ADVANCED CARTOGRAPHY

Code: 18KP1GELGI UNIT – I

DEFINITION OF CARTOGRAPHY

Cartography or mapmaking is the study and practice of making maps .Map making involves the application of both scientific and artistic elements, combining graphic talents and specialized knowledge of compilation and design principles with available techniques for product generation. Map function as visualization tools for spatial data. Spatial data is stored in a database and extracted for a variety of purposes.

The traditional analog methods of map making have been replaced by digital interactive maps that can be manipulated digitally. Modern cartography like many other fields of "information technology" has undergone Rather than merely drawing maps the cartographic process is concerned with

I) Data manipulation,

II) Data capture,

III) Image processing and

IV) Visual display.

Cartographic representations may appear in printed form or as dynamic images generated on a computer display screen. Computer assisted mapping systems have added a new and exciting dimension to cartographic techniques and tradional methodologies have to be augmented with new skill. The fundamental nature of cartography has changed with the evolving technologies, providing cartographers with new methods for visualization and communication of spatial information.

Nature and Scope of Cartography

Cartography is the study and practice of making maps in all their aspects. It is an integrated part of geography. By combining science, aesthetics and technique, cartography shows that eality can be modeled in ways that communicate spatial information effectively. It includes almost every operation from original field-work to final printing of maps. Modern cartography is closely integrated with geographic information science (GIS), which you will learn later in cartography-II or digital cartography.

Cartography involves:

- Collecting and selecting the data for mapping
- Manipulating and generalizing the data
- Designing and constructing the map
- Reading or viewing the map
- Responding to or interpreting the information

With the increasing number of draftsmen who can make fair drawing under the supervision of a cartographer, without knowing much about why a map has been designed in a particular way, the theoretical aspects of cartography have acquired considerably greater importance in recent years. One can be designated as a cartographer even though he may not have the manual skills for drawing maps, but a good draftsman without the intellectual and technical skills needed to plan and design a map cannot be called a cartographer.

Artistic Side of Cartography

The aim of cartography is to improve the graphic representation of the earth. A map not only portrays details visually but also in a way that is pictorial and aesthetic. Since the birth of cartography, several artists are exploring the artistic or aesthetic side of it. To what extent cartography is an art is a controversial question. There are cartographers without much artistic skills; there are also cartographers who are artists first. However, there can be no cartographer who does not have a sense of beauty, proportion and order. And anyone who has this sense can aspire to become a cartographer.

The purpose of cartography is not the same as that of art. Cartography does not aspire to produce the greatest work of art. Art and artists require complete freedom of expression. They utilize this freedom to create a piece of work which may be incomprehensible or even meaningless to the common man. Unlike an artist, a cartographer functions under severe limitations set by topographical and statistical details, symbols and colour standards. Moreover, a cartographer can never afford to create a piece of work that will be incomprehensible and meaningless to its user. A piece of art is valued for its aesthetic beauty and sensibility whereas a map is valued for its mundane utility.

WHAT IS A MAP?

A map is a drawing of the earth or a part of it on a plane surface according to a scale; it is manually or mechanically drawn showing the location and distribution of various natural and cultural phenomena. One can have maps of the heavenly bodies as well. Maps showing the location and distribution of stars and the planets are only too many to need emphasis. Already, we have maps depicting the surface of the moon and the days are not far off when we will have as detailed maps of the moon as we have of the earth.

TYPES OF MAPS

On the basis of certain common features, maps can, be classified into several types. The following are some of these types:

1. Types by Relief Representation:

On the basis of the amount of topographic details given, maps can be classified as.

a. Hypsometric maps

b. Planimetric maps.

The hypsometric maps are those which show the relief and the terrain in detail and often at the cost of other details. The large scale topographical sheets produced by the Survey of India fall in this category.

The planimetric maps give more emphasis to other details and limit the relief portrayal to the inclusion of a few spot heights here and there. Most of thematic maps representing the cultural features of the landscape fall in this category.

2. Types by Scale:

Taking the scale as the criterion, maps can be classified as:

1. Small scale maps

2. Medium scale maps

3. Large scale maps,

To understand the use of the terms, first think about the ratio method of showing map scale:

- The ratio 1:10 000 - means that the size of objects on the map is 1/10 000 of their size on the ground.
- The ratio 1:250 000 - means that the size of objects on the map is 1/250 000 of their size on the ground. 1/10 000 is a larger fraction than 1/250 000, so 1:10 000 is the large scale map. (In the same way that 1/2 of an apple is a large piece of apple when compared to 1/8 of an apple).

There is no universally accepted standard to classify maps according to scale. As a result of this each specialized group of map users sets up its own standards for classification.

For the purpose of this book, maps having scales of 1: 63,360 or more are classified as large scale maps; those falling between 1: 63,360 and 1: 1,000,000 as medium scale and those having scales below 1: 1,000,000 as small scale maps. The million sheets of the Survey of India and the National Atlas of India are considered to be medium scale maps.

3. Types by Information:

Depending on the information provided on the maps, they can be classified as follows:

1. General purpose maps

2. Thematic maps

3. Special purpose maps.

General purpose maps show many different elements that are usually found in individual maps. For example, Topographic-sheets and atlas maps.

Maps dealing with a single factor such as geology, rainfall, crops, population etc., are classified as thematic maps. In these maps, other data are represented only to highlight the basic data.

The special purpose maps are those which are constructed for a group of people having special reading or perceptual problems. For example, the maps for the blind, children and neoliterates

4. Types by Military Use:

There are certain maps which are drawn specifically for the use of military personnel. These maps classified as:

1. General maps

2. Strategic maps

3. Tactical maps, and

4. Photomaps

General maps depict only the broad topographic features and are usually used by the high Command for general planning purposes. Those maps are usually on a scale of 1: 1,000,000 or more.

Maps having scales ranging from 1: 1,000,000 to 1: 500,000 are often classified as strategic maps. These maps are used for the general planning of more concentrated military effort.

Maps with scales of 1: 500,000 or less are called tactical maps. A tactical map serves as a guide to small units like battalions and patrol units prior to and during the movement anywhere near the front line. These maps show almost all the relief and planimetry details and hence, are used in planning the tactics of smaller combat units. At times maps having scales of 1: 250,000 to 1: 500,000 are classed as strategic –tactical maps. These are mostly transportation and communication maps with relief and planimetry shown on them. They are used mainly for logistic planning and operations involving infantry and armored corps.

A photomap is an air photograph with strategic and tactical data superimposed on it. It is not a map in the true sense; it is rather a map substitute. Because of its wide use, it has been discussed here. A photomap may constitute just one photograph or it may be a mosaic composed of several of them. The scales of the photomaps range from 1: 5,000 to 1: 60,000. As the photomaps show the details against their photographic image, they are easily comprehensible to army personnel. Therefore, these maps are used by troops often.

Maps help us through the following ways.

To Locate Places:

The most universal use of maps is for locating places and things. Location of an object involves the knowledge of the site, i.e., the precise geographic location and its location in relation to surrounding features. Travelers often use road maps to reach their destination.

Education and Research:

Maps are good visual aids to easily understand the distribution of natural or cultural features on the earth's surface. Good maps have the capacity to crystallize the facts and figures in a way which makes them comprehensible and clear Maps can show what plants cover the land, where people get their food, and how quickly glaciers are melting. Maps of natural vegetation, eco-regions, climate zones or population trends can tell a vivid story. Maps can highlight the problems and present a picture of the problem easily. Use of statistical and quantitative techniques in processing of data to be represented on maps has further increased the utility of maps as research tools. The net result of this development is the increasing number of thematic maps.

Planning and Development:

Maps are of considerable use in planning socioeconomic development of a region. While planning for a community such as a village or a city, the present, past and future land use patterns must be depicted on maps. The existing property ownership lines must be shown clearly. The educational and recreational facilities and shopping centres must be planned on the basis of the needs of different areas. Industrial and residential locations should be planned by taking into account the transportation, sanitation, education, recreation and other facilities.Maps are equally useful in regional and national planning in building roads, rails, bridges, etc.Maps are useful in showing the progress made in different parts of a region or a nation.

Military Strategy:

Often, military operations have to be carried out in areas which have not been visited by the armed forces before. These forces have to know the details of topography so exacting as to be able to locate the mounds, canals, ditches and wells.

A single movement of troops requires several different types of maps; and when the operation involves a combined effort from all the branches of the armed forces, the variety of maps needed further increases. The land forces need one type of maps, while the air forces another type and the naval forces a third type. With the help of accurate maps, military operation can be executed more efficiently.

Other Uses:

Maps are being increasingly used by aerospace science. The use of mapping techniques to represent the surface of moon and other planets and to show the movement of satellites and rockets are examples of new uses of cartographic products.

Scientific Bases of Cartography

Cartography is geographic science. The subject matter of cartography is the surface of the earth and sometimes the planets and stars. It represents them as realistically as its principles and rules permit.

A cartographer must,

- Get firsthand knowledge of the earth either by observation or by study.
- Know well the spatial distribution and location of various objects since maps show them according to a given scale.
- Know to select the important data and reject or suppress the unimportant data (generalizing the data).

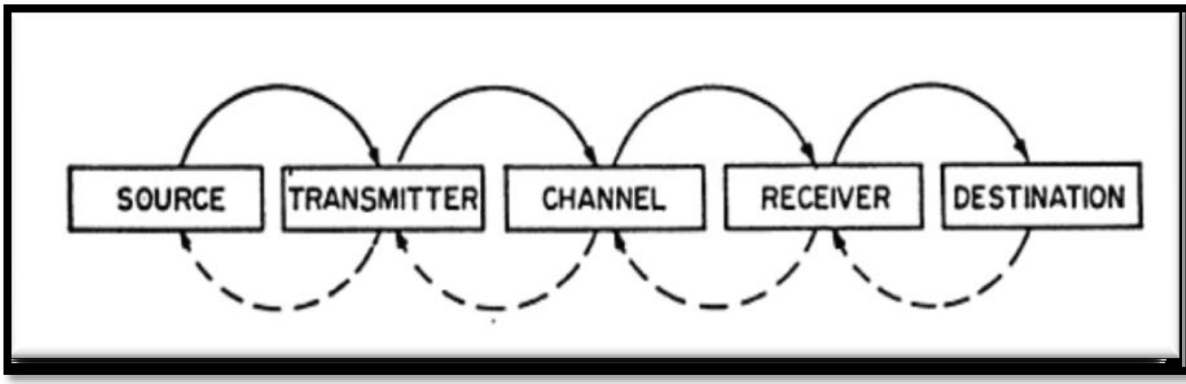
The geodesist and the topographic surveyor give the size and shape of the earth and the location of its surface feature; the economists, geologist, botanists. etc., give the subject matter.

The cartographer classifies and generalizes these details and converts them into map able form. He also designs and draws a map which the printers use to produce a number of identical copies. Sometimes, the surveyor not only surveys but also draws. His field drawings are then used to compile maps on smaller scales. The number and the size of the original drawings depend on the color scheme of the map and the printing process to be used. The financial resources also limit the freedom of the cartographer. It is because of this interdependence of the various cartographic processes that most official mapping agencies in the world combine all these operations from original surveys to drawing, printing and marketing of maps. A writer can be easily separated from the printer of his book, but a cartographer cannot be separated from his map printer. The two have to work together.

