through the case studies.

1. The growth in university courses in the U.S.A. has not been matched by the development of technical training programmes. This has resulted not only in a lack of skilled technicians, but also the restriction of employment opportunity both in terms of the higher costs involved in employing and training graduates and the number of graduates in relation to technicians required by the cartographic industry as a whole.
2. Although university courses preceded the introduction of technical programmes in Great Britain, cartographic education has tended to remain concentrated in fewer institutions. The gradual broadening of the degree courses has not only led to the acceptance of academic qualifications but has enabled British universities to provide for a

small but consistent demand for graduate cartographers. The introduction of technician courses within the general technical educational structure has provided for the national control of course curriculae and study programmes. The maintenance of standards has resulted in the general acceptance of the technical qualifications by leading cartographic organizations.

3. Under the influence of a strong professional association, the initial emphasis on technical programmes has helped provide Australia with the skilled technical personnel necessary for large scale mapping development programmes. The subsequent introduction of academic programmes has provided for the small but increasing demand for graduate cartographers.

The exceptional growth of educational and training programmes which has taken place almost world-wide since the 1950's appears to substantiate Ormeling's (1978) claim to 'better education and training'. In contrast, little advance, interest or awareness appears to have been generated in cartography in South Africa. The only diploma course offered is directed almost entirely towards the training of technician draughtsmen in the Civil Service. The concept of cartography in the universities does not appear to have progressed much beyond being a function of topographical mapping, or its use as an illustrative aid or tool in geographical analysis.

The relevance of the case studies, particularly in the consideration of the future development of cartography in South Africa lies, first, in the recognition of a two-tier educational structure in which both academic and technical programmes provide for specialist requirements and second, in the importance attached to the development of either, in relation to the needs of the cartographic community as a whole. Whereas cartography programmes in the U.S.A. have tended towards an academic approach to cartography, the technical aspects have been neglected resulting in the shortage of skilled technicians. The whole field of cartography in Great Britain appears to be better served by the introduction of technician training programmes, in support of the development of the more specialist academic aspects, concentrated in fewer universities. Graduate programmes in Australia, on the other hand, have grown out of personnel needs which could not be met even in the existing well developed technical education programmes.

The selected case studies have focussed on the nature of the development of educational and training programmes in cartography. Consideration of the nature of improved education or training opportunity in any cartographic community appears to depend upon the nature of the needs or requirements of that community. To this end, an assessment of some of the needs of the South African cartographic community may supply the guidelines for future education and training programmes.

CHAPTER FIVE

THE SOUTH AFRICAN CARTOGRAPHIC COMMUNITY : EDUCATION  
AND TRAINING - A PRELIMINARY ASSESSMENT

INTRODUCTION

Considering the educational developments in cartography which have taken place in many countries overseas, the lack of cartographic education and training programmes in South Africa, noted in Chapter Four, suggests that either there is little or no demand for education and training in cartography, or the requirements of the South African cartographic community have not yet been recognized or determined. The very existence of a cartographic sector in S.A., however, implies a need for cartographic personnel and therefore a possible need for education and training. The provision of education and training programmes would, however, not only depend on the nature but also the specific educational requirements of the cartographic community. If these requirements can be identified, would education or training, or a measure of both, best provide the necessary skills to meet these needs? The essential differences between the concepts 'education' and 'training', with particular reference to cartography, need to be appreciated. While at least one technical training course is available in S.A. a possible place for cartography as a field of study within the university structure needs to be considered. The first section (A) of the chapter considers the nature of the S.A. cartographic community and the second (B), the methodology of assessing the requirements of that community. The private and public cartographic sectors are discussed in sections (C) and (D); the essential differences between 'education' and 'training' in section (E); and the possible place for cartography in the S.A. university structure is considered in section (F).

A. THE SOUTH AFRICAN CARTOGRAPHIC COMMUNITY

The potential cartographic community embraces all organizations, government or private, which undertake the production of maps, plans and charts and employ cartographers as an integral part of their general staff establishments. Cartographic organizations in South Africa can be broadly classified, on the nature of the work produced, into three major divisions, i.e. institutional, private and commercial. The basis of institutional cartographic activity has been the production of maps for

national cartographic programmes (Watson, 1970). The responsibility in South Africa for these national cartographic undertakings has been assumed by the State, the Provincial Administrations or the state-funded (public) corporations such as Transport Services, Soekor, Sasol, Escom and Iscor. Consequently the larger portion of all activity in administration, topographical, cadastral, military, hydrographic, hydrological, mineral, geological, planning, agricultural, road, rail and aeronautical mapping, emanates from state sources.

Local government bodies, comprising mainly the larger city councils or municipalities, although part of the public sector, have, together with the mining and mineral exploration companies, been taken to constitute part of the private cartographic sector as the nature of their cartographic work is primarily for internal or company use only. The private commercial sector, on the other hand, includes the air survey type company and the general mapping agencies producing cartographic work as a commercial enterprise. For the purposes of the discussion in this study, all state agencies will be termed the public cartographic sector while the city councils, mining companies and the commercial enterprises together, will be considered as the private cartographic sector. Irrespective of the classification of an organization, or the type of work undertaken, the employment of personnel to undertake cartographic work pre-supposes that, either a measure of education or training in cartography is required of, or offered to employees.

It was noted in Chapter Four that the educational and training opportunity for cartographers in South Africa, in comparison to many overseas countries is poorly developed (Table 4.1). Only one institution offers a recognized technical qualification and there are no specialist courses at university level in cartography. It is also evident from the case studies for the U.S.A., Great Britain and Australia, presented in Chapter Four, that the development of a two-tier, academic and technical educational structure appears to provide the best basis for supplying the overall personnel requirements of the cartographic community. For the consideration of any improvement to educational or training opportunity to be of value, however, cognizance must be taken of the educational or training standards required by employers of cartographers. There is no evidence in literature of any survey having been undertaken of the education or training requirements of the South African cartographic

community. In an attempt to assess the needs of the South African cartographic community, a questionnaire was prepared for distribution to all potential employers of cartographers.

## B. THE SURVEY

### 1. The Questionnaire

The objective of the questionnaire was to ascertain the possible education or training standards required by the South African cartographic community. Five aspects were considered of importance in framing the questionnaire.

- a) The determination of the overall employment opportunities in cartography in South Africa with particular respect to the recognition of cartographic work as distinct from that of general draughting.
- b) The minimum educational or training levels required by employers and the additional training offered to, or required of, employees in cartographic work.
- c) The importance of various functions in cartographic work as indicators of the need for either education or training or both.
- d) The attitude of employers to possible university educational programmes in cartography through a degree in Geography.
- e) Recruitment sources and difficulties experienced by employers in finding suitably qualified personnel for cartographic work.

A questionnaire relating to each of these aspects was drawn up, together with a covering letter setting out the basis of the survey, and distributed to all potential employers of cartographers (Appendix B2).

### 2. The Questionnaire Distribution

The initial distribution of the questionnaire was based on a search of all telephone and business directories for South Africa. Key words such

as map(s), mapping, plan, planning, chart, atlas, publishing, survey, air survey, air photo, and the prefixes photo- and geo- were used to identify all possible organizations which may employ cartographers. In addition, all mining and mineral exploration groups or companies, the public corporations and the metropolitan city councils or municipalities were included in the questionnaire distribution as potential employers of cartographers. The Secretaries to the Provincial Administrations were requested to either forward copies of the questionnaire to, or supply a list of, departments in which cartographers were employed. The Commission for Administration, the chief executive agency for appointment in the civil service, was provided with questionnaires to complete on behalf of, or forward to, all government departments, divisions or agencies, the army, navy and air force. The South African Institute for Draughtsmen (S.A.I.D.) was approached for information regarding registered cartographers and employing organizations. Finally, by the inclusion of a request for names of other employers of cartographers, known to recipients of the questionnaire (Question 14), it was hoped to include any organization which may have been excluded in the original search.

### 3. Questionnaire Responses and the Problems Encountered

The questionnaire was eventually distributed to 49 organizations representing 10 in the public, and 39 in the private sector. Responses to 28 questionnaires, all from private sector organizations were received, of which 23 employed cartographers and/or draughtsmen with five offering no employment in the field. The initial response to the questionnaire revealed three major factors which specifically affected the results of the survey.

- a) The approach to the Commission for Administration and the Provincial Administrations failed to elicit any response and subsequent requests for information or permission to approach individual departments or agencies directly were also unsuccessful.
- b) The South African Institute for Draughtsmen declined to offer any information as the nature of their records did not differentiate between cartographers and any other draughting discipline.

- c) Although the covering letter and instructions for the questionnaire defined cartography and cartographers specifically, almost 80% of the respondents regarded cartographers as being synonymous with draughtsmen. Exceptions were the air survey companies and the agencies producing road and general maps, where specific cartographic skills were recognized.

Respondents were encouraged to comment on the questionnaire and the information supplied and many did so extensively. As this additional, and often most useful information cannot be included in the statistical analysis, the relevant comments have been included in the discussion.

The non-participation by the public sector, possibly the largest employer of cartographers, resulted in the survey being less comprehensive than originally planned and it is therefore only applicable to respondents from the private cartographic sector. Consequently, the survey can only be regarded as a pilot study and the results indicative of either the education or the training needs of that sector. The analysis and discussion of responses of the private cartographic sector to the survey questionnaire are presented in the following section. Comment on the public cartographic sector is confined to an appraisal of the employment situation and trends contained in the annual reports of the Chief Director, Division of Surveys and Mapping, the primary cartographic production organization in South Africa. The selection of the Division of Surveys and Mapping (D.S.M.) was based on the following considerations:

- i) the cartographic activities in other departments or divisions represented only a portion of the overall activity, and they were not often included in the annual reports;
- ii) the D.S.M. represented the primary cartographic production organization, staff trends therefore constitute an important part of the day to day organization and operation of the division;
- iii) the staff employed on cartographic work are specifically designated as cartographers in all grades.

C. THE PRIVATE CARTOGRAPHIC SECTOR : A Pilot Study

Of the 23 positive responses received, 14 employed draughtsmen only, four employed draughtsmen and/or cartographers without differentiation, and five only designated cartographers as their primary production personnel. All respondents however, completed the questionnaire irrespective of the designation of the particular personnel employed. In view of the small numbers involved and the lack of distinction between cartographers and draughtsmen, the following methods of analysing the data are proposed.

1. The data furnished by all 23 respondents, irrespective of employee differentiation, is considered as one data set for analysis.
2. A second data set of nine responses comprising the four respondents which coupled cartographers and draughtsmen and the five respondents specifically designating cartographers is considered independently. The rationale for the grouping was based on the following considerations:
  - a) the nature of the work undertaken by the four respondents coupling cartographers and draughtsmen was more cartographically orientated than general draughting;
  - b) the numbers represented by these firms were small and unlikely to affect the overall results;
  - c) in terms of the work undertaken, the occupations were considered synonymous by the employers.

Although the methods may constitute an overlap of the data sets, comparisons between them may provide for the identification of both general and the more specific cartographic education or training requirements. The questionnaire data is presented in Tables 5.1 and 5.2. For the purposes of the discussion, the terms staff, staff complements, employees, establishments or firms relate only to the draughtsmen and/or cartographers employed by each organization and not to the organization as a whole.

TABLE 5.1: SELECTED EMPLOYMENT DATA FOR THE S.A. PRIVATE CARTOGRAPHIC SECTOR, 1981<sup>1</sup>.

	ALL FIRMS EMPLOYING CARTOGRAPHERS AND/OR DRAUGHTSMEN N = 23		FIRMS EMPLOYING CARTOGRAPHERS N = 9	
	No.	%	No.	%
TOTAL NUMBER OF FIRMS	23	100	9	100
a) TOTAL NUMBER OF ESTABLISHED POSTS	149	100	31	100
i) Number of vacancies	18	12	8	26
b) FIRMS WITH STAFF COMPLEMENTS OF				
i) less than 8 employees	18	78	7	78
ii) 8-15 employees	5	22	2	22
c) FIRMS SPECIFYING MINIMUM EDUCATION				
i) Standard 8	2		1	
ii) Matriculation	18	78	6	67
iii) Post-matriculation diploma	0		0	
iv) Not stated	3		2	
d) FIRMS OFFERING ADDITIONAL TRAINING				
i) On-the-job training	16	70	6	67
ii) Other training (e.g. block course centralized training)	0		0	
iii) Not stated	7		2	
e) FIRMS REQUIRING ADDITIONAL FORMAL QUALIFICATION AFTER APPOINTMENT (e.g. DIPLOMA)	4	17	2	22
f) ACCEPTABILITY OF GEOGRAPHY/ CARTOGRAPHY GRADUATES AS POSSIBLE EMPLOYEES				
i) Firms agreeing	10	43	3	33
ii) Firms disagreeing	11	48	5	56
iii) Not stated	2		1	

	ALL FIRMS EMPLOYING CARTOGRAPHERS AND/OR DRAUGHTSMEN N = 23		FIRMS EMPLOYING CARTOGRAPHERS N = 9	
	No.	%	No.	%
g) SPECIFIC PRE-EMPLOYMENT TRAINING DESIRED				
i) General draughting techniques	15	65	-	-
ii) Cartographic techniques	-	-	7	78
iii) Geological mapping techniques	4		-	
iv) Computer techniques	3		1	
v) Printing techniques	-		1	
vi) Not stated	1		-	
h) RECRUITMENT DIFFICULTIES EXPERIENCED				
i) Lack of applicants generally	20	87	8	89
ii) Lack of suitably trained applicants	13	56	7	78
iii) Other (low salaries specified)	4		1	
i) PRIMARY RECRUITMENT SOURCES				
i) Schools and colleges	11	48	1	
ii) Universities	-		2*	
iii) Public sector or government service	3		4	44
iv) Other similar organizations or firms	9	39	2	

\* Graduate land surveyors employed for combined photogrammetric and cartographic work.

1 In view of the small numbers involved percentages have only been given for the major divisions.

TABLE 5.2: CLASSIFICATION AND RANKING OF PREDOMINANT ACTIVITIES PERFORMED IN THE S.A. PRIVATE CARTOGRAPHIC SECTOR, 1981.

PREDOMINANT ACTIVITY	ACTIVITY CLASSIFICATION AS % OF TOTAL ESTABLISHED POSTS		CLASSIFIED ACTIVITY RANKING ACCORDING TO SENIORITY/EXPERIENCE <sup>1</sup>	
	ALL FIRMS N=149 %	FIRMS EMPLOYING CARTOGRAPHERS N=31 %	ALL FIRMS N=23	FIRMS EMPLOYING CARTOGRAPHERS N=9
Research and planning	7	11	High	High
Supervision	6	5	High	High
Computer-assisted techniques	5	10	Inter-mediate	Inter-mediate
Draughting and technical production	82	74	Low	Low
	100	100		

With respect to the private cartographic sector the following are the main points that can be noted from Table 5.1.

- i) For cartographers, employment opportunity was restricted with a possible maximum of 31 of the 149 established posts designated as cartographic. Of greater importance however, was that current vacancies for cartographic personnel constituted over one quarter of the total number of posts available (Table 5.1a). Comments related to concern over the lack of training institutions, particularly with the discontinuation of the Pretoria Technikon programmes. Comment also indicated that if more suitably trained applicants were available, not only would vacancies be filled but establishments would also be increased.

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<sup>1</sup> The rankings allocated by respondents to the activities specified (Question 8), have been classified as high, for a ranking 1-2, intermediate for 3-4 and low, for 5 and below.

- ii) With almost 80% of all firms employing less than 8 as a full staff complement, firm size in this sector could be regarded as small. There were no firms employing more than 15 persons in either draughting or cartographic work. However it was noted in Leverenz's (1974) survey of 120 cartographic firms in the U.S.A., small firms also tended to predominate with 87% employing less than 8 staff members.
- iii) While matriculation was the minimum educational entrance standard required by some 70% of firms, the National Technicians Diploma course in draughting or cartography, which has been offered since 1958, was not considered or specified by any of the firms as an entrance requirement (Table 5.1c).
- iv) Although 70% of all firms offered on-the-job training, it constituted the only form of training available and little emphasis appeared to be placed on the attainment of a post-appointment diploma qualification by employees (Table 5.1d and 5.1e). The fact that the diploma courses were only offered in Pretoria and Cape Town, and particularly orientated towards training technician draughtsmen and cartographers for the civil service, was cited by some respondents as making it virtually impossible to insist on further formal training. Organizations which did encourage post-appointment training were all either based in Pretoria or Cape Town and predominantly survey orientated rather than cartographic.
- v) In response to the hypothesis that geography/cartography graduates could find employment in these fields, firms were almost equally divided on the merits of a university programme. Of the cartography related firms, however, a greater proportion considered graduates unsuitable for employment (Table 5.1f). Several respondents, commenting on the hypothesis proposed in the questionnaire, considered a degree course unable to provide the necessary practical and technical elements required for the job situation.
- vi) Tables 5.1g, h and j, provide the most explicit indication of the needs of the private sector. The responses to the 'open' questions 10 and 13 of the questionnaire contained the almost identical information with regard to specific aspects and 'gaps' in the education or training of applicants. The responses, arranged

according to the five most common aspects listed, are given in Table 5.1g. Pre-employment training, related predominantly to general draughting skills, was the primary listing of almost two-thirds of all respondents. For specific cartographic skills, however, the pre-employment training need rose to almost 80% of respondents (Table 5.1g). Whereas all firms expressed difficulty in recruiting staff, 78% of cartographic employers again indicated the lack of suitably trained applicants. When considered in relation to the primary recruitment sources (Table 5.1j), although school and college matriculants, based on a first ranking, constituted 48% of the intake of all applicants, cartographic firms did not generally recruit from this source. The consideration that a measure of pre-employment training was required by cartographic firms is supported by the indication that the public sector, where some form of training is available, provides 44% of all recruits to these firms. Of note also is the 40% recruitment from similar work orientated firms, (e.g. the mining houses), which indicates a value being attached within the sector to job situation training.