Cartography as a Science of Human Communication

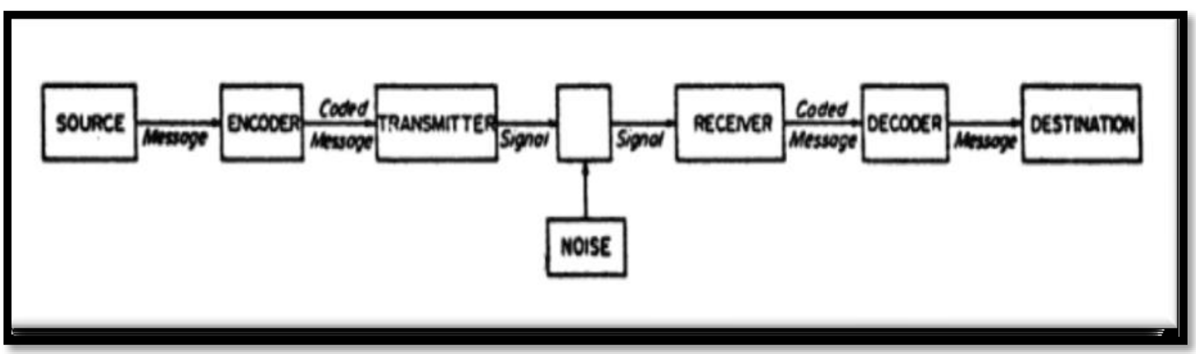
The ultimate purpose of cartography is to communicate facts and ideas clearly through a combination of drawings, words and symbols. It is distinct from other forms of graphics since it communicates facts and ideas about the earth alone. Now let us discuss more about the human communication system and the role of cartography in it. A communication system has five elements, i.e., source, transmitter, channel, receiver, and destination.

Fig.1: Elements of a communication system.



An ideal communication system functions something like this. The transmitter gets a message from the source. He encodes this message into a language that can be fed into the channel selected for the transmission of the message. At the other end of receiver reads this message and decodes it into a common language.

Fig.2. Decoding of message.



The likelihood of a message reaching the destination depends upon a variety of factors. The first is the nature of the message itself. Clearly stated messages coming from an authentic source have a better chance of reaching the destination than the one which is ambiguous and has emanated from an unreliable source. The second is the efficiency with the transmitter encodes the message. The third one is the noise or disturbance in the channel itself (Fig.2.2), and one is the attitude of the receiver and his ability to decode the message. If we apply this system to cartography we will have the following arrangement:

1. Information Source - All the natural and social sciences concerned with the study of earth and its surface features.

2. Message - Ideas and facts about the earth and its surface features; also about the heavens and heavenly bodies.

3. Transmitter - Cartographer who converts these ideas and facts into words, drawing and symbols.

4. Signals - The words, drawings and symbols and their mutual arrangement.

5. Channel - Maps and other cartographic products.

6. Noise Source - Poor design or drawing, cluttering of the symbols, incorporation of unnecessary facts to the detriment of the relevant ones, poor printing, etc.

7. Received - Signal Symbols, etc., as perceived by the map user.

8. Destination - Map user the world over.

The cartographer modifies his maps depending on the users' reactions. He has to so develop his product that they assist the users in clearly perceiving the facts about the earth. Our preceptor sensory mechanisms are in continuing contact with the real world of this things and events. The eyes, the ears, and the nerve ending respond to a variety of stimuli as temperature, pressure, odour, and taste. They are the means of perception. When we perceive something, we translate the impression made upon our senses by stimuli into awareness of the objects or events received. We construct our world of things and events out of our sensory process and the physical objects, as we know them through sight, sound, taste, smell and touch.

Understanding results from coordinate perception which is the outcome of multiple impressions recorded through the sensory mechanism. Lack of any sensory receptor eliminated the possibility of complete perception. We cannot acquire a perfect knowledge of the earth and its surface features unless we are in a position to see it with our eyes also. Reading and listening give only half the truth. Observance gives a real experience and associative feeling. Observation of the whole earth with all its minute details and pattern being impossible, man, from the very beginning of his civilization, developed means of portraying it cartographically. A map is the model of the earth or a portion of the earth. It is a graphic model. It gives a more realistic picture of the earth than any verbal description can give. Maps stimulate thinking and understanding about the earth; they also lay the foundation for attitude formation.

Attitude is a mental and neural state of readiness, developed through experience with persons, things and events. It has a directive or dynamic influence upon our response to all those objects and situations with which we come in contact. Our attitude towards parts of the world depends upon this state of readiness developed through experience with the real world. It can be changed by carefully planned learning situations. Maps are the means through which leaning situations can be changed to create a better understanding of thephysical and cultural contents of the world. Cartography, the science and arts of making maps, is, therefore, a science of human communication too.

HISTORY OF CARTOGRAPHY

The history of cartography is largely the study of the increase in the accuracy and effectiveness with which the tangible as well as the intangible contents of the earth's surface are measured and portrayed on maps. The scope of cartography has, therefore, been directly linked with the knowledge about the earth. During prehistoric times, man kept this knowledge in his mind for it was too little to need recording. Nor there was a readily available technique of recording this knowledge. Even today our so-called primitive people carry mental maps of the areas in which they live or hunt.

But with the passage of time mental maps proved to be inadequate because the horizons of the world expanded beyond the neighborhood, community and hunting area. Gradually the whole of the earth became the stage on which man started playing the drama of life. Man was rather forced to develop a variety of techniques and means to keep the records of his experiences for posterity. Cartography is one of these many techniques. The history of maps and of all that they have meant to mankind is, therefore, as vast and old a field as the history of art or literature. And the hundreds of thousands of maps which have come down to us, have within them an invaluable record for those who are interested in exploring the man's past.

As the subject matter of cartography has changed through time so also have its functions. In the past it was more concerned with the measurement and the representation of the shape, size and other broad details of the earth's surface. Today these broad details are well-known to us. We have at our disposal minute details of the contents of the earth's surface. Our problem is to analyze these complex data and to present them in a form comprehensible to map users. Modern cartography, therefore, functions more as a graphic science representing the details of the earth's surface rather than as a science engaged in the measurement of the shape and size of the earth.

Like modern science and technology, modem cartography appears to be essentially of Western origin. It represents a phase in the development of cartography tradition that stems from ancient Greek times. About the origin of Greek cartography, we do not know well. It might be that it owes its origin and fulfillment to the developments in other preceding or contemporary cultures of Southeastern and Western Asia. But the available historical facts are not strong enough to give evidence in favour of such a hypothesis.

On the basis of the existing knowledge about the historical development of cartography four distinctive stages may roughly be marked out. These are ancient period (up to 400 A.D.); medieval period (400 to 1500 A.D.); early modem period (1500 to 1900 A.D.); and recent period (1900 A.D. to date). The above stages should not be treated as discrete. There have been periods of retrogression and stagnation, interrupted by others of rapid development, during which outmoded ideas have held their place beside the new. Further, the theoretical knowledge was not closely followed by its application. Thus many of the processes cut across these stages.

THE ANCIENT PERIOD (UPTO 400 A.D.)

This period may be studied under the following heads:

1. Primitive cartography,

2. Greek cartography;

3. Roman cartography; and

4. Asian cartography.

Primitive Cartography:

A visit to any good ethnographic museum proves beyond doubt that graphics is not a science of recent origin. Even the most primitive people expressed their ideas and experiences graphically. Primitive people like the Eskimoes of the Arctic, the Bedouins of the Arabian Desert, the Polynesians of the Pacific islands, and the Banjaras of India, have a remarkable ability to draw sketches of the areas with which they are familiar.

Such maps drawn on a piece of skin, wood, bone or terracotta indicate the relative position and distances of localities known to them. It appears that such activities were quite common among the early inhabitants of Southeast Asia and Western Asia including those of Eastern Mediterranean. As these ancients improved their cultural heritage, they started producing better maps - maps which were used as tools to solve problems of day-to-day life.

Egyptians used geometrical methods for land measurements and for establishing land ownership lines after each flood in the Nile. These lines were shown on cadastral plans. Many of such plans included specifications for the construction of temples, palaces, canals and roads. Such maps were produced not only by the Egyptians, but also by the Babylonians, the Chinese, the Aztecs and the Incas.

Although the mapping of this nature showed a definite improvement over the one practised by their predecessors, the range of its coverage was still limited to the earth with which the people were concerned and not to the earth as it was. To them the earth was not only flat but also infinite in the sense that beyond their own territorial limits lay unknowns of various types. The first were the Babylonians who gave some thought to the shape and the size of the earth as a whole. They believed the earth to be flat and circular surrounded by sea and heavens.

Greek Cartography;

Ionians were the first Hellenic people to take interest in the development of scientific thought. They had an advantage of being close to Babylonians who were pioneers in the fields. They prepared itinerary maps showing the stages along the routes leading to such trading areas and centre as the coasts of Mediterranean and Susa the capital of Persia.

By 600 B C they established maritime settlements from east coast of Spain to the far reaches of the Black Sea They established a number of ’city states’. These city states maintained close relations with the mother cities in Greece. These relations opened up new opportunities for knowing more about the world beyond and to speculate about the shape and the size of the earth and the causes of the physical world.

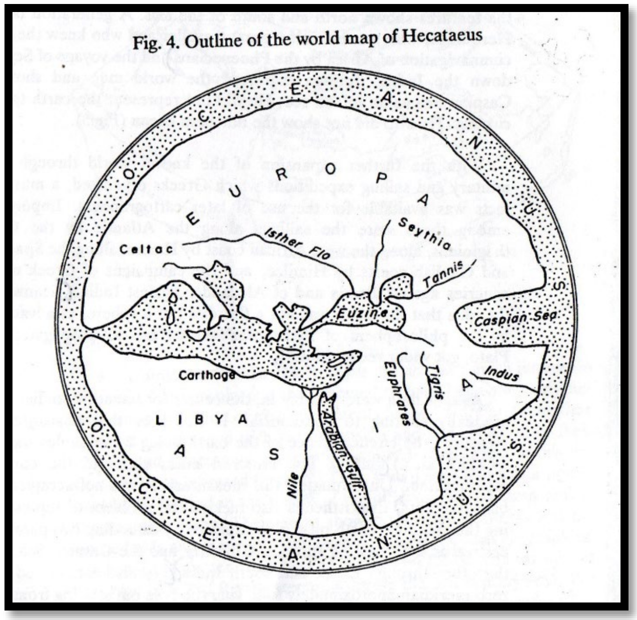


Fig 4 Outline of the world map of Hecataeus

By 600 B C the Greeks had developed Miletus as 'centre for geographical studies and cosmological speculations One of the early products of this centre was Thales who is considered to be the founder of natural philosophy Anaximander who prepared the first map of the world (as known at that time) and Hecataeus who wrote the first book of geography also came from this centre.

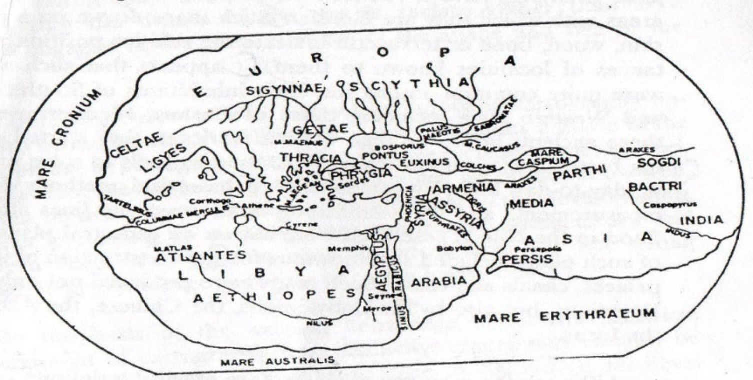
Hecataeus believed the earth to be a circular plane, surrounded by continuous belt of ocean with Greece in the centre (Fig.4). Another general principle which governed much of Greek thinking was the symmetry in nature. So that in the maps of Anaximander one finds 'a balance in the features shown north and south of the axis.

A generation later, Herodotus, who was himself a great traveller and who knew the circumnavigation of Africa by the Phoenecians and the voyage of Scyiax do™ the Indus, further improved the world map and showed Caspian Sea as an inland sea. He did not represent the earth to be circular. He also did not show the northern ocean.

With the further expansion of the known world through the military and sailing expeditions which Greeks organized, a mass of facts was available for the use of later cartographers. Important among these were the sailings along the Atlantic by the Carthaginians, along the west African coast by Hanno, along the Spanish and Gaulish coasts by Himilco, and the campaigns of Greek mercenaries against Persia and of Alexander against India. Meanwhile the idea that the earth was not a flat disc but a sphere, as advanced by the philosophers of Pythagoras' school and as propagated by Plato, got wider recognition.