The predominant activity classification together with subjective ranking of these activities by each organization (Table 5.2) further emphasises the need for adequately trained entrants to both the general draughting, and more specifically, cartographic employment in South Africa. The indication that between 74% and 82% of all personnel are employed on technical production or draughting procedures, ranked lowest in terms of employee seniority or experience (Table 5.2), implies a need for basic technical training programmes, particularly when taken in conjunction with the pre-employment training requirements, the lack of suitably trained applicants and the recruitment sources noted in Tables 5.1g, h and j. Planning, research and supervision are functions of seniority or experience and the proportion of 13%-16% of personnel occupied in these activities accords with Leverenz's (1974) finding of 10%-20% for small firms in the U.S.A. noted in Chapter Four (Table 4.8). Of note also is the involvement of personnel in computer-assisted techniques, and although small at present, may be indicative of a field in which expansion can be anticipated.

In terms of education and training, the primary needs of the private sector lie in the provision of trained technical cartographic production or draughting personnel. Nevertheless, on the basis of the survey, up to

30% of employers would consider employing geography/cartography graduates whose courses contained substantial cartographic theory and practical components (Table 5.1f). Finally if the acceptance of a graduate qualification for employment is related to employee numbers, assenting or agreeing organizations employ some 71 or 48% of all personnel, and 7 or 23% cartographic personnel specifically. This latter figure may prove more significant in respect of university educational programmes in cartography, when the employment potential of the public sector is considered in the next section.

#### D. THE PUBLIC CARTOGRAPHIC SECTOR : A Preliminary Investigation

The non-participation of State, Provincial and state-funded organizations in the survey has rendered it less comprehensive than originally planned. A study of the annual reports of but one state department, the Division of Surveys, Department of Agricultural Credit and Land Tenure, reflects the staff position and current trends all too clearly. The Division of Surveys, headed by the Director-General of Surveys (D-GS)<sup>1</sup>, represents the primary government cartographic organization producing all official topographical cadastral, general administrative and military mapping for the Republic of South Africa and South West Africa (Namibia). The annual reports of the D-GS, 1974 through to 1980 summarize the staff situation in the following terms.

1974/1975

The very serious staff shortage militated against full production. The training of diploma students, although successful is nullified by the spate of resignations and no more than 5% of successful candidates remained in employment in the Department. As there are not enough experienced or capable persons to take the place of retiring senior officials, a complete breakdown of all services due to a lack of training, expertise and ability could result (D-GS, 1974/75).

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<sup>1</sup> The Annual Report 1981/1982 reflects the change in title from Director-General to Chief Director of Surveys and Mapping.

1975/1976

Professional and technical staff shortages remain a major and serious problem, with senior officials retiring and young recruits resigning on completion of training. The high turn-over of staff, particularly woman technicians, who can only be partially trained in an average working life of 18 months to two years, led to frustration, inefficiency and loss of production (D-GS, 1975/76).

1976/1977

Difficulty is being experienced in filling supervisory posts with sufficiently experienced personnel to ensure efficiency and control (D-GS, 1976/77).

1977/1978

The staff position continues to remain critical. The impending retirement of senior officials is exposing the dearth, not only of suitable candidates for promotion posts, but the meeting of mapping demands with a dwindling skilled and experienced staff. The recently reduced education and training admission requirements could lead to the possible lack of candidate potential for higher technical posts. Consequently the gulf between the training received and the requirements of modern technology is growing wider and may necessitate a re-assessment of staff structures (D-GS, 1977/78).

1978/1979

The lack of experienced staff and suitable candidates has created a more critical staff position than ever before. An increased resignation rate has necessitated the increased reliance on inexperienced and untrained staff (D-GS, 1978/79).

1979/1980

The staff position has deteriorated to the point where a complete breakdown of services threatens. The appointment of untrained female technical assistants, who average a one year employment period, has proved counter productive. Ten senior officers retired and only 13

learner technicians, mostly untrained female technical assistants were recruited (D-GS, 1979/80).

The problem areas are very evident and require little critical discussion. While the lack of adequately trained staff is a cause for grave concern, of greater significance is the lowered educational and training admission requirements for technicians, particularly in a field where modern technology is being increasingly applied. The already noticeable disparity between the technical requirements and training available could lead, by implication, to the assumption that more highly educated or trained personnel may need to be considered and integrated into the present staff structure. Although not statistically substantiated, the basic need for well trained, skilled technician cartographers is also very much evident.

The realization that the D-GS employs some 60 cartographic personnel (D-GS 1979/80) or twice as many as the sampled private sector, inevitably leads to speculation as to the total number of cartographers employed by the public sector. Considering that departments or divisions such as Geological Survey, Co-operation and Development, Conservation, Agriculture, Forestry, Tourism, Water Affairs, National and Provincial Roads, the Army, Navy and Air Force together with Escom, Soekor and Sasol all possibly undertake cartographic work, the number of cartographers could probably be more than doubled. Postulating on an assumption of this order, the public sector cartographic employment potential could be in excess of 120 established posts. Further, assuming even a 20% graduate employment acceptance as indicated by the private sector, (Table 5.1f), the total public sector could generate posts for and employ a possible group of at least 24 geography/cartography graduates. While these are admittedly merely assumptions, when measured against the needs reflected in the Annual Reports 1974-1980 of but one government division, graduates could well constitute a small but desirable source of cartographic manpower in the future.

The non acquisition of the necessary technical skills as a primary requirement for employment however remains a problem. By the very nature of the structure of graduate degree programmes in South Africa, with split major subjects and a probable maximum of one three hour practical period a week during the academic year, it is improbable that sufficient time could be allocated to the acquisition of the actual technical skills

required by most employers. In consequence the dichotomy between the education of cartographers at university level or training to diploma level at technical institutions, becomes a realistic issue. Education or training? As the need for both undoubtedly exists in South Africa, it is necessary to clearly distinguish between the basic concepts 'education' and 'training' and more particularly as they apply to cartography. While the distinction may appear semantic, it may be that the lack of recognition of the distinction between them has contributed to the lack of suitably qualified technicians in cartography and has also impeded the development of cartography as a field of study and research in South Africa.

#### E. EDUCATION AND TRAINING

Grant (1976) considers that education infers the acquisition of knowledge, the ability to use this knowledge under flexible circumstances and the ability to think logically, arrive at conclusions and make decisions. Training, on the other hand, infers the acquisition of specific technical and mechanical skills and the ability to use these skills to perform related tasks. These distinctions conform, from an academic viewpoint, to those of Schofield (1972) who contends that education must provide those committed to it with knowledge, understanding and cognitive perspective. Training however is the process of imparting to an individual the skill to perform some operation or set of operations "... whether the acquisition of the skill is, or is not, accompanied by the understanding of the principles on which the operation depends" (Schofield, 1972 p.44).

Schofield (1972) further asserts that training can never be equated with education. Education will include training and it can never be that the smaller concept, training, would contain the larger, education. These distinctions have now become apparent in cartography, through both technological and academic developments. Map-making or the technical process of compiling and producing maps can now be distinguished within the broad field of cartography or the study of mapping methods and map information in the cartographic communication process (Monmonier, 1977). Technological advances in photography, photo-lithography and scribing and its allied photo-mechanical processes have fragmented some of the basic crafts, skills and methods of the traditional cartographer into a series of photo, mechanical and technical operations. Differentiation between

the technology and the art and science of maps does not imply an inherent separation of roles, but rather a continuing trend from map-making to cartography and the realization that knowledge about map design, production and use, demands more than the mechanical artistic skills required to produce orderly representations of the landscape (Muehrcke, 1972; Monmonier, 1977).

The distinction has also become important for, notwithstanding the attempts to define the nature, content and methods of cartography, it is the map-making or trainable technical aspects that have received the most attention (Grant, 1976). Traditionally considered as the aggregate of the largely individual and technical processes normally associated with the actual map production, these aspects have formed the only basis for cartographic instruction and have permitted map-makers, in many cases "... with little formalized scientific training in the various forms of cartographic representation to produce barely acceptable maps" (Muehrcke, 1972, p.2). Cartography on the other hand, has become increasingly associated with the philosophical and theoretical bases, scientific principles and rules for maps and mapping procedures and introduces the graphic model nature of maps with the resulting implications for research and study into map-making methodology and use (Robinson et al., 1978). By including map study and use, cartography explicitly concerns the relative effectiveness of various information and communication techniques and requires a clear understanding of the uses to which the map information will be put (Muehrcke, 1972; Williams, 1972a; Robinson, 1973; Morrison, 1974; Board, 1978). The inability of map-makers to synthesize effectively the wealth of cartographic technique, reflects a lack of education in and attention to the conceptual foundations of cartography and often results in the practice of cartography as an intuitive discipline following long established standards and norms. In simplest terms "... cartography is now characterized by conceptual, problem-orientated research directed at formalizing the science underlying the art and technology of cartography" (Muehrcke, 1972, p.2). Seen then in the context of Schofield's (1972) assertion, cartographic education will include cartographic training but that training will not necessarily constitute education in cartography.

Cartographic training can generally be related to the acquisition of the largely individual mechanical and technical skills associated with the processes of map production. Education in cartography can be related to

development, research and study in map design, map methods, map production and map use in the cartographic information communication process. Considering the developments in cartography as a science of information communication, the advances in thematic and computer-assisted cartography, as well as the increased production capabilities provided by a specific and adaptable technology, university education should not duplicate training programmes in the traditional skills which can be provided elsewhere. Essentially universities should provide students with the ability to improve overall cartographic and production efficiency, which may require traditional skills up to the ability where technically trained expertise or an automated system can take over. The role of universities is the education of personnel capable of making cartographic decisions, working in the control of cartographic products, cartographic management and cartographic research (Grant, 1976).

Training and educational patterns in North America, Europe and Australia have recognised a two-tier development by introducing both technical training and academic university programmes. Although in South Africa, limited training facilities do exist through at least one technical institution, the universities have not exhibited any real development over the past three decades, in the broader bases now associated with education in cartography. The implementation of university training programmes, in particular the specific aspects of syllabus construction, content and methods would, however, need to be identified in relation to the requirements of the private, public and possible research sectors of the cartographic community. This in turn would require a more comprehensive investigation of employers requirements than the pilot study afforded in order to provide a realistic basis for the introduction of cartographic educational programmes. Nevertheless, assuming that, on the evidence of the pilot study, limited academic programmes could be viable, it may be advantageous to consider a place for cartography in the South African university degree course structure.

#### F. A PLACE FOR CARTOGRAPHY IN THE UNIVERSITY STRUCTURE

If, on the basis of the assumption made in Chapter Four, there is a demand in South Africa for education in cartography at university level, the problem becomes one of establishing cartography either as an autonomous, independent discipline or as a subject in association with an already established university department. Consideration of these

alternatives may give an indication of a possible place for cartography in the South African university structure.

Disciplinary specialization at university level, even in the most simple terms, requires a distinctive subject identity, a proven continuous demand for personnel and an established commitment to research in the field (Robinson, 1979). Cartography in South Africa cannot yet meet even these most elementary requirements. It is not yet recognized as a definitive field of study, the possible demand for cartographers is relatively small and there is at present no indication of any research programmes being undertaken. Separate departments at S.A. universities, even if desirable, appear then a remote possibility. Further, at a time when inter-disciplinary approaches are gaining acceptance, the boundaries between disciplines are becoming less evident. It is often in these overlapping areas of association where the major activity and interaction is occurring (Grant, 1976). Cartography as a field of study, with its essentially inter-disciplinary art, science and technological components would appear most conveniently to be accommodated not only in an existing discipline within the university structure, but in one in which an acknowledged inter-disciplinary environment has been established.

Courses in cartography in overseas countries are integrated with, or hosted by, a number of differing disciplines within the university structure. Full degree or specialization courses in cartography are offered through departments of geography, geodesy, engineering, survey, geology or forestry in the U.S.A., Canada and Australia. Independent degree or diploma programmes in cartography, coupled with photogrammetry or survey, or as a specialization within geography, are offered in Great Britain, the Netherlands and the U.S.S.R. In the technical universities of Austria, Switzerland and West Germany, cartography is taught through the faculties of survey, geodesy and engineering. It is the growth and development of academic educational programmes through a broad spectrum of university disciplines but more particularly Geography, that has provided the impetus for the now considerable body of research that is evident in all aspects of cartography (Morrison, 1974; Ormeling, 1978). It has been noted, however, by Grant (1976), that while cartography courses are offered by many apparently differing disciplines at North American universities, it is primarily through Geography, Survey and the survey component of other disciplines, such as Geology and Forestry, that cartography is taught. It has also been noted in literature that it is

generally the Survey disciplines in Western Europe, and Geography in Great Britain which appear the principal host disciplines for cartography. Geography and Survey then appear to be the most common host disciplines in the university structure for cartography.

Traditionally it has been the disciplines of Land Surveying and Geography that have nurtured cartography in South African universities. It has been noted in Chapter Four, however, that the cartographic tuition offered by these disciplines has not developed beyond that of a very basic introduction to practical map work. Cartography is not yet regarded by either discipline as a field of study in its own right and consequently very few, if any, research programmes in cartography have been developed. In support of these contentions, contributions published in the three S.A. journals, the S.A. Survey Journal, S.A. Geographical Journal and the S.A. Geographer were examined for possible research papers with cartographic content. Of the 616 papers published between 1968-1982, 10, or less than 2%, had a cartographic content or orientation. Four constituted historical aspects of cartography; three, technical applications in cartography; two, the use of cartography in geographical analysis, and one, education in cartography. The authors comprised four land surveyors all appointed in senior survey/cartographic posts in State departments, two geographers and one cartographer. Nevertheless the existing structures of either the Land Surveying or Geography departments at South African universities could well be expanded as in other countries, to provide for specialization in cartography. Which, however, would provide the most suitable accommodation, requires consideration.

To accommodate cartography many aspects of the degree and course structure, such as an arts or science affiliation, allied and inter-disciplinary subject associations, career opportunity and orientation and the availability of academic and technological expertise and resources would need to be considered. Specialization at departmental level also implies that certain curriculum requirements, both general and specific to cartography, would need to be met. Ultimately the accommodation of cartographic education will best be achieved where the art, science and technological requirements of cartography can be integrated in the most amenable curriculum (Grant, 1976). While of major importance to the introduction of cartographic educational programmes, the scope of this study does not allow for a

detailed discussion on these more specific aspects. A possible indication, however, to Surveying or Geography being the most suitable host discipline, or possessing the most suitable curriculum requirements, may be found in the growth of research opportunity provided by these disciplines. The expansion of research opportunity, according to Wolter (1975) appears to be naturally correlated with the development of educational programmes. Wolter (1975) attributed the significant increase in the scientific nature of cartographic literature, throughout the 1960's and early 1970's, to exponential increases, during the same period, in both the number of courses offered, and the number of institutions offering, cartography. As Geography and Survey constituted the primary host disciplines for cartography (Grant, 1976), increased research output could be attributed, to a large measure, to the increased educational opportunities provided by them. The apparent lack of both educational and research programmes in cartography through either discipline in S.A., provides little evidence as to the suitability of either for specialization courses in cartography. In the absence of specific cartographic research literature in South Africa, it is proposed to draw again on overseas journal literature to provide a basis for comparison and discussion. A review of selected journal literature should provide a measure of the research contribution made by both surveyors and geographers to cartography and thereby possibly indicate the most accommodating disciplinary structure not only for research, but the development of cartographic education.

On the assumption that journal literature would not only reflect the state of cartographic research, i.e. the creative and systematic investigation towards increasing scientific knowledge, but also the academic affiliation of researchers, selected cartographic journals were examined with particular reference to research content and authorship for the period 1968-1982. The 14 year reference period was regarded as adequate to make allowance for a range of material or any significant shift in subject matter in the content of journal papers and approximates the doubling-rate time period for science literature suggested by Wolter (1975). English language publications were selected because journals from Europe were not readily available and even if they were, difficulties of translation would emerge. It was required that the journals selected were the official organ of an accredited cartographic society or association as these would tend to supplant established geographical and survey journals for the publication of cartographic research papers.

To obtain a cross-section and possible basis for comparison, four journals, three of which were established prior to 1968, all official publications of accredited associations, were selected. Three of the journals were publications in the countries selected for the case studies on the development of education and training discussed in Chapter Four. The journals selected were the Australian publication CARTOGRAPHY, established in 1954; the British CARTOGRAPHIC JOURNAL and the CANADIAN CARTOGRAPHER/CARTOGRAPHICA, both established in 1964 and the AMERICAN CARTOGRAPHER established in 1974.

The journal papers were then examined with regard to:

1. The percentage research papers in relation to the total number of papers published.
2. The disciplinary affiliation of the author.

The research content of each journal was established by examining and noting the number of major papers which could be adjudged as contributing substantially and realistically to the body of scientific knowledge in cartography. For convenience the papers were classed in three major categories:

- a) Theoretical: Papers investigating philosophical and theoretical aspects of cartographic communication and information theory, psychological, psychophysical and perception studies; graphics, design and presentation; generalization, symbolization, colour transformations, the development of projections and user research.
- b) Automation and computer-assisted cartography: Investigating the development of cartography related software programmes; data processing, storage, retrieval and methods of image processing and display.
- c) Historical cartography: The work of early cartographers, historical maps and atlases, and the study of cartographic eras, epochs and early developmental 'schools' of cartography.