As new data were pouring in, the centre for scientific studies was gradually shifting to Alexandria. It was here that Eratosthenes measured the circumference of the earth being 24,662 miles (about 39,4592 kms.) only a few hundred miles short of the correct measurement. Unfortunately this measurement was not accepted by his successors.

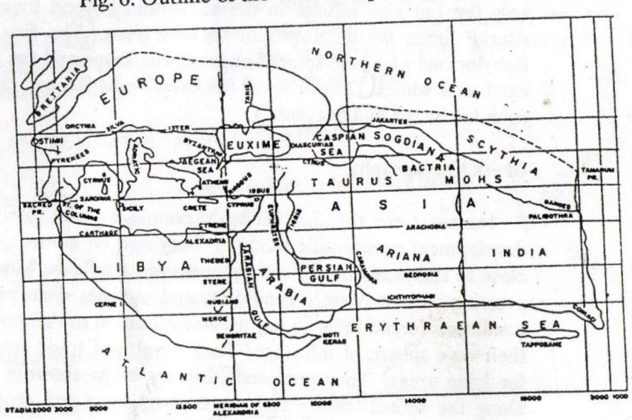
Fig. 5. Outline of the World Map of Anaximander



Eratosthenes also tackled the problem of representing the spherical earth on a plane surface by extending two parallels eastwards, one passing through Gibralter and the Caspian Sea and the other through Egypt and south India.

He also established the zero meridian approximately following the Nile but starting from the mouth of river Don (Fig.6). Later on, the ground work prepared by him was challenged and improved by Hipparchus who compiled a table of latitudes. He proposed a scheme of 360° of latitudes and longitudes but it could not be given effect to for want of appropriate apparatus and instruments which could give necessary astronomical data for the purpose. Nevertheless, he laid the foundation for siren Between Hipparchus and Ptolemy came a period which is known as Posidoman period.

Fig. 6. Outline of the World Map of Eratosthenese



The period is named after Posidonius who led the Greek thinkers to pause and consolidate the progress already made This period thus became the period of compilation The compilations of this period were used by the Romans in constructing their maps .The Romans in turn transmitted this handbook information to the Latin countries of Europe, resulting in the stagnation of cartographic progress until the Renaissance Even Ptolemy based much of his work on these compilations. He rejected Eratosthenes' calculations of the circumference of the earth and preferred Posidonius' estimates His estimates were used as late as 15th century A D Strabo's Geography in 17 books is one of the several works of this period.

The development of geography at Alexandria reached its pinnacles during the second century A D It culminated m the contributions of Claudius Ptolemy Ptolemy released his "Geography' in 8 volumes The first of these volumes deals with the principles of mathematical cartography and methods of represented a spherical surface on a plane surface.

The other volumes give the location of places or features of geographical interest There are twenty six regional maps and one world map attached to his book In addition to these, sixty-seven maps of smaller areas are also given One finds several inconsistencies between the text and the maps It has, therefore, been doubted whether the maps were done by Ptolemy or someone else As no manuscript older than twelfth century A D is traceable, this doubt does not appear to be baseless It is now widely behaved that the maps were not drawn till the thirteenth century Ptolemy miscalculated the circumference of the earth to the extent that his one degree of latitude was equivalent to 90 4 kms in contrast to Eratrosthenes' 99 6 kms Thus when converting distances into degrees, he got greatly exaggerated figures and the east-west extension of his world became too long His concept of Asia was erroneous as he overlooked Peninsular India and estimated the size of Ceylon several times larger than its true size He also showed Indian ocean as a land locked water body He committed similar mistakes in the representation of south east Asia and north Africa (Fig 7) All these mistakes were carried forward by later geographers and cartographers and had to do much with the slow rate of growth of cartography in the centuries that followed.

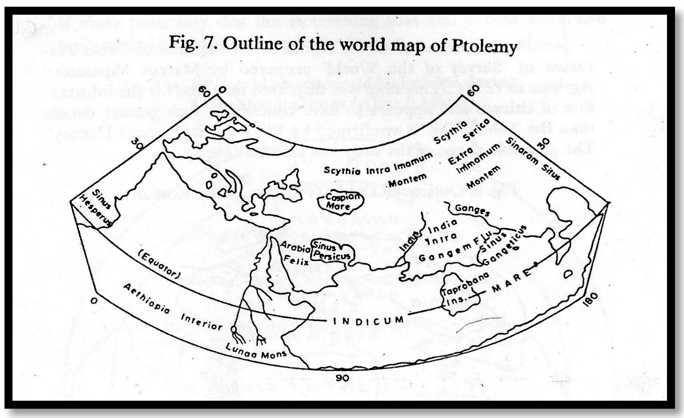


Fig. 7. Outline of the world map of Ptolemy

Fig: Outline of the-world map of Ptolemy

Roman Cartography:

As against the Greeks, the Romans did not take much interest in Scientific Cartography and they seemed to have been singularly unconcerned with the Greek achievements in the field. For a long time they were concerned with the expansion and consolidation of then empire and hence only those maps which assisted them in this endeavor were favoured by them. Thus a map for them was a practical tool to be used in the travels of the officials and the campaigns of their armed forces.

Their maps showed the road networks and the battle fields and many of them were nothing more than geographical renderings of written records. The'Peutinger Table' is an example of this type of work. It was prepared during the 3rd century A.D. For all practical purposes it is a road map of the Roman empire. The roads are shown by straight lines and the distances between any two stages are marked. As true directions are neglected, the shape and relative positions of various features are considerably distorted. It includes Europe, Africa and Asia and contains 534 illustrations, 311 for Europe, 62 for Africa and 161 for Asia.

Another contribution of the Romans was the famous Orbis Terrarum of 'Survey of the World' prepared by Marcus Vipasanius Agrippa in 12 B.C. This map was displayed in Rome for the information of citizens and appears to have contained much greater details than the Table. This is confirmed by Pliny in his 'Natural History'. The probable shape of the map was circular (Fig.8).

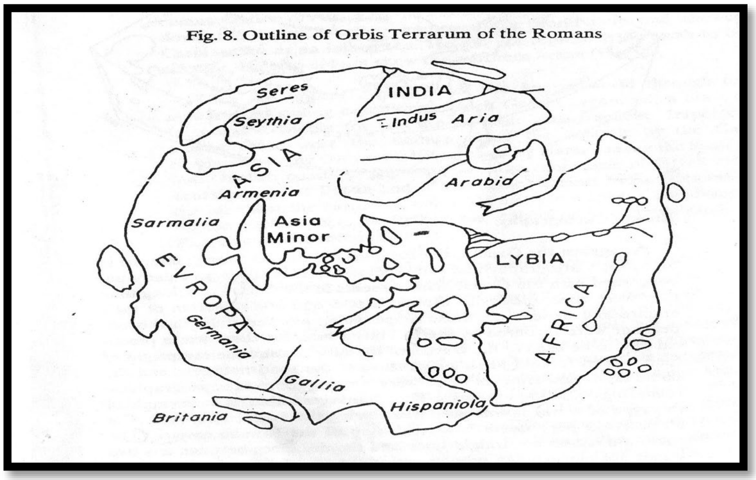


Fig: Outline of Orbis Terrarum of the Romans

Indian Cartography Ancient Tunes to 800 AD.):

As stated earlier it is not yet known as to whether map making was practised in ancient India or not. It is, however, now well known that the knowledge about the universe and the earth was quite advanced in India in ancient times. During the Siddhantic period that followed these expressions were crystallized into Siddhantas or laws. The post-Siddhantic period gave rise to classical treatises by great astronomers like Arya Bhatta, Varahamihira, Bhaskara and others.

In addition to these, there were works on positive sciences like the Bhouthika Sutras which gave astronomical as well as terrestrial details. Many of the revelations in the ancient literature point to the conclusion that some of the so-called discoveries by the West were known hundreds of years before in India. For example, Arya Bhatta discovered the relative movement of the earth and the sun, a clear thousand years before Copernicus. Even earlier, the Aitareya Brahmana said, "the sun never sets or rises; when people think that the sun is setting, he only changes about after reaching the end of the day and makes the night below and day to what is on the other side.

Bhaskara calculated the circumference of the earth to be 39,967 kms (24,385 miles), diameter 12,722 kms (7,905 miles), and the surface area 10,26,48,395 sq.kms (396,325,850 square miles). He also estimated the atmosphere to extend to a height of over 97 kms (60 miles). Knowledge about the world appears to be quite extensive in ancient India.

The world as a whole was undoubtedly considered to be round and surrounded by water. The southern waters were considered to be salty whereas northern ones to be milky. This was the position during the Mahabharata times. One interesting feature of this conception of the world is that India was not put in the centre of the earth The Mere or Pamir Mountain was considered to be the centre.

It is believed that maps of one sort or the other were prevalent in China, India, Japan and Korea Considering the large extent of migration of the people of Asia from one region to another it is doubtful that the routes to be followed and the countries to be visited were not well known. There is every possibility that the intervening seas and oceans were also well charted bj the Chinese and the Indians. Fig 10 World as conceived by Indians during Mahabharata times.

EARLY MEDIEVAL PERIOD (400 A D to 1200 A D)

During the earl) medieval period geographical knowledge in Europe was standstill Maps and the data already recorded were further manipulated during this period without verification and more errors were introduced in them. Cartography became a copy work of existing maps. Most of the maps of this period are the so called T-0 maps.

These maps were oriented with the east at the top. 0 represented the circular world whereas the horizontal and the vertical strokes of T represented Don-Nile meridian and the axis of the Mediterranean respectively. Some of the maps of this period were rectangular but with same details as in T-0 maps.

This innovation might have been brought in to accommodate the Christian view of a four-cornered world. It is interesting to note that the notion of the earth being round as enunciated by the Greeks was used by cartographers of this period. The maps of this period, practically without exception, showed the earth as a flat disc.

The main type of cirular world map of this period, i.e,, Mappa Uundi, was a modified form of the world map of Agrippa, And the modifications were made at the instance of the Christian theologians, so that Jerusalem was shown in the centre of the map and the area of Palestine was considerably enlarged to accommodate minute details.

The text of ’Geography’ by Ptolemy was translated into Arabic in the 9th century, and its maps were well known to the Arab scholars like Masudi. In the 12th century Idrisi compiled a world map using Ptolemy’s map as one of the sources. Chinese had developed mariner’s compass, and notable advances were made in India toward the calculation of latitudes and longitudes.

LATE MEDIEVAL PERIOD (1200 to 1500 A.D.)

By the end of the J3th century the use of mariner’s compass and the construction of charts giving navigational aids to sailors had become quite common. The Italians were the leading cartographers who made such charts. These charts are often referred to as Portola charts. About twenty of these charts have survived to give us a glimpse of the state of cartography during the 14th century. These charts were made on the skin of parchment measuring 91x46 cm to 142x76 cm.

The coastlines and the names except the names of important harbors were usually given in black. Islands, rivers, deltas, rocks and shoals were shown in red. Land details were extremely few and the design was decorative. Most of these charts show coastline of the Mediterranean and Black seas and part of the European coast of the Atlantic, with some accuracy, but representation of the coasts beyond these limits is full of inaccuracies. Even the Baltic coast has been shown very crudely.

The charts do not show the latitudes and the longitudes. The sphericity of the earth was also not taken into account in their construction. The area covered by these charts being small, this deficiency did not create any large scale error. These lines showed the approximate compass directions.