From the biographical data given in the journals, the disciplinary affiliation and contribution by geographers, surveyors and cartographers

in each of the research categories were established. Papers by cartographers were also noted, so as to determine whether, recognized proponents in what is regarded as essentially a technical field, had contributed to what is essentially considered academic research in cartography. In the final analysis, however, it was accepted that the research represented in three categories contributed to the body of scientific knowledge in cartography and could therefore be combined to represent the broad research front in cartography. The summary of selected journal research papers is presented in Table 5.3.

The indication that 410 or 69% of the combined total of 591 major papers published in the journals between 1968-1982 could be classed as research orientated, denotes a considerable emphasis towards research in cartography (Table 5.3). Individually, in three of the four journals considered, the number of research papers exceeds the number of non-research papers by a substantial margin. Of principal interest, however, are the collective contributions by geographers, surveyors and cartographers. Without exception, geographers have made the greater contribution (60%) to the published research literature in the selected journals. While Survey is considered a major host discipline to cartography, interest in cartographic research by surveyors appears to lag behind even that of practising cartographers. The relatively low research contribution of only 27% by geographers in the Australian journal, may well be attributed to the later development of cartography in academic geography programmes generally, as was noted in Chapter Four. The expansion of research opportunities in terms of journal contribution, when related to the development of educational programmes since the 1950's, would appear to substantiate Wolter's (1975) contention of a correlation between them.

Several factors may be advanced as possible reasons for the overwhelming contribution to cartographic research by geographers. Whereas cartography has always been considered an integral part of survey (Leppan, 1966), degree and course orientation has primarily been towards the production of qualified surveyors, for whom cartography, or the mathematical and technical aspects of map construction and production, represented only a subsidiary aspect. As a consequence, surveyors are more often found to be appointed to represent the 'professional' responsibility and identity for cartography in the larger state controlled institutional cartographic programmes notably in Canada, Great

TABLE 5.3: SUMMARY OF SELECTED JOURNAL PAPERS, 1968-1982.

JOURNAL	TOTAL NO. OF PAPERS	RESEARCH PAPERS	%
AMERICAN CARTOGRAPHER	85	63	74
Research papers		63	100
By: Geographers		46	73
Surveyors		-	-
Cartographers		7	11
CANADIAN CARTOGRAPHER/CARTOGRAPHICA	189	152	80
Research papers		152	100
By: Geographers		103	68
Surveyors		1	1
Cartographers		4	3
CARTOGRAPHIC JOURNAL	209	150	72
Research papers		150	100
By: Geographers		83	55
Surveyors		-	-
Cartographers		14	9
CARTOGRAPHY	108	45	42
Research papers		45	100
By: Geographers		12	27
Surveyors		5	11
Cartographers		9	20
COMBINED TOTALS	591	410	69
Research papers		410	100
By: Geographers		244	60
Surveyors		6	1
Cartographers		34	8

Britain, Australia and South Africa (Grant, 1976; Maling, 1973; Birtles, 1976; West, 1979). Geographers, on the other hand, have become more concerned with the development of cartography as a science in which the map is considered a means of information communication, and the study and use of maps as a fundamental tool in the information process as well as in geographical analysis (Fuson, 1969; Robinson, 1979). The academic nature of the geographers approach, together with the more highly developed educational programmes, in cartography, particularly through Geography (Dahlberg, 1981), would more readily tend to engender research aspects in cartography. The development of cartography as a research field may well be associated with advances which also occurred in Geography, such as the so-called 'quantitative revolution' of the 1960's, and the recognition of cartography or 'graphicacy' as adding a fourth to the geographers skills of 'literacy', 'articulacy' and 'numeracy' (Balchin and Coleman, 1966). Further, geographers appear to have accepted a more active role in the formulation and promotion of cartographic education through participation in the deliberations and Commissions of the I.C.A., which in turn has promoted a new and specific identity for cartography as a specialization in Geography. Finally, the recognition of more amenable or versatile curriculae and course content conditions, as well as the established inter-disciplinary affiliation to be found within Geography, have allowed cartography to develop as a specialized, scholarly and scientific field of study.

On the basis of the survey, the determining of research contribution and author affiliation in overseas journals, as a measure of research opportunity provided through educational programmes, indicates that the eclectic art, science and technological nature of cartography would appear to have been accommodated and developed to the greatest advantage within Geography, rather than Survey. For cartography as a field of study in South Africa, the implication is that it should be to the discipline of Geography, with its established inter-disciplinary associations and amenable curriculae, that one should look for education and the directing of research and a place for cartography in the university structure.

Recognition of the developments in technology, research and better education and training which have taken place in cartography since the 1950's, does not appear to be widespread in either the cartographic community generally, or the universities in South Africa. That

cartography has a specific scholarly and scientific identity, albeit as a specialization within an associated discipline, belies the traditional purely technical concept of the field. Concentration on the development of a specialized cartography related curriculum at but one South African university could well provide a small but essential source of cartographic manpower, not only to the cartographic community of South Africa, but for the eventual development of a research field in cartography in South Africa.

#### SUMMARY

The chapter has focussed attention, through a pilot study and a preliminary investigation, on some of the needs, in terms of education and training, of the private and public cartographic sectors in South Africa. A small but consistent need for education in cartography has been noted and some of the basic differences between the concepts 'education' and 'training', relative to cartography in the university situation, have been discussed. A place within the university structure in which the art, science and technological nature of cartography may best be accommodated has been considered through an analysis of the development of research opportunity, as reflected by author affiliation in research literature.

CHAPTER SIX

RETROSPECT AND PROSPECT

Cartography has, throughout a long evolutionary process, undergone major changes in its content, methods and tasks. Technological advances, as well as conceptual and philosophical shifts have occurred in cartography to accommodate the many varied and increasing demands for cartographic products and services. The future of cartography depends on the recognition that adequate education and training opportunities exist for the personnel required to meet these demands. In view of developments which have taken place in other countries during the past three decades, there is concern for the lack of educational opportunity in South Africa.

To appreciate the situation as it existed in cartography immediately prior to the 1950's, it was necessary to trace the historical growth and development of cartography from earliest times. The underlying influence of adopted technological innovation, through printing and photography, had been a major factor in the development of cartography. By the 1950's, for the first time the possibility of a specific and adaptable technology, combining quality of image with shorter production times through the introduction and use of plastics, was to revolutionize the technology of cartography. The long established concept of a traditionally orientated topographical cartography required serious re-examination and evaluation in terms of the alternate functional and thematic demands being made of cartography. Finally, the erosion of the functions of the once independent cartographer to that of a skilled technician requiring little more than a basic education and an ability to draw, determined the nature of the training available. By the mid 20th century, cartography, with little literary output and few societies, had reached a stage of relatively minimal noticeable growth of development. Within the next three decades, however, the whole field of cartography was to advance more technologically, conceptually and institutionally than during any other period in its history.

The early post-World War II period witnessed a new and growing academic interest and awareness in cartography as a field of study. The introduction and development of educational programmes throughout the next 30 years provided the basis for exponential growth in all aspects of

literature and the impetus for intensified research in cartography. The formation of national societies and an international organization as forum for discussion and debate, led to a new concept and definition and consequent identity for cartography and cartographers. More particularly, advances in technology and the fragmentation of processes and procedures highlighted the dichotomy between education and training in cartography. Ideal syllabuses and the identification of progressive cartographic expertise were framed and recommended. Case studies were used to explore the differing emphasis in the introduction and demand for education and training in the U.S.A., Great Britain and Australia. Notwithstanding the different patterns exhibited in each case, the studies support the consideration of a two-tier academic and technical educational system to supply the overall needs of the cartographic community. In relation to overseas development in education and training in cartography, the current situation in South Africa, with only one technical diploma course and little, if any, academic tuition or research in cartography, appears to be critically inadequate.

Without an assessment of the needs or requirements of the cartographic community, however, the random introduction of education or training programmes lacks justification and purpose. The attempt to provide such an assessment, however, proved less effective than planned. The overall response by the private cartographic sector, although small, did provide an indication as to the possible education and training requirements of the sector. The disappointing non-participation of the public sector has necessitated various assumptions being made, with regard to education and training requirements, based on staff trends in the Division of Surveys and Mapping. Whereas the primary need of both sectors appears to lie in the provision of well trained technician cartographers, the survey also indicated that a small number of graduates could well constitute, not only a desirable, but employable source of manpower in cartography. Considering then a place for cartography within the university structure, on the basis of research opportunity afforded and author affiliation, it would appear that Geography, with its well established inter-disciplinary associations, could possibly best accommodate the eclectic, art, science and technological nature of cartography.

For future research into cartographic education and training in South Africa, hopefully this study raises more questions than it has attempted

to answer. Certainly many aspects need to be clarified by further research and study. The education and training requirements of the whole cartographic community need more comprehensive examination and determination, possibly through the reframing of the questionnaire in consultation with both private and public sector organizations. Participation by the public sector is essential in any future survey if the overall education and training requirements in cartography are to be accurately assessed. The extension or improvement of second-tier technical training programmes needs to be studied and reassessed on the evidence of the developments overseas and in relation to the requirements of the cartographic community as a whole. While the possible demand for university graduate cartographers is obviously small, the provision of a specialist course at but one university in South Africa would not only fulfil these needs but eventually provide the opportunity for the future development of a much needed research field in South African cartography. Course content, orientation and structure, as well as the disciplinary association for cartography would all need to be considered in relation to tuition expertise and the differences between an 'education' and a 'training' in cartography.

The exponential growth and the development exhibited in all aspects of cartography since the 1950's, substantiates the claims to a revolutionary or watershed period during which cartography has emerged towards being a discipline and scientific field of study in its own right. The inadequacy of present education and training programmes, when viewed in conjunction with the requirements of the cartographic community, necessitates a reconsideration of educational and training policies and standards for cartography in South Africa.

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APPENDIX A

SELECTED DEGREE AND DIPLOMA COURSES IN CARTOGRAPHY

1. University of Alberta, Canada.  
4-year Degree Programme.
2. Range of Cartographic Training in Canadian Community Colleges.
  - a) Algonquin College.
  - b) Sir Stanford Flemming College.
3. International Institute for Aerial Survey and Earth Sciences (I.T.C.).  
Courses in Cartography.
4. International Cartographic Association (I.C.A.).  
Typical Syllabus of matters to be taught in Cartography.
5. University of Wisconsin-Madison, Wisconsin, U.S.A.  
Degree Programmes in Cartography.
6. University of Glasgow, Scotland.  
Degree Programmes in Topographic Science.
7. Royal Melbourne Institute of Technology (R.M.I.T.) Melbourne,  
Australia.  
Certificate of Technology (Cartography).
8. Canberra College of Advanced Education, Canberra, Australia.  
Cartography Major/Applied Geography Degree Programme.
9. Cape Technikon, Cape Town, South Africa.  
National Diploma (Cartographic Draughtsmanship).

APPENDIX A1

UNIVERSITY OF ALBERTA, CANADA

4-YEAR DEGREE PROGRAMME THROUGH GEOGRAPHY (KLAWE, 1970)

1st Year

- Geography - Physical geography or general geography
- Mathematics - Algebra, elementary calculus and probability theory
- Physics - Basic general physics
- Chemistry - Introductory university chemistry
- Language - French or German

2nd Year

- Geography - Topographic cartography
- Astronomy - Introductory
- Art - Fundamentals of visual communication
- Economics - Principles of economics
- Computer Science - Elements of programming

3rd Year

- Geography - Economic and social mapping
- Meteorology - General meteorology
- or
- Geography - Intermediate physical geography
- Botany - Plant geography
- Civil Engineering - Theory and practice of plane surveying
- Geodesy and photogrammetry
- Sociology - Population studies
- Migration studies

4th year

- Geography - Cartographic design and editing
- Chemistry - Organic chemistry
- or
- Anthropology - North American archaeology
- Philosophy - Introduction to logic
- Symbolic logic
- Classics - Early civilization
- Geology - Introductory
- or
- Geography - History and nature of geography
- Agriculture geography

APPENDIX A2

RANGE OF CARTOGRAPHIC TRAINING IN CANADIAN COMMUNITY COLLEGES  
(GRANT, 1976)

1. ALGONQUIN COLLEGE CARTOGRAPHY PROGRAMME

Semester 1

Cartography  
Cartography Lab.  
Photogrammetry  
Geomorphology  
Survey  
Mathematics  
English  
Descriptive Geometry

Semester 2

Cartography  
Cartography Lab.  
Photogrammetry  
Air Photo Interpretation  
Survey  
Map History  
Descriptive Geometry  
Mathematics  
English

Semester 3

Cartography  
Cartography Lab.  
Photogrammetry  
Air Photo Interpretation  
Survey  
Mathematics  
English

Semester 4

Cartography  
Cartography Lab.  
Town Planning  
Mathematics  
Graphic Arts  
Computer Programming  
English  
Speciality Project

2. SIR STANFORD FLEMMING COLLEGE CARTOGRAPHIC TECHNOLOGY PROGRAMME

Semester 1

Mathematics I  
Developmental Reading and  
Communications  
Drafting Techniques I  
Graphic Communications I  
Lettering I  
Photography I  
Map Reading

Semester 2

Mathematics I  
Developmental Reading and  
Communications  
Drafting Techniques II  
Graphic Communications II  
Lettering II  
Elementary Cartography  
Photography II

Semester 3

Mathematics II  
Production Techniques I  
Graphic Communications III  
Photogrammetry I  
Air Photographic Interpretation  
Surveying I  
Geomorphology  
\* General Studies Elective

Semester 4

Mathematics III  
Production Techniques II  
Graphic Communications IV  
Photogrammetry II  
Physics  
Surveying II  
Computer Programming I  
\* General Studies Elective

Semester 5

Mathematics IV  
Production Techniques III  
Graphic Communications  
Computer Programming II  
Thematic Cartography  
\* General Studies Elective  
\*\* Technical Elective

Semester 6

Mathematics V  
Production Techniques IV  
Research and Production Project  
Computer Applications  
Thematic Cartography  
Remote Sensing  
Management  
\* General Studies Elective

\* One from: English, Economics, Politics & Government and Law

\*\* One from: Geology, Forestry and Community Planning

## APPENDIX A3

### INTERNATIONAL INSTITUTE FOR AERIAL SURVEY AND EARTH SCIENCES (I.T.C. - ENSCHEDE, THE NETHERLANDS (I.T.C., 1982))

#### COURSES IN CARTOGRAPHY

##### C.1 M.Sc. Degree programme in Cartography

Duration 12-16 months followed by a period of about 6 months for writing a thesis.

Minimum entrance requirement: B.Sc. degree.

The M.Sc. programme allows for a research specialization in any aspect of cartography. Holders of this degree should be able to reach senior managerial levels and to develop the subject further in both teaching institutions and production services.

##### C.2 Post-graduate Diploma course in Cartography

Duration 12-16 months.

Minimum entrance requirement: B.Sc. degree.

The Post-graduate course is to a large extent similar to the Technologist's course, but with less practical training and more theoretical studies. Computer-assisted Cartography is extensively treated and emphasis is also laid on map compilation, checking, cost estimating and other managerial tasks.

##### C.3 Technologist Diploma in Cartography

Duration 12 months.

Minimum entrance requirement: University entrance qualification.

The Technologist's course, in addition to providing extensive practical training, goes deeper into the theoretical aspects of cartography. Students who complete this course should be capable of occupying senior supervisory posts in cartographic agencies.

##### C.4 Technician Diploma in Cartography

Duration 9-12 months.

Minimum entrance requirement: Secondary education level.

In the Technician's course the emphasis is on education and training in practical aspects of cartography (drawing and reproduction) with a view to producing cartographic technicians capable of acting as supervisors of small sections of the drawing office of a cartographic organisation.

## APPENDIX A4

### INTERNATIONAL CARTOGRAPHIC ASSOCIATION TYPICAL SYLLABUS OF MATTERS TO BE TAUGHT IN CARTOGRAPHY (I.C.A., 1970a)

#### GENERAL INSTRUCTION

Mathematics	- Algebra and analysis
	- Differential geometry
	- Algebra and geometry
	- Dimensioned plans and descriptive geometry
	- Plane and spherical trigonometry
	- Notions on applied mathematics
Physics	- General physics
	- Optics and photography
Chemistry	
Elements of general geography	
Regional geography	- World geography
	- National geography
Foreign languages	

#### EARTH SCIENCES AND HUMAN GEOGRAPHY

Physical geography	- Geophysics
	- Geology and Pedology
	- Geomorphology
	- Biogeography
	- Meteorology and climatology
	- Oceanography
Human and economic geography	- Political geography
	- Population geography
	- Economic geography
Synthesized geographical studies	

#### APPLIED SCIENCES

Astronomy, geodesy  
Topometry, topography  
Aerial photography and remote sensing processes  
Photogrammetry  
Toponymy

CARTOGRAPHY

The Cartographic work

- The field of cartography
- History of cartography

Mathematical cartography

Theoretical cartography

- Cartographic expression and representation
- Topographic cartography
- Thematic cartography

Techniques of reproduction and printing

Maintenance of maps

Automation

DOCUMENTATION

Documentation sources

Statistics

ORGANIZATION

Cartographic organizations

Legislation, copyright

Organization of the work, costs

## APPENDIX A5

### UNIVERSITY OF WISCONSIN-MADISON, WISCONSIN, U.S.A. DEGREE PROGRAMMES IN CARTOGRAPHY (ROBINSON, 1975b)

The Department of Geography at the University of Wisconsin-Madison has received formal Regent approval to offer new bachelor's and master's degrees in cartography in addition to their usual degrees in geography. The Ph.D. degree will continue to be labelled as geography although the principal area of concentration can be cartography.