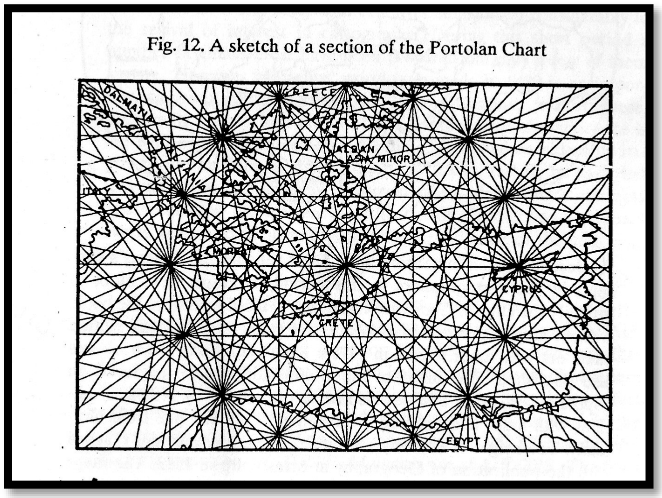


Fig. 12. A sketch of a section of the Portolan Chart

Fig: A sketch of a section of the Portolan Chart

These charts were later improved as more detailed surveys were carried out. This is dear from the fact that the charts prepared subsequently were more accurate. For example, in Carte Pisane (late thirteenth century), Britain is represented in a very crude form but in Perrinus Vesconte's outline of 1327, the representation of the coastline of southern England is considerably improved By the beginning of the fourteenth century the Catalonians, mainly Major cans, took over from the north Italians as leading cartographers. This revival is embodied m the Catalan world maps published in the Catalan Atlas map about 1375 AD.

The sources of the Catalan Atlas were many but the following four were most important

(1) the circular world maps of the classical and medieval tunes

(2) Portolan charts showing the outlines of the Mediterranean Sea, Black Sea and the European coasts,

(3) Narratives of the 13th and 14th century travellers such as Marco Polo, and

(4) narratives and charts prepared by Arabs and available at Barcelona It was for the first time that the whole of Asia had been shown in a map, although very inaccurately as compared to Europe The lakes, the rivers and the mountains together with important places were shown m accordance with the narratives of Marco Polo Indian peninsula was emphasized and innumerable islands were shown in the Bay of Bengal and along the coasts of South east and East Asia.

He started from the usual practice of having Jerusalem in the centre of the map but tried to modify many of the concepts of Ptolemy. He doubted many other prevalent concepts and thus displayed a critical spirit in cartographic thinking. But at the same time he gave a distorted picture of many of the bays, peninsulas and islands in Asia and Africa.

Toward the close of the 15th century, Martin Bchaim, a native of Nuremburg prepared a globe. It was 50 cm in diameter and showed equator, the two tropics and the Arctic and Antartic circles. The equator was divided into 360 degrees; the 80° meridian to the west of Lisbon was also shown. The worst mistake that Behaim committed was to accept Ptolemy's longitudinal measurement of the old world (177°) and to add 57° more to accommodate the eastern parts of China.

This gave a total of 234°, the correct figure being 131°. This being so, the distance between European and Chinese shores had to be reduced from 229° to 126° longitude for the total could not be more than 360°. Another map of importance was Henricus Martellus' world map of 1489. This was also based on Ptolemy's map.

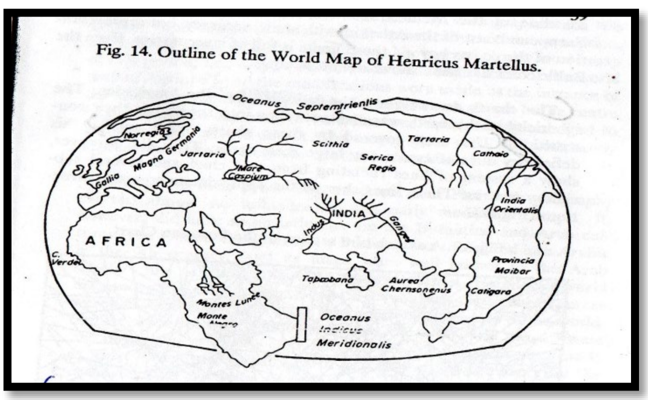


Fig: Outline of the World Map of Henricus Martellus.

Because of the increasing use of and reliance on Ptolemy's concepts by the cartographers of this period, attempts were afoot to multiply the copy of Geography. The first printed edition of the book, without maps, appeared in 1447 and two years later Bologna edition came out with maps. Again in 1478 a Rome edition of the book was also published. The maps of the Rome edition were engraved on copper. Soon, other editions also came out so that by 1482 four editions with maps had appeared, three from Italy and one from Germany.

The publication of Ptolemy’s Geography had two important influences on contemporary cartography. One was the extensive use of his ideas and the other the development of printing processes. The cheap edition of this book made the use of maps more common. It also enabled the people to judge the accuracy of Ptolemy’s Geography against the data supplied by discoveries of Diaz, Columbus, Vasco- da-Gama, Cabral, Alfonso-d’Albuquerque and Magellan.

EARLY MODERN PERIOD (1500 TO 1800 A.D.)

By the first decade of the 16th century Ptolemy’s maps were in good circulation and their accuracy was being increasingly questioned against the data supplied by the seamen who visited different parts of the old world. Henricus Martellus’ world map made in 1489 is an important contribution of this decade. Albert Cantino, a Portuguese,’ prepared Cantino chart around 1500. Another map of significance is the King-Hamy chart of 1502. All these maps had considerably improved the outlines of Asia and Africa.

Pedro and Jorge Rcinel were the two official cartographers in the Portuguese court. Pedro made a chart of the Indian Ocean in 1518, and Jorge made a world map for Magellan's use. The fact that Maluccas, the chief source of spice, lay near the Spanish-Portuguese demarcation line in the eastern hemisphere had a stimulating effect upon the study of cosmology and cartography of the region. In the western hemisphere this line of demarcation was 46° 37W and in the Eastern hemisphere 133° 23’E. Maluccas are at 127° 30’E. The Portuguese part lay west of 133° 23’E longitude.

The Portuguese chart makers were famous ail over the Western world. Leading cartographers were Pedro Reinel and his son Jorge Reinel, Lope Homem and his son Diogo Ribeiro, Fernao Vaz Dourado and Luis Teixeira. Most of the maps and charts were done at Casada India at Lisbon. cartographers of this centre were Nuno Garda de Toreno, Ribeiro and Alonso de Santa Cruz.

By 1525' the German and Netherland’s geographers and cartographers had devised geometrical methods of survey with more precise instruments for observation of angles. The famous geographer and cartographer Sebastian Munster, while at Heidelberg University, wanted his friends to survey an area within a radius of 9 to 12 cms of the town. He suggested the use of compass for this purpose. The method of elementary triangulation was first described by Gemma

Frisius in his Cosmographia published in 1533. He suggested the fixing of positions of the objects by intersecting rays.

Mercator's world map is conspicuous not only in respect of using a projection which gave correct shape and bearing s but also in the sense that it gave a new conception of the world- a conception which was different from that of Ptolemy, He showed three major land-masses the one including Asia, Europe and Africa, the other, North and South Americas (erroneously called India Nova) and the third, the continent of Australia.

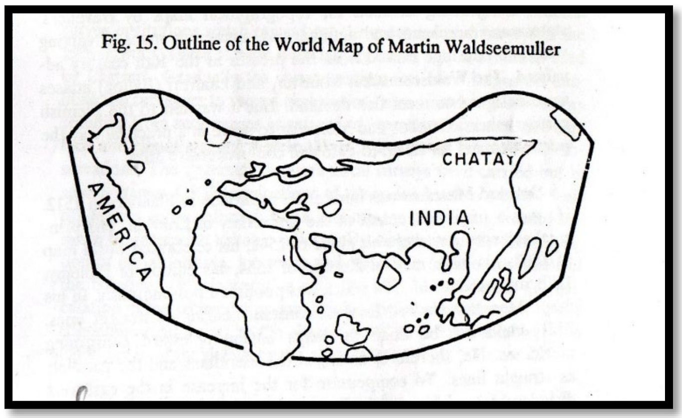


Fig. 15. Outline of the World Map of Martin Waldseemuller

FIG: Outline of the World Map of Gerhard Mercator

During the later part of the 16th and the 17th centuries further data about Australia, North America, China and other parts of the world were gathered. In the meantime survey and other observational methods were improved with the development of telescope, logarithmic tables, pendulum clock and level.

The earliest British map showing spot heights was Christopher Packe's Physico-chorographical chart of Kent. It was published in 1743. A further step in emphasizing the third dimension was taken when the colouring of areas between successive contours by a given scale of tints was adopted in Stieler's Hand Atlas published in 1820. The quadrant was improved by John Hadley who added reflecting mirrors and Vernier scale to it. Chronometer was developed by John Harrison in 1772. Theodolite (in its essentials) was also developed during this period.

RECENT PERIOD (1900 A.D. ONWARDS)

The chief characterstics of this period are the: (1) the conducting of national surveys; (2) mass production and use of a variety of maps; (3) ever increasing influence of science and technology; and (4) International cooperation, During this period a number of countries established national survey institutions which carried out the great national surveys of the 19th century. These surveys were largely based on the methods used by Cassinis.

The systematic topographical surveys were carried out in Severn stages: (1) determinations of mean sea level to which all alitodss si to be referred; (2) a prsbrsaisar}' plane taMs reeesaaissance to determine suitable points for triangulation; (3) determination of initial latitude, longitude and azimuth; (4) measurement of the baseline; (5) triangulation with the help of theodolite; (6) calculation of the triangulation and heights, and the transference of the trigonometrical points to the sheets issued to the plane tabler; and (7) filling in of the details by the plane table.

The development of several electronic devices has further revolutionized the cartographic processes. Almost all the countries of the world have establishments charged with surveying of land. Those which do not have, rely on other countries for this purpose. In the United Kingdom, the Ordnance Survey of Great Britain was officially established in 1791.

Computer technology - both hardware and software has brought a revolutionary change in cartography during the last four decades. It represents a completely new and different technology for the cartographic discipline.

. The camera has revolutionized the cartographic processes not only by enabling the surveyors in getting quick and better results but also by assisting the cartographers in their laboratory here maps are designed and developed. Special cameras have been developed which help cartographers in compilation, drafting and reproduction of maps.

With these developments, the problems of cartographic portrayal have, however, not decreased. As the variety in the availability and type of data increases and as new demands emerge from the increasing number of map users, new and better methods have to be evolved. There are thus greater opportunities in store for cartographers as professionals. There is now a greater need to attract people to the profession who will be devoted to further improving the techniques of cartographic representation.

Unit- II

Map as a tool in Geographical Studies

A Maps a map is a flat representation of a part of Earth. Geographers use many different types of maps. Maps can show lots of different information including the location of places on the world. Maps use projection to try and display a round object (Earth) on a flat surface (a map). Cartographers (map-makers) have long struggled with trying to find the most accurate projection to make maps with.

Atlas an atlas is a book of maps. An atlas contains maps of the world or a region of the world. Some atlases also include more information about the places they include in the maps. Atlases can be very helpful for traveling. Instead of brining many maps, you can bring one atlas.

Globe A globe is a model of the Earth, used to avoid distortions in spatial relations on the world. Maps of the world are distorted from trying to make a round object fit on a flat surface. The globe is round, so it remains accurate. The globe provides an accurate scale of how far apart locations are. You can also use a globe to get a comparison of the size of different locations.

Aerial Photographs Aerial photographs are photographs taken from the sky and used to take measurements or create maps. Aerial photographs can be taken from airplanes, balloons, or even kites.

Information Graphics Information Graphics or Info graphics are visual symbols of data. They are images that show information using pictures or symbols. Information graphics can be as simple as a bar graph or as complex as the image to the left.

GIS (Geographic Information System) GIS is a computer based program used to store, manage, and analyze data A GIS map is more than a map because it can pull up a lot of information. Geographers use GIS to help make decisions. Imagine that you wanted to make sure schools were not near any factories that might pollute the air. With a GIS map, geographers can use the database (place that stores information) to show where all the schools are. They can then use the database to also show where all the factories are. The GIS helps geographers see all kinds of information and how it relates to locations.

Thematic Maps

Graphs and diagrams serve a useful purpose in providing a comparison between the internal variations within the data of different characteristics represented. However, the use of graphs and diagrams, at times, fails to produce a regional perspective. Hence, variety of maps may also be drawn to understand the patterns of the regional distributions or the characteristics of variations over space. These maps are also known as the distribution maps.