#### BA/BS in Cartography

- a) One course in each of
  - (1) physical geography,
  - (2) human geography,
  - (3) regional geography and the colloquium for undergraduate majors in the Geography Department.
  
- b) Three required courses in cartography:  
Principles of Cartography: Large-Scale  
Principles of Cartography: Small-Scale  
Problems in Cartography.
  
- c) Four elective courses chosen from the following:  
Maps and Air Photos (only if taken as the first course in cartography)  
Graphic Design in Mapmaking  
Applied Cartographic Design  
Cartographic Methods in (Scientific) Research  
Map Transformations and Coordinate Systems  
History of Mapmaking
  
- d) A course in statistics.
  
- e) A course in field surveying.
  
- f) Completion of option A or B.  
Option A: Competence in either French, German or Russian; 9 semester credits in history, history of science, art history.  
Option B: Two semesters of college Calculus, a course in Photogrammetry and the course in Map Transformations and Coordinate Systems.

MA/MS in Cartography

- a) Acceptance by the Graduate School and a background of one course in physical geography and one in human geography, one of which must be advanced; a course in statistical methods.
- b) Completion of either the language or mathematics requirement specified for the undergraduate major in cartography.
- c) Proseminar in Cartography.
- d) Twelve semester credits in cartography courses, including the Problems course.
- e) Seminar in Cartography.
- f) Thesis.

## APPENDIX A6

### UNIVERSITY OF GLASGOW, SCOTLAND DEGREE PROGRAMMES IN TOPOGRAPHIC SCIENCE (PETRIE, 1979)

#### UNDERGRADUATE PROGRAMME

##### Degrees in Topographic Science

The courses in Topographic Science may be taken either as the major item in a B.Sc. degree with honours in Topographic Science, which allows the student to go into the whole subject area in depth, or as part of an ordinary or general B.Sc. degree, with less specialization and coverage.

For the B.Sc. degree with honours in Topographic Science there are two compulsory basic science subjects - Geography and Computing Science - which are normally taken in the first year and which must be passed before entry to the honours years of the Topographic Science degree. A typical curriculum is as follows:-

1st Year: Geography (Ordinary); Computing Science (Ordinary);  
Mathematics or General Physics (Ordinary).

2nd Year: Topographic Science (Higher Ordinary); either Geography or  
Computing Science (Higher Ordinary) or Geology or Archaeology  
(Ordinary).

3rd Year: Topographic Science (Junior Honours)

4th Year: Topographic Science (Senior Honours).

Topographic Science may also constitute a substantial part of an ordinary or general B.Sc. degree. A typical combination is the following - many others are possible!

1st Year: Geography (Ordinary); Geology (Ordinary); Mathematics or  
General Physics or Chemistry (Ordinary).

2nd Year: Topographic Science (Higher Ordinary); Geography or Geology  
(Higher Ordinary).

3rd Year: Topographic Science (Advanced Ordinary); Archaeology or a  
social science subject, e.g. Politics or Political Economy  
(Ordinary) or Geography (Advanced Ordinary).

## POST-GRADUATE PROGRAMME

### Post-Graduate Diplomas in Cartography

Applicants for admission to Diploma courses should be in possession of a university degree. It is inadvisable to enter cartographic studies with defects in vision, especially colour vision.

Each Diploma candidate also undertakes a practical project in the third term and submits a short written report together with his finished survey, map or other project material at the end of the course.

### SCHEDULE OF COURSES

#### Diploma in Cartography

Cartography I comprising Metrics (including projections, scale changing, etc.) Graphics I, Map Reproduction I, Foreign Map Series and History of Cartography.

Cartography II comprising Metrics II, Graphics II, Map Reproduction II, Boundaries and Cadastral Surveys and Maps.

Cartography III comprising Orthophotographs and Photo Maps, Digital Mapping and Automation in Cartography, Map and Chart Production, Atlas Design and Production, Thematic Maps.

Computing Science including Computer Programming in BASIC, Data Processing and Computer Graphics.

#### Master of Applied Science Degree in Topographic Science

The Master of Applied Science (M.App.Sci.) degree in Topographic Science is obtained partly by course work (using the courses instituted for the post-graduate Diplomas) and partly by a dissertation on an approved topic of an applied nature.

The M.App.Sci. degree normally takes two academic years of full-time study.

### Research Degrees

Graduates wishing to undertake research in Topographic Science are admitted (as are all other such students in the Faculty of Science) simply as research students. They are not normally registered at the outset for a specific degree. As their research develops they may, with the approval of their supervisors, decide to submit a thesis either for the degree of Master of Science (M.Sc.) or for the degree of Doctor of Philosophy (Ph.D.) provided that they have been registered for the minimum period required in either case. In the case of an M.Sc. this is normally two years. The minimum period of fulltime study for the Ph.D. degree is three academic years.

It must be emphasised that these two degrees are obtained wholly by research, course work playing no part in the award of either degree, which is based solely on the submission of an acceptable thesis.

## APPENDIX A7

### ROYAL MELBOURNE INSTITUTE OF TECHNOLOGY, MELBOURNE, AUSTRALIA (R.M.I.T., 1979)

#### CERTIFICATE OF TECHNOLOGY (CARTOGRAPHY)

##### Recognition

This course is presently recognized by the majority of government departments and by many private firms. Employment promotional prospects are usually based on this qualification. The qualification is also recognized by the Australian Institute of Cartographers on application.

##### Structure

Students are required to pass 25 compulsory units and 4 elective units. Elective units must include one pair of consecutive units, e.g. Geology 1A and Geology 1B as a pair. Students are also required to have completed two years of approved industrial experience.

##### Compulsory Subjects

Mathematics 2V  
Mathematics 2W  
Survey Science 1A  
Communication and Report Writing  
Computer Studies  
Reprographics 1A  
Reprographics 1B  
Physical Geography 1A  
Physical Geography 1B  
Cartography/Survey Drafting 1A  
Cartography/Survey Drafting 1B  
Survey Drafting 2A  
Survey Drafting 2B  
Surveying 1A  
Surveying 1B  
Surveying 1AC  
Surveying 1BC  
Cartography 2A  
Cartography 2B  
Cartography 3A  
Cartography 3B  
Photogrammetry 1A  
Photogrammetry 1B

##### Elective Subjects

Town Planning 1A  
Town Planning 1B  
Acts and Regulations 1A  
Acts and Regulations 1B  
Geology 1A  
Geology 1B  
Civil Engineering 1A  
Civil Engineering 1B  
Photogrammetry 2A  
Photogrammetry 2B  
Hydrology 1A  
Hydrology 1B  
Physics 1H  
Surveying 2C  
Survey Drafting 3A  
Survey Drafting 3B

## APPENDIX A8

### CANBERRA COLLEGE OF ADVANCED EDUCATION, CANBERRA, AUSTRALIA. CARTOGRAPHY MAJOR/APPLIED GEOGRAPHY DEGREE PROGRAMME (BIRTLES, 1974)

#### Syllabus

The Cartography major consists of six semester units. A semester unit constitutes the equivalent of twelve to sixteen hours of student work per week (including formal classes) for an academic period of fifteen weeks. The six semester units are:

- First Year Units:   Introductory Mapping  
                          Surveying
- Second Year Units:  Cartography I  
                          Cartography II
- Third Year Units:   Cartography III  
                          Remote Sensory Mapping

The Cartography major is designed as one form of elective sequence to co-ordinate with the Applied Geography degree programme. A recommended course of twenty semester units that fulfills the degree schedule is set out as follows:

#### a) Applied Geography Major

##### i) Four units as follows:

- |                                 |                    |
|---------------------------------|--------------------|
| Introduction to Human Geography | (First Year Unit)  |
| Resource Location               | (First Year Unit)  |
| The Physical Environment        | (Second Year Unit) |
| EITHER                          |                    |
| Location Analysis               | (Second Year Unit) |
| OR                              |                    |
| Land Tenure and Settlement      | (Second Year Unit) |

##### ii) Three units selected from the following:

- |                              |                    |
|------------------------------|--------------------|
| Air Photointerpretation      | (Second Year Unit) |
| Geography of Urbanization    | (Third Year Unit)  |
| Social Geography             | (Third Year Unit)  |
| Applied Physical Geography   | (Third Year Unit)  |
| Urban Planning               | (Third Year Unit)  |
| Geography of South East Asia | (Third Year Unit)  |
| Geography of the Pacific     | (Third Year Unit)  |

b) Cartography Major

Six units as follows:

Introductory Mapping

Surveying

Cartography I

Cartography II

Cartography III

Remote Sensory Mapping

c) Techniques Units

i) Four units must be taken as follows:

English Expression

Computers and Computing

Computer Programming I

Linear Algebra

ii) Three units selected from the following:

Introduction to Mathematics

OR

Finite Mathematics

Computer Programming II

Computer Organization II

Information Systems I

Calculus I

Numerical Analysis I

Elements of Statistics

Probability Theory

Statistical Analysis

Quantitative Geography

## APPENDIX A9

### CAPE TECHNIKON, CAPE TOWN, SOUTH AFRICA NATIONAL DIPLOMA (CARTOGRAPHIC DRAUGHTSMANSHIP) (CAPE TECHNIKON, 1982)

#### CAREER DESCRIPTION

The Cartographic Draughtsman is concerned with the compilation and production of maps. He is employed by concerns such as, Director General of Surveys, Surveyor-Generals' Office, Municipalities, land survey offices, town planning offices and air survey companies.

As most maps are now-a-days produced on stereoplotting machines from air photographs, the function of the cartographer includes the operation of such machines compiling or revising maps.

Practical training takes place in any of the above-mentioned offices, and to begin with the cartographer is engaged on simple drawings, tracing, lettering, and inking up maps. He is advanced to the drawing of maps and generally is engaged on all of the various cartographic procedures. This would include the mapping from air photos, also scribing and fair drawing methods.

#### ENTRANCE QUALIFICATION

Senior Certificate or equivalent qualification with a pass in Mathematics.

#### DURATION OF COURSE

This is a three year 'sandwich' course. Students must attend three semesters full-time at the Technikon, alternating with equal periods of appropriate in-service training.

#### LIST OF SUBJECTS

##### SEMESTER ONE

Geography T1  
Engineering Mathematics T1  
Communication T1  
\*Construction (Surveyors) T1  
Surveying T1  
Drawing (Civil and Survey) T1  
\*Applied Mechanics (Civil) T1

##### SEMESTER TWO

Photogrammetry T2  
Engineering Geology T2  
Engineering Mathematics T2  
Surveying T2  
Survey Drawing T2

SEMESTER THREE

Photogrammetry T3

Map Projections T3

Cartography T3

Cartographic Project T3

Survey Law T3

NOTE: Candidates must include one of the subjects marked \* in their course. All other subjects are compulsory.

APPENDIX B

SURVEY QUESTIONNAIRES

1. Cartographic Teaching Survey Questionnaire
2. Cartography Questionnaire

APPENDIX B1

CONFIDENTIAL

R H O D E S U N I V E R S I T Y

DEPARTMENT OF GEOGRAPHY

CARTOGRAPHIC TEACHING SURVEY

1. Name of University

.....

2. Number of students taking Land Surveying or Geography 1979:

- |                        |                      |
|------------------------|----------------------|
| a) 1st year            | <input type="text"/> |
| b) 2nd year            | <input type="text"/> |
| c) 3rd year            | <input type="text"/> |
| d) 4th year or Honours | <input type="text"/> |

3. Do you offer a course in Cartography as an integral part of the Survey or Geography syllabus? YES NO  
 |

4. Do you offer a course in Cartography as a separate specialized course in the Survey or Geography syllabus? YES NO  
 |

N.B. If the answer to both the above is NO please ignore the remaining questions and return the form.

N.B. If the answer to either or both the above is YES please complete the following:-

5. During which year(s) is the Cartography course offered?

- |             |                      |
|-------------|----------------------|
| 1st year    | <input type="text"/> |
| 2nd year    | <input type="text"/> |
| 3rd year    | <input type="text"/> |
| 4th/Honours | <input type="text"/> |
| Other       | <input type="text"/> |

6. What is the average duration of the course?

Week(s)	<input type="text"/>
Term(s)	<input type="text"/>
Semester(s)	<input type="text"/>
Year(s)	<input type="text"/>

7. What is the average duration of the sessions offered in cartography per week?

	<u>HOURS</u>
Theory	<input type="text"/>
Practical	<input type="text"/>

8. Do you expect students to complete to a prescribed standard:-

- a) Some cartographic work
- b) Most drawing work handed in
- c) All drawing work handed in
- d) A specific cartographic project or projects

9. To what standard are students expected to become proficient:-

- a) Pencil drawing
- b) Basic penmanship and hand or stencil lettering
- c) Advanced monochrome diagrams and maps
- d) Fair drawing for colour separation

10. Are post-graduate students expected to complete all their own cartographic work for theses and seminars?

<u>YES</u>	<u>NO</u>
<input type="text"/>	<input type="text"/>

11. Does cartographic theory, practical work or projects feature specifically for marks in:

- a) Course or year work
- b) Term or semester examinations
- c) Year end examinations

12. Which of the following techniques are specifically taught to and undertaken by students:

- a) Simple outline maps, diagrams and graphs
- b) Hand or stencil lettering
- c) Statistical maps and diagrams
- d) Thematic mapping
- e) Plotting and drawing projections
- f) Compilation and drawing maps from air photos
- g) Topographical mapping including relief portrayal methods
- h) Model building
- i) Colour separation fair drawing
- j) Scribing techniques
- k) Carto/photographic techniques
- l) Printing procedures and techniques

13. Does the department have specific cartographic laboratory facilities available for:

- |                | YES                      | NO                       |
|----------------|--------------------------|--------------------------|
| a) Students    | <input type="checkbox"/> | <input type="checkbox"/> |
| b) Staff       | <input type="checkbox"/> | <input type="checkbox"/> |
| c) Technicians | <input type="checkbox"/> | <input type="checkbox"/> |

14. How many of the staff are responsible for teaching/ conducting cartography courses:

- |                                   |                          |                          |
|-----------------------------------|--------------------------|--------------------------|
| a) Academic                       | <input type="checkbox"/> | <input type="checkbox"/> |
| b) Technical (cartographers etc.) | <input type="checkbox"/> | <input type="checkbox"/> |

15. Number of technical staff (cartographers, cartographic assistants, draughtsmen) appointed to the department employed specifically on cartography work:

- |           |                          |                          |
|-----------|--------------------------|--------------------------|
| Full time | <input type="checkbox"/> | <input type="checkbox"/> |
| Part time | <input type="checkbox"/> | <input type="checkbox"/> |

Thank you for your co-operation.



7. Considering all your cartographic undertakings, state the number of employees normally assigned to the following type activities:

- i) Planning and /or Research only
- ii) Compilation and/or plotting only
- iii) Drawing and/or scribing only
- iv) Stick-up and/or allied processes
- v) The whole process (7i - 7iv) as one job component
- vi) Computer or automated mapping
- vii) Editing or checking only
- viii) Quotations or costing only
- ix) Supervision only
- x) Other (specify)

Number Question 7	Rank Question 8

8. Please rank items 7 i) - 7 x) in Question 7 from 1 through to 10 according to the seniority, qualification or experience of the staff undertaking these respective activities.

- 1 = most senior, qualified or experienced
- 10 = least senior, qualified or experienced

9. Assuming a possible 3 or 4 year degree in Geography embodying a substantial cartographic component, your comments on the following thesis would be appreciated.

"In view of the developments in the field of cartography, there is scope for selected geography/cartography graduates as being distinct recruitment possibilities for our type of cartographic organizations".

Please indicate your response by marking the appropriate block on the following scale with an X.

Strongly agree	Agree	Undecided	Disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If you wish to explain your response by further comment please do so.

.....

.....

10. What specific aspects of cartographic work would you consider as the MOST IMPORTANT in which a student cartographer should be trained, in order to be employable by your organization? (Specify).

.....

.....

11. Please indicate your major employee recruitment sources by ranking the following from 1 - 7.

- i) School leavers
- ii) Technical College (Technikon) leavers
- iii) University graduates
- iv) Public sector or government service
- v) Mining companies or groups
- vi) Other private sector companies
- vii) Other (specify) .....

Rank

12. Mark with X the appropriate block:

a) Do you have difficulty in filling vacant posts for cartographic work?

--	--

If yes, is it because there is

i) a lack of applicants generally

--	--

ii) a lack of suitably trained applicants, or

--	--

iii) (specify own reason) .....

b) Assess the demand, if at all possible, for cartographers over the next five years

i) in your organization

Number: .....

ii) in the private/public sector generally

Number: .....

13. What in your opinion are the main "gaps" in the education/training of the people you employ for cartographic work? (specify).

.....  
.....

14. Are there any other companies, departments or organizations known to you who undertake cartographic work and who may be able to assist with additional information?

Names .....  
Addresses (if possible) .....  
.....  
.....  
.....

15. Further comments on any aspects of cartographic education, training or employment which you feel have not been adequately covered by this questionnaire would also be most appreciated.

.....  
.....  
.....  
.....

Thank you for your co-operation.