Requirements for Making a Thematic Map

(a) State/District level data about the selected theme.

(b) Outline map of the study area along with administrative boundaries.

(c) Physical map of the region. For example, physiographic map for population distribution and relief and drainage map for constructing transportation map.

Rules for Making Thematic Maps

(i) The drawing of the thematic maps must be carefully planned. The final map should properly reflect the following components:

a. Name of the area

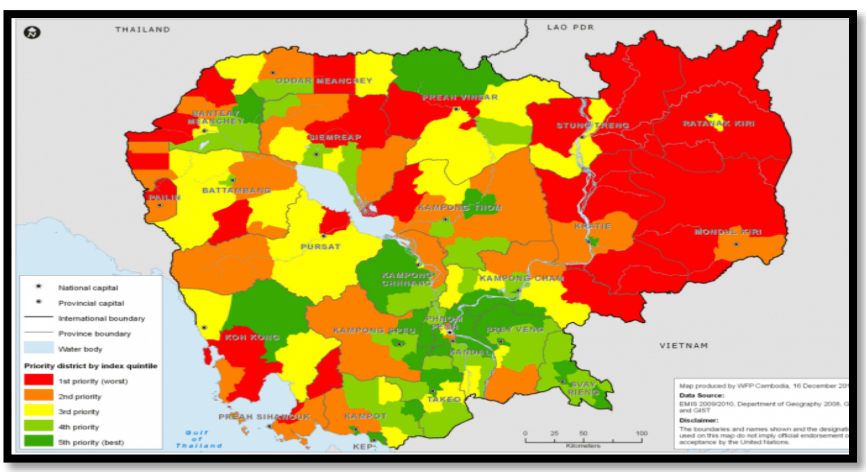
b. Title of the subject-matter

c. Source of the data and year

d. Indication of symbols, signs, colours, shades, etc.

e. Scale

(ii) The selection of a suitable method to be used for thematic mapping

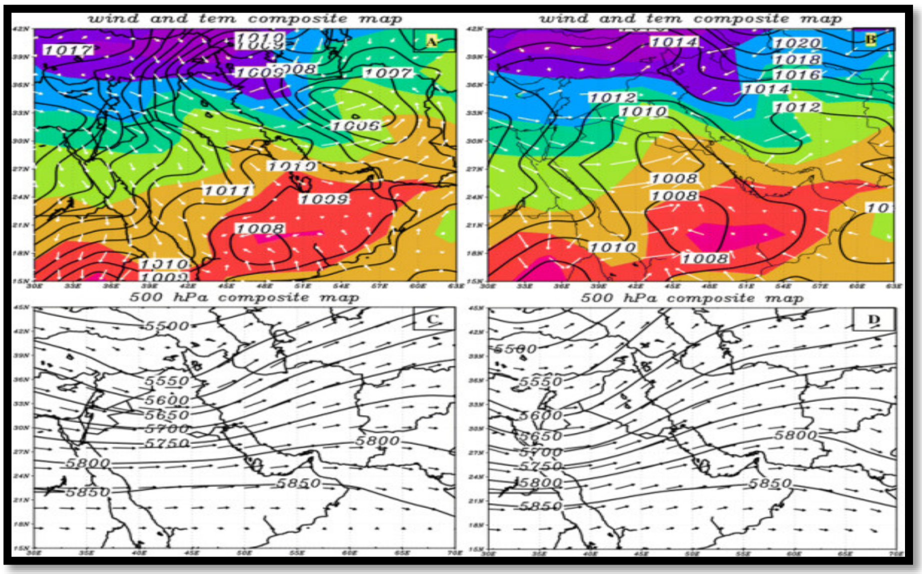


Thematic Map

COMPOSITE MAP

Flow maps have long been used to illustrate the movement of objects between locations. One prominent application of flow maps is the migration of population between multiple geographic regions. Many fields where users have to explore massive movement data can benefit from using flow map techniques. For logistics, delivery flows between sources and destinations are of interest. Modern architectural planning requires considering possible evacuation scenarios, where flow maps can represent people heading for emergency exits. In flood management, the flows of flood or storm water are important as they may carry potentially dangerous debris. In all these cases, for effective decision support, interactive exploration of multiple flow components at once is needed. The flow components may be given by two opposite transportation directions, alternative scenarios in consideration (e.g., "at least", "worst case", "expected"), different kinds of materials being transported, or people evacuating from specific rooms. At different stages of scenario assessment, the decision maker requires either an overview of general flow trends or a detailed representation of local features. We suggest that such levels of detail should be driven by the application semantics. While uninteresting local flows may be merged to reduce clutter, important details should still be preserved and possibly highlighted using additional overlay visualization.

Generation of flow maps from large movement data. Multiple flow components are combined in one visualization by means of ribbons representing different materials, directions, or flows related to particular origins or destinations. Alternatively, such composite flow maps can display information from different scenarios. Our technique is based on splitting the domain into multiple zones, where the zones are derived from application semantics and the geospatial context. After this zonation, we compute the flows between adjacent zones. From these, the flow map is generated. The presented technique enables the visualization of composite flows between an arbitrary number of zones in both directions. Additionally, our flow maps support varying levels of detail driven by the geospatial semantics inherent in the application. Irrelevant local features can be generalized, whereas important details are preserved and possibly highlighted. We demonstrate and evaluate our technique in real-world applications. The logistic application (Figure 1, left) considers planning of delivery routes in an urban area. In the field of flood management (Figure 1, center), we address the surface water movement and interaction with the sewer network in an urban area at the time of a heavy rain (storm water event). The evacuation application considers evacuation scenarios for an office space.



Choropleth Map

The choropleth maps are also drawn to depict the data characteristics as they are related to the administrative units. These maps are used to represent the density of population, literacy/growth rates, sex-ratio, etc.

Requirement for drawing Choropleth Map

(a) A map of the area depicting different administrative units.

(b) Appropriate statistical data according to administrative units.

Steps to be followed

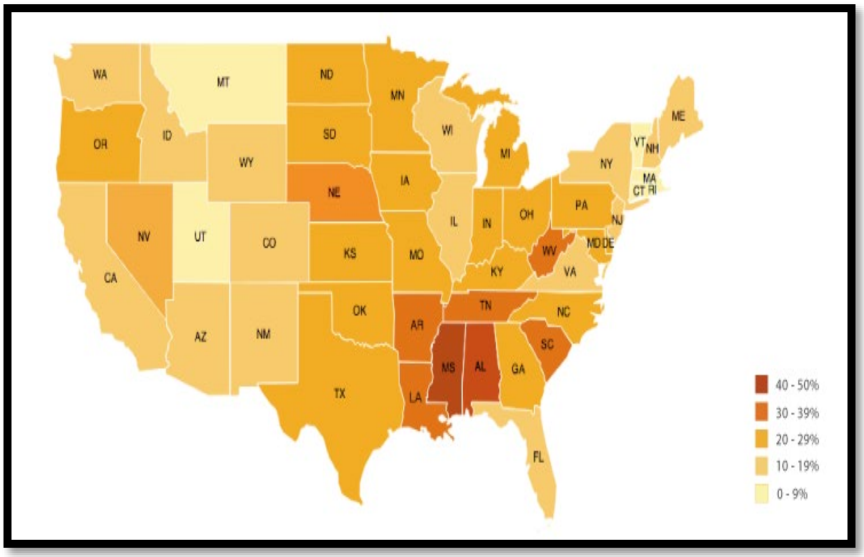
(a) Arrange the data in ascending or descending order.

(b) Group the data into 5 categories to represent very high, high, medium, low and very low concentrations.

(c) The interval between the categories may be identified on the following

Formulae i.e. Range/5 and Range = maximum value – minimum value.

(d) Patterns, shades or colour to be used to depict the chosen categories should be marked in an increasing or decreasing order.



Choropleth Map

Isopleths Map

We have seen that the data related to the administrative units are represented using choropleth maps. However, the variations within the data, in many cases, may also be observed on the basis of natural boundaries. For example, variations in the degrees of slope, temperature, occurrence of rainfall, etc. possess characteristics of the continuity in the data. These geographical facts may be represented by drawing the lines of equal values on a map. All such maps are termed as Isopleth Map. The word **Isopleth** is derived from **Iso** meaning equal and **pleth** means lines. Thus, an imaginary line, which joins the places of equal values, is referred as Isopleth. The more frequently drawn isopleths include Isotherm (equal temperature), Isobar (equal pressure), Isohyets (equal rainfall), Isonephs (equal cloudiness), Isohels (equal sunshine), contours (equal heights), Isobaths (equal depths), Isohaline (equal salinity), etc.

Requirement

(a) Base line map depicting point location of different places.

(b) Appropriate data of temperature, pressure, rainfall, etc. over a definite period of time.

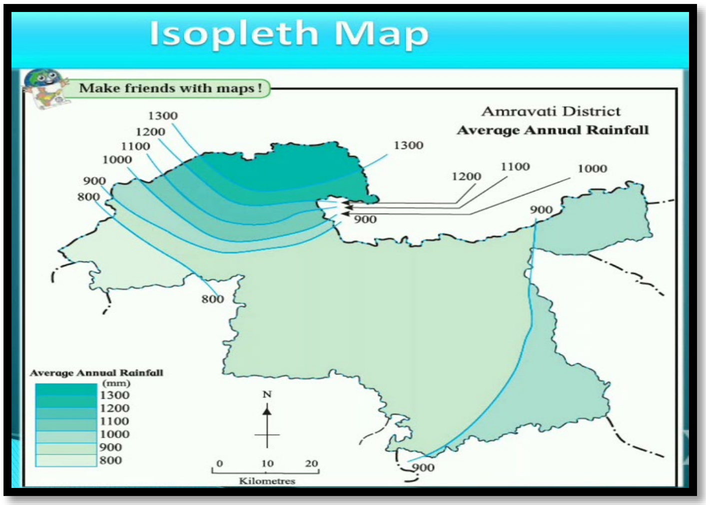
(c) Drawing instrument specially French Curve, etc.

Rules to be observed

(a) An equal interval of values be selected.

(b) Interval of 5, 10, or 20 is supposed to be ideal.

(c) The value of Isopleth should be written along the line on either side or in the middle by breaking the line.



Chorochromatic Maps:

Chorochromatic maps can be simple or compound. In simple chorochromatic maps, single features with patchy occurrence are depicted (for example, to show the distribution of forest reserves or coal fields in a country). Compound chorochromatic maps on the other hand show phenomena in which types and categories can be recognized. Chorochromatic maps can be used to show different types of soil, rocks, vegetation, etc. For example, in a full vegetation map, all different kinds of vegetation are shown on the same map, using different symbols or shading patterns.

Usually the classification resulting in the identification of the unit types shown on a compound chorochromatic map is qualitative, based on apparently discontinuous features. However, in certain cases (for example, soil and vegetation) the aggregate unit area characteristics form parts of a continuum. Cartographers should be aware that chorochromatic maps that display non-area-related phenomena like religion or language may cause the map reader to misinterpret the map. The map reader may assume that the size of the area is proportional to the number of people in the area with that qualitative characteristic. To avoid misleading the map user, the cartographer can add a diagram showing the actual numbers involved.

Unit –III

MAP DESIGN AND LAYOUT

Among the various aspects of cartography, map design and layout is by far the most crucial and complex one There is too much of information which can be depicted on maps, but to depict them all with clarity, simplicity, accuracy and aesthetic touch is not easy job Like an artist, a map maker has to follow certain principles of visual art but unlike an artist he does not have a complete freedom with the portrayal techniques and media.

A cartographer shows his artistic talents within the framework of two types of constraints The first results from what we call cartographic traditions and conventions, and the second from the basic requirements of maps themselves A map is designed to serve certain utilitarian purposes Its aesthetic value is only incidental to its utilitarian value The artistic talent has, therefore, to function within the framework of the utilitarian requirements.

There are innumerable things which can be shown on maps. But everything that exists or that can be conceived to exist is not represented on all maps. Some maps do represent a variety of things-the things about which people are more intimately concerned in their day-to-day life. These maps are called the general or reference maps. Most other maps give specialized information only. Such maps are called thematic maps. In these maps only a few details are given visual prominence. The other details are either not shown at all or are shown merely to produce a background effect.

The problem of making certain things visually significant without giving the impression of imbalance in the total design of a map is the most crucial problem in map design and layout. A map has to be an integrated whole, but within this whole certain components get prominence over many others, not necessarily because they are more prominent in reality but because the cartographer desires to tell more about them than about other details.

In order to prepare a balanced map and, yet, to make certain component of it visually more significant, we have to have the understanding of

(1) Theory of visual perception;

(2) Techniojres of making things visually significant; and

(3) Limitations within which cartographers function.

THEORY OF VISUAL PERCEPTION

Perception means the awareness of objects in the environment. This awareness comes through sensations like sight, sound, taste etc. One of the older theories of perception suggests that the objects which we see emit something of themselves to our eyes, to enable us to see them (Epicurean Greek philosophers). After Newton's discoveries, it was generally believed that the objects, rather than emitting something of themselves, reflect light to our eyes, very much as in a camera. This image was supposed to be the exact copy of the objects seen. Experiments later disproved this theory also. Various optical illusions were given as the basis for discarding this theory.

Then came the theory which proposed that perception is an interaction between the perceiver and the objects perceived. This theory can be explained better by taking the example of the sunlight falling on an object, say, grass.

We see grass to be green because it absorbs all the light waves except the green. The light waves creating green arc not green so long as certain cells in the retina of the eye do not interact with the light wave in certain ways to produce the experience of green. Neither the light emitted by the grass nor the censory cells in the retina, are green. It is the interaction between the two which produces green.

The most recent theory of visual perception disapproves all the above noted theories. It suggests that perception is in reality a transition and that various shapes, colours etc., that we perceive exist only

in terms of the situation in which they are perceived. It says that

(1) Total environment in which the object lies enters into perception as active participant, and

(2) The object, if removed from the given environment, loses its whole meaning.

An example will make this clear. When we look at the sunset, we do not see certain colour, lines, shapes and shades. We see the sunset. We do see the details of the colour and shapes but only sub-consciously. What we get, however, is a total visual experience. The bright colours which we see in the sunset do not bother us, but they surely bother us if we have wall papers of the same colours.

The above noted shift in the theory of perception is very pertinent and relevant to map design. It, in effect, tells us that various symbols that we use in a map, acquire their desired meaning only in the context of the map as a whole

After these broad features are recognized, the smaller internal relations begin to unfold themselves. We see the rivers, railways, roads, canals, and towns and the interrelations among them. This is just like the situation of visiting a factory for the first time. At first everything is inarticulate, but soon we distinguish various sounds, machines and sections. Finally, and after a necessary period of time has elapsed, the various parts appear to present a meaningful whole.

We get the integrated picture of a factory or a map in three, phases:

1. Diffusion phase

2. Differentiation phase

3. Integration phase

MAKING SYMBOLS VISUALLY SIGNIFICANT

In the diffusion phase

During this phase, only the visual outline of the map is seen by the map reader. Whether it is a reference map or a thematic map, the visual outline gives to the reader an idea of what is emphasized in it. According to Robinson, the fundamental elements of the visual outline are :

(1) The place, (2) the data, (3) the position of the data in the area and (4) the relative positions of various symbols. If the objective is to emphasize the place, it should be made distinct from the rest of the map area. This is often done when we prepare a location map.

An arrangement of the type suggested above will make the prominent aspects of the map stand out from the rest of the data. Such an arrangement enables the map reader to catch the main purpose of the map as soon as he looks at it. The visual outline serves the same purpose as the chapter headings in a book. By making the outline prominent the map maker succeeds in transforming his product into an effective too! of visual communication.

In the differentiation phase:

In this phase of visual communication the map reader's eyes are set upon knowing further details of the data shown on the map. The data represented should have two characteristics

(1) They must be correct and

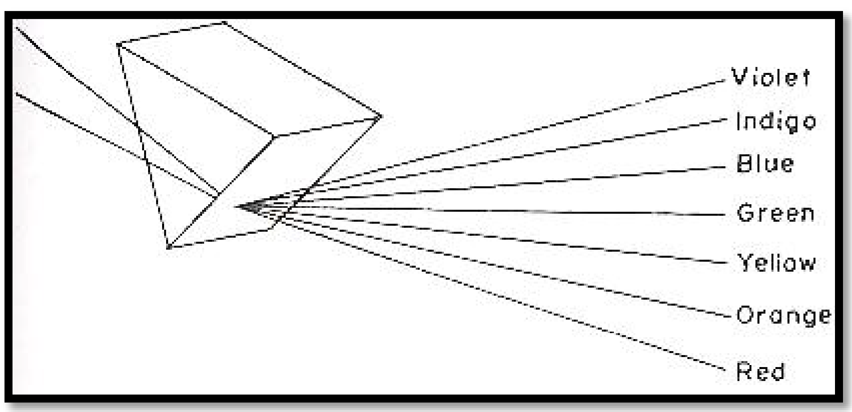
(2) they must be represented effectively, clearly and legibly.

An effective, clear and legible representation is no substitute to correct representation. A good balance has to be struck between accuracy and effective, clear and legible representation.

Presentation of symbols : To make a map clear and legible, symbols used must be adequately dfferentiated from each other. For example, all lines must be drawn clearly, sharply and uniformly. To differentiate one line symbol from the other, we can either use varying

Sizes and shapes: The size or width of the symbols used in a map should be large enough to be visible to map readers. In this connection two facts must be kept in view. The first is that an unfamiliar symbols can be seen by a normally sighted person only if it subtends an angle of at least one minute at the eye. It means, that farther away a symbol is from the observer's eyes, larger it should be in size in order to be legible. As all the so-called normally sighted persons do not really have normal sight, it is better to keep this limit a bit higher. Experiments in this regard indicate that the angle subtended by the symbol at the eye should be between 1.75 minutes to 2.5 minutes.

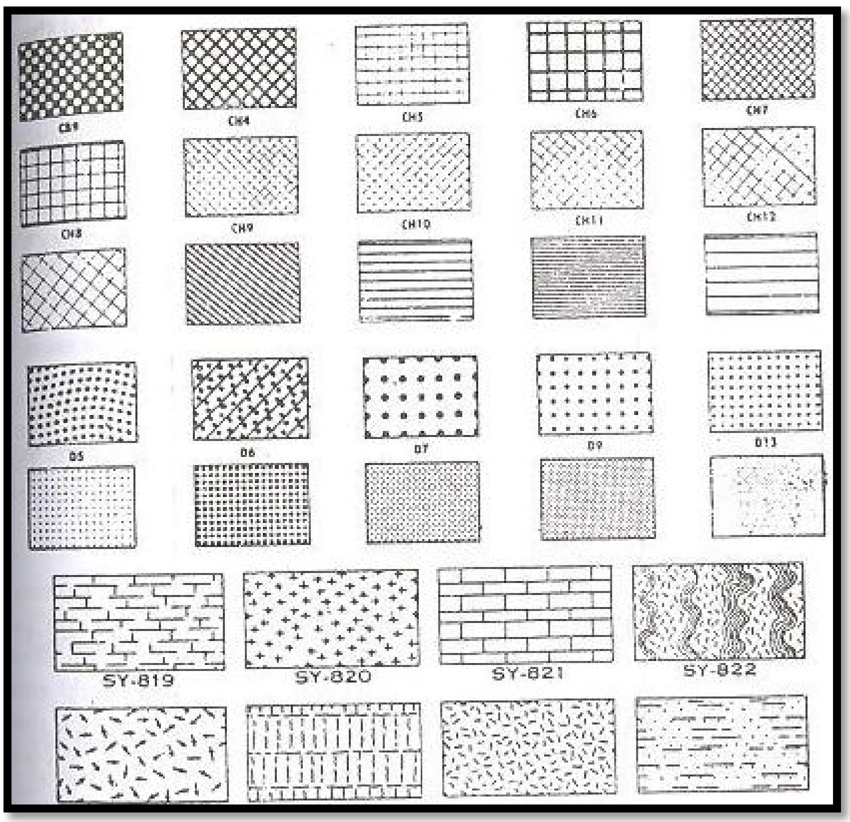
Colour and shade: Colour is by far the most important single medium in map design. It enables us to create a better contrast in symbols. Used in conjunction with other graphic symbols, it makes the portrayal of data visually most interesting. It also enables more information to be fed in a map without making it congested. Some thing about its relevant characteristics. As we know, Newton showed that colour is an ingredient of sun light.



It can be separated in the form of familiar rainbow or spectrum by passing light through a prism The wavelengths of the seven colours which constitute sun light vary from 1/31,250 of an inch for the red to 1/62,131 of an inch for the violet. Wave-lengths of less than 1/62,131 of an inch or more than 1/31,250 of an inch cannot be perceived by the human eye as colour. Many insects can perceive ultra-violet rays in the form of a colour because their sensory are made to respond to them as a colour experience.

The spectrum of the seven colours which we can see is derived from three primary colours. These are red, yellow and blue. These are called primary colours because all other colours can be produced by a combination of these three.

Patterns: Patterns are also the means which help us in differentiating various phenomena represented on a map. Patterns can be and are used in place of colors, where use of colors is not possible, for reasons, explained later. Patterns are made by varying arrangement of lines and dots, separately or together. The possibilities of getting patterns of lines or dots or both are surely unlimited. But there are not more than 100 patterns which are used by cartographers in designing various types of maps. The most common among them do not exceed 25.



From the visual point of view, the dot patterns are better than the line patterns. As the lines have directions, the viewer's eyes tend to give an image of something unstable. At times they join the boundary lines, and make the letterings merge in pattern. Unless the line patterns are formed by closely set fine lines, they are irritating to the eye. As against this, the dot patterns give an indication of stability, and are pleasing to the eye.

In the Integration Phase:

The final phase of perceptual development or observation of a map occurs when various articulated elements of a map are composed into a coherent whole. A well integrated map will give sufficient material or information to produce understanding of the purpose of the map. It will be simple without ornate artistry, so that the attention of the reader is not diffused. Finally, it will evoke similar responses among many map readers. Too large, too bright, or too light.

The importance of each component is directly related to its position and visual significance. To determine whether a map is balanced or not we have to view it with respect to its visual centre which is little above the centre of the area enclosed within the neat line of the map (Fig. 137). If an item is out of balance it may be above or below the visual plane. The aim of a cartographer is to balance the various map components so that they appear natural for the purpose of the map.

CONSTRAINTS IN MAP DESIGN

We have already noted that unlike an artist, a cartographer functions under severe constraints. Because of these constraints, many of the principles and processes of map design which we discussed earlier in this chapter do not hold good. These constraints can be grouped together under following heads:

1. Cartographic restrictions

2. Technical restrictions

3. Resource restrictions

Cartographic restrictions:

A number of conventions have been developed in cartography, which are generally followed in all maps. Many of these conventions have now been internationalized, so that any departure from them appears to be unnatural and incorrect to the average map reader. Take, for example, the question of representing water features by blue and plains by green. We know that all water bodies do not necessarily appear blue nor are all the plains green. On our physical maps the evergreen Sunderban forests are shown as green as parts of Rajasthan desert. Supposing we try to reverse the colour scheme and show the water features by green and the plains by blue. We can imagine the consequences of it. The only logic behind the existing method of representation is, what we can say, usage.

If we compare the topographic maps published by various government agencies the world over, we will find that most of the symbols used in them are common to each other. These symbols are often referred to as conventional signs because they have been conventionalized. Whether these symbols are logical and aesthetic or not, is of secondary importance.

The map users have become used to such symbols and hence their replacement will create confusion. It does not, however, mean that a cartographer has no freedom at all. Firstly, there are only few symbols which have been conventionalized and secondly, even the conventional symbols to a certain extent can be modified in size and style to present an improved picture.

Technical Restrictions:

A cartographer, while designing a map, has to work with a number of technical restrictions. Some of these restrictions are discussed below:

Publishers Specifications: Persons who approach a cartographer for preparing a map have certain set ideas about the kind of map they want. It is not uncommon to find a map lover who wants every information he needs to be shown on a single map. He gives a long list of facts to be portrayed and then tells at the end that the size of the map should not exceed, say, 8" x 8”.

Maps are used for a variety of purposes. Some of them go as wall maps, many others as atlas maps, but a vast majority of them go as illustrations in various types of books. For each purpose, the cartographer has to have a different design, although the information to be given might be the same. Wall maps are to be seen from a distance of more than five feet. In these maps only outstanding features of the data are to be shown clearly, legibly and boldly. Atlas maps are to be seen from a distance of about 15 feet.

Data, Scales and Projections: The nature of the data, including the size and the shape of the area to be represented, also influences the design of a map. For example, a map of Chile has to be an elongated one. A map of the USSR has to have large longitudinal and relatively small latitudinal extent. The nature of the data also influences the process of symbolization. Some facts can be shown by line symbols, certain others by point symbols and still others by area symbols.

Scale also influences the design of a map. On a large scale map objects can be represented in greater detail without creating cluttering. If the same data have to be shown on a small scale map, many of the details may have to be dropped in order to keep the map legible.

Projections are also important factors influencing the design of a map. Projections are of different types but there is none which can represent area, shape and direction truly at the same time. Most of the distributional data have to be shown on equal-area projections. To show correct direction, one has to select the Mercator’s or one of the zenithal projections. A cartographer has very little choice in this regard.

Reproduction processes: The reproduction technique to be used has a great influence on the design of a map. If direct contact prints are to be made, using the original as a positive, as in the case of ammonia printing, the original drawing will have to be done on a transparent or translucent paper. The reproduced map will be of the same size and design as the original drawing.

As against this, if the original has to be reduced photographically to get a negative or positive for final printing, it will have to be designed differently. A map to be printed in multi-colour, will have as many originals as the colours. Far more data can be shown on a multi-colour map than on a black and white map. Different printing processes require different kinds and numbers of originals, which in turn require different map designs (for details, see chapter on map reproduction).

In most of the printing processes maps are drafted at a scale larger than the reproduction scale. This is done with a view to get a more refined picture of the fair drawing. It is, however, often forgotten that a well designed original does not necessarily give a well- designed print. In fact the design of such maps should have the scale of the reproduced map in view.

Resource Restriction:

The third set of restriction under which cartographers function is related to cartographic materials, instruments, time and finances. Design of a map and its quality is often determined by the cartographic materials and instruments used in drawing. Design has to vary with the quality of the paper, ink, pens, and other aids used in drawing the originals. Availability of time and finances also influences the design. A multicolor map is a costly proposition. If finances are limited, one will be forced to think of a black and white map. Similarly, the time at the disposal of the cartographer influences the design.

Lettering and Toponomy

Letters are verbal symbols. They from words which give us certain meanings. There letters and words have to be incorporated in the body of the map along with other symbols. Letters are conventional symbols of linguists. We have to use these symbols as they are given to us whether we like them or not. What we can do however, is to change the style, form, size colour, etc. of these system to suit our specific needs.

Lettering has always been an important aspect of map design. In the past ornate lettering was very common. It was partly used as a device to fill up vacant spaces in the map. In those days all lettering was done freehand. Subsequently it came to be engraved to be more important than its usefulness. Ornate lettering are difficult to read (Refer to fig.6.2). The style of lettering has changed with the change in the printing technology and the taste of the people. At present the best lettering is considered to be one which can be read easily. While lettering on a map, one has to decide following:

1.Style 2. From 3. Size 4. Colour5. Method 6. Position 7. Relation to reproduction 8. Standardization

Style of Lettering

There are three main styles of letterings. They are (1) classical, (2) modern, and (3) sanserif. The original of the classical style is Roman. In this style the proportion of thick to thin lines making the letters is not great. The stoker of the letters have long and curved serifs. It is an ornate style and difficult to read. The modern style was developed in about 1800 A.D. It has precise geometric shapes, and the difference between the thick and thin lines making the letters is often excessive to give an unbalanced design. The lines are marked by small horizontal strokes. The sanserif style is the most modern and up-to-date one. It has no serifs at all. It gives a clear cut, new and nontraditional appearance. It is the best style from the point of view of legibility.

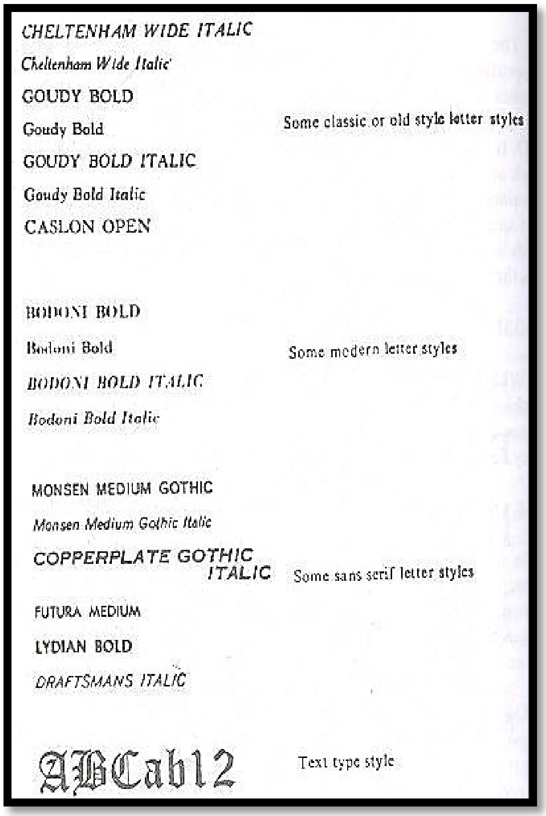
From of Lettering

Within these styles on can develop several sub-style or forms by changing the slant, thickness, and complexity. The style which can be considered to be good is one which is easy to read. Ornate and fancy designs are good to look at but difficult to read.

Size of Lettering

In view of the complex and varied nature of the data represented on maps, it is often desirable to use several lettering style to create contrast. But this should not be overdone. Within the modern style, we can have several combinations by using the capital and small letters and by varying the size and thickness of letters.

The selection of the size of lettering is very important in map design. It is true that certain style of letters are difficult to read but even the most modern and legible style will be of no use if the size is not properly selected. The size of letters is designed by points. Points 1 is equal to one twelfth of inch. Lettering that is one fourths of an inch high is equivalent to 18 points. Perhaps point 3 is the smallest type which can be read from a distance of 1 foot. It is safer to use 4 or 5 point types (Fig 6.1).Fig 6.2.



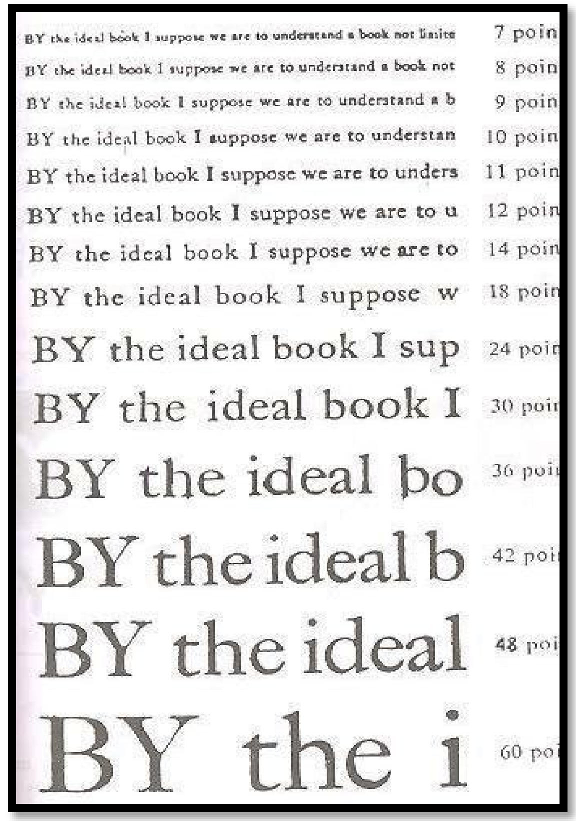


Fig 6.2.Lettering against varying background

Table 6.1 Relative visible of Type size

Size in points	Relative visibility From 18 inches
3	1.10
4	1.60
5	2.11
6	2.64
8	3.64
10	4.65
12	5.66
14	6.67
18	8.67
24	11.68

The table 6.1 can be used to determine the size of letters which will give the required perception. For example, if we want to increase the relative visibility of certain letter 5 times (point 3 being the base), we will have to select points 12 and not point 15.

Color and Back Ground:

Another way of creating contracts and making letterings more legible and easily perceptible is to them in varying colours and against contrasting backgrounds. Greater the contrast between the lettering and the background, more the legibility and perceptibility. Black lettering on a white background stands out at the top of the scale; on a gray background it looks faint and unimportant (Fig. 6.2).

Positioning:

Positioning of lettering means placing it in the map in relation to other symbols. The layout of letters should normally be parallel to the top and bottom of the neat line. This, however, Creates some imbalances if the parallels and meridians are also shown in the map, for in many cases the parallels and will not be parallel to the neat line. It is therefore, desirable to eliminate the graticules from the land areas of the map. They can be shown by strokes along the neat line. they need not be eliminated from the water features. This should not, however, be considered to be a rule, for in many cases the graticules may have to be shown to serve certain specific purpose.

In case where the features to be named have a real extents such as countries, mountains atc.,letters should be spread to include the entire feature. They should be equally spaced and easily distinguishable. Names of the rivers should be positioned along their courses and the letters should be slanting. The alignment of lettering used for railways, roads, canels,telegraph lines, air-routes, sea routes, etc., should be the same as that of the objects. Place names should be so positioned that they do not mix up with symbols. They should be placed a little above or below on the right or left of the symbol, to avoid mix up. The titles and legends, if put in more than one line, should be balanced around a central line and positioned carefully. It is advisable to first write the letters on a tracing paper and to adjust the position by shifting the paper left and right.

Mechanics of Lettering

There are several lettering devices. The following three are discussed below:

1. Freehand,
2. Stick up and
3. Mechanical

Freehand lettering

Freehand lettering is done with the help of a pen. It requires good planning. Guidelines are drawn with the help of a ruler, curve or lettering angle. For all capital lettering only two guide lines are needed but for mixed letterings, three lines are more appropriate. First the letters are drawn with a lead pencil (Fig. 6.3). Freehand lettering requires considerable practice. It is quick and more suited for maps in which letters have to follow certain crooked lines.

Stick up lettering

To make lettering easier, one can get the terms printed in appropriate style and size. These terms can then be cut off from the sheet and placed at their appropriated positions with the help of some adhesive. The commonly used names and letters are available in the market. These are printed on wax-backed transparent papers. One can cut the individual letters or a group of letters or build desired terms.

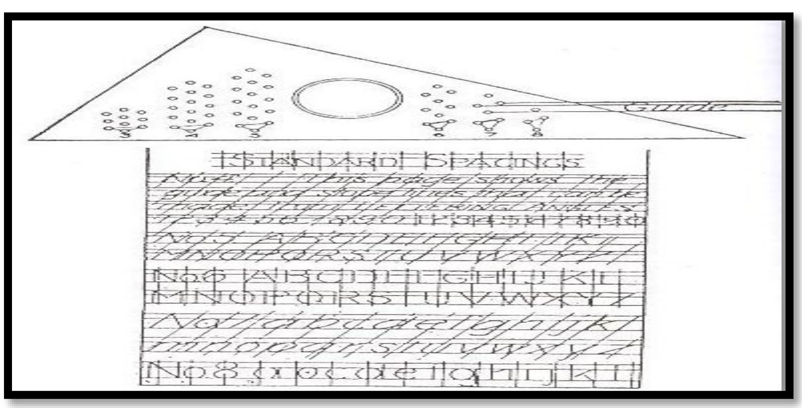


Fig..Stick-up lettering

Besides this, letter-sets (beautifully printed alphabets and figures of various sizes and styles) are also available which can be transferred on the map as per requirement. Quick and precise lettering is also done with photo-type.

Mechanical lettering

Mechanical lettering is one in which instruments are used to control the size, style and thickness of letters. Following are the most commonly used devices.

(1) A Uno pen consists of a pen attached to a small tube in which the ink is fed. The size and style of letters are determined by the templates in which the letters are stenciled.

(2) Leroy Set is an American product. It contains a scriber to which a pin and a pen are attached. The pin moves along a groove in the template and the pen gives the required letters. Templates of a variety of letter styles and symbols are available for this purpose.

(3) Varigraph is the most mechanized of the lettering devices discussed here. It also consists of a template with engraved letters and a stylus. Its functioning is based on the principles of a pantograph. Adjustments to make the letters large, small, elongated etc., are possible

(4) wrico uses stencils as in the case of the Uno pen but the pen is of a different type.

Fig. Leroy set.

The conventional drawing pen has been handicapped by a number of knotty problems-line breadth variations, drying and clogging of the point, blotting, ink spillage and soon. For better work, nowadays the “Hope graph” is used. This equipment is thoroughly functional precision. While selecting the size and style of lettering, it must be kept in view that the letters are also reduced with the rest of the symbols drawn on an original. They should be so selected that they will be legible in the printed map.

Geographical Names

As already seen, lettering on map is not as complex process and requires planning and creativity. This complexity is further increased by the fact that it is not always easy to find out the standard names of places or features depicted on a map.

Attempts to rationalize and standardize geographical names have been made for nearly 100 years. The international Geographical Union took this matter up in 1872. It has not, however, proved to be an easy and the recommendations of the Union have been disregarded by almost all the member countries.

The problem involved in the standardization of geographical names can be gauged from the following example. In the 1930s a river was discovered in the western half of New Guinea. It was named after its discoverer as Father Le Coq D’Armandvill River. The Papuans of New Guinea could not make either head or tail of it and continued to call the river ‘The Broad River’. The principle of giving local names (advocated by the IGU) had been disregarded in this case.

The irrational changes in place names are only too common. In the USSR almost all the names given to commemorate the Czar were hanged to commemorate Lenin or Stalin. One extreme example can be given again from New Guinea. Upto 1957 the capital of Dutch New Guinea was called Hollandia. After the Dutch withdrawal in 1957, it was renamed as kolaBaru. Subsequently it was renamed as SukranaPura. Now it is called Ayapura.

There is also the problem of disparity between the official names and the popular names. For example, Banaras in U.P. is now officially called Varanasi but the people call it either Banaras or Kashi. Duplication of place names is another problem. Many of the names are too often repeated in the same country.

There are so many Washington in the U.S.A. It thus appears that it is difficult to standardize geographical names unless all the member countries adhere to the principles laid down by I.G.U. in this regard. A cartographer has to use his judgement in determining the authenticity of place names. It may involve considerable amount of library and at times even field research.

Base maps

The term base map is seeing often in GIS and refers to a collection of GIS data and/or orthorectified_imagery that form the background setting for a map. The function of the base map is to provide background detail necessary to orient the location of the map. Base maps also add to the aesthetic appeal of a map.

Typical GIS data and imagery that make up the layers for a base map: streets, parcels, boundaries (country, county, city boundaries), shaded relief of a digital elevation model, waterways, and aerial or satellite imagery. Depending on the type of map, any combination of those layers can be used. For example, for a map showing foreclosed properties, the base map would consist of GIS data such as streets (with labels) and parcel lines. A map showing hiking trails would benefit from a base map containing a digital elevation model or topo lines that shows elevation, thus allow viewers to understand the rise and fall of a trail's path.

In the example above showing the regions of Ancient Greece, the base map used is comprised of a shaded relief showing the land areas, waterways and ocean layers. The foreground data showing the regions makes up the actual subject data of the map.

Base maps are also pre-authored datasets that can be pulled from online sources. Esri's ArcGIS online offers a selection of predefined base maps that can be used for creating online maps or that can be pulled into ArcGIS for use as a base map when using the desktop mapping software

COMPILING MAPS FROM OTHER MAPS

Maps arc one of the most important sources of cartographic information. There is no doubt that each map produced by cartographers is always a new product and incorporates new data, but most thematic maps use data already incorporated in other maps All maps must have certain basic ingredients like outline, relative location and important natural and cultural details.

which can be had only from topographic maps For e.\ample, if we want to make a population map of Mysore State, we have, at first to prepare the outline map of the State For this purpose we do not conduct original survey for we know how complicated and time consuming is the work of surveying. We therefore prepare a base map of Mysore from the maps produced by the Survey of India and other agencies Whether we will use 1 1,000,000 or quarter inch or one inch sheets in this process will depend upon the amount of details we would like to incorporate.

While compiling maps from other maps we fate two problems

(1) reduction or enlargement, and

(2) generalization

ENLARGEMENT AND REDUCTION OF MAPS

There are four ways of changing the scale of a map

1 Geometrical method

2 Mechanical method

3. Projection method

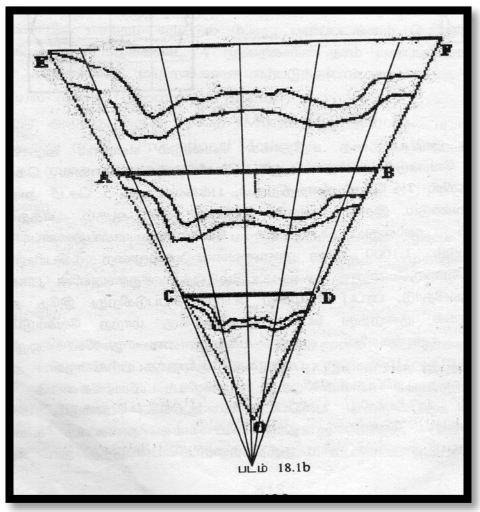
4. Photographic method

Geometrical method

Geometrical method is based on the principle of similar triangles and squares. The principle of similar triangles is used in the enlargement or reduction of relatively narrow areas, and the principle of similar squares in those of larger areas. Both the methods are very cumbersome and time consuming.

Similar triangles method

Suppose we have a river course between A and B. To reduce it to one-third of its size, join A and B by a straight line. Select a point P at a distance about twice the length of AB. Join PA and PB and extend them to A’ and B’ if enlargement is also needed. Locate the bends and other details of the river course, and join them to F by rays as shown in figure 126. Extend these rays up to line A’ B’. Now draw a line CD within the triangle PAB parallel to AB but only one-third of its length. Line CD will also be cut by the rays emanating from P at points which have same dimensional relationships as those on A B. With the help of these points the river can be reduced.



Similar triangles method

Similar Square-method

The triangle method, discussed above, cannot be of much help if the area to be reduced has large longitudinal and latitudinal extensions. In this method the area to be reduced or enlarged is first divided into a convenient number of squares. Then, on a separate sheet of paper, we draw another net work of squares whose sides are proportionately reduced or enlarged. For example, if we want to reduce a map to half and the squares drawn on this map have their sides 1 inch long, the sides will be only 0.5” long in the reduced squares.

After the network of the squares is ready, the details are carefully transferred from the map, square by square. First prominent details ‘ like rivers, roads etc, are marked, the minute details are filled later.

Mechanical method

Proportional Compass Another, and perhaps more efficient, method of reducing or enlarging a map is the use of instruments like proportional compass, pantograph or ediograph Proportional compass consists of two bars clamped together by a sliding screw and having a pair of needle points at both ends to act as dividers It forms a handy aid m enlarging and reducing maps The sliding screw can be fixed to any ratio engraved on the bars, so that the distance between the two points of the divider on one side arc in desired proportion to the distance between the corresponding points on the other side.

Pantograph Panlograph is made on the same principle as the proportional compass It consists of four tubular bars two long ones and two short ones lunged together at the joints to form a parallelogram. The most common pantograph used in India is the so called Stanly s model.

Projectional methods'

Many small size maps or small areas from large maps can be projected on a paper by an epidioscope. An epidioscope has a built in mechanism to reduce or enlarge an image. It is defficull, however, to reduce or enlarge a figure to any difinite scale. Distortions in scale are also present on the margins of the enlarged figure. Moreover, only a small figure can be used in the epidioscope There is no doubt, however, that for works where scale is not an important factor, it is an excellent device. It is inexpensive, quick and easy to operate. For accurate reduction and enlargement one may use a plan variograph.

Photographic method:

Photographic method of reduction and enlargement is by far the most precise but costly method. This method also can be manipulaled'to be used in different ways. One way is to use an ordinary camera to take photographs of a map to be reduced and then to prepare a positive slide which can be projected through a slide projector or enlarger to obtain the required size of a map. But in this process one has no control over the scale of the map projected. So the defects of projection method creep in here also.

Photostat machines can also be sued to get copies at required scales. This is a camera like device with a prism fixed to its front frame and magazine to its back frame. It is mounted on a heavy pedestal stand. The original map is placed on an adjustable copy holder which lies in an horizontal position vertically below the prism. The prism transfers the image on to a sensitized photostat paper placed in a vertical plane in the magazine. There are several mechanical devices to vary the distances of the copy holder and the magazine with respect to the prism to obtain the necessary enlargement or reduction. (See chapter on map reproduction).

PROCEDURE FOR COMPILATION

In general, the purpose of compilation is to utilize larger scale source materials covering the same area as the base, for cartographic portrayal on a different scale. The required data are traced upon a transparent medium. The resultant transparency is called a pull-up or 'guide-map.' Laying out the pull-ups:

The first and the foremost thing is the tracing of the required details. Tracing paper or tracing doth can be used for this purpose. But tracings made on them are subject to shrinkage or expansion. Hence heavy weight "acetate" is preferable. It is an economical and efficient medium for tracings. An added advantage of this medium is that it permits considerable amount of erasing with the help of a sharp etching knife or blade. Plastic ink is better suited for trading than pencils because :

(1) It is difficult to keep the pencil sharp,
(2) The images 'drawn with pencil become blurred when the trading are stacked, and
(3) Uneven application of the penal results in light spots. Care should be taken in using plastic inks, as they dry rapidly.

General practices for physical details:

Relief data arc always drafted in brown. While drafting the contours, one can displace them when no other adjustment to drainage or communication symbols can be made. In the process of generalization, contour curves must be maintained in order to retain the character of the landform being depicted.

Where contour lines arc so close together that they coalesce, intermediate contours can be dropped. Usually, every fifth contour is taken as an index contour and the brown line drawn to represent it should be twice the weight or gauge of intermediate contours. Green ink should be used for drainage. Streams can be drawn with double lines to represent the two banks and if unity of the banks is not apparent, links should be drawn between the double lines.

The general criteria for giving drainage details is to show enough so as to present the same pattern on the reduced pull-up as appears on the large scale source. The appropriate ratio of larger and smaller streams can be maintained by using discrimination in the width of lines representing them.

General practices for cultural details:

Transportation'.

In preparing a guide map, road transportation comes next to drainage pattern. Red is the accepted colour for this. Only important roads need to be shown. Rail road are drafted in black. Solid lines are intersected at specified intervals by cross ticks to represent the ties.

Built-up areas:

To patterns are generalized according to their boundary outlines if they cover large areas. The choice of towns is determined by their strategic location or importance, such as at road junctions, junctions of roads and rail roads, roads crossing streams or at gateways to other important areas. Each closely built-up area must have a name on the final map. At times some features may have to be eliminated or shifted to provide space for lettering.

Boundaries:

Boundaries of different administrative or political units should be indicated with different line symbols. When a boundary follows a single line or closely spaced double line such as a river, drain or road, it is necessary to show only every third boundary symbol placed alternatively on two sides of the line.

Selection of details:

The next important step in the compilation of maps is the selection of details. Original map from which compilations are made may consist of many details but all those details cannot be depicted on a small scale map. Some of them have to be shown in full and popular shape, others only symbolically while still others may bar e to be left not altogether.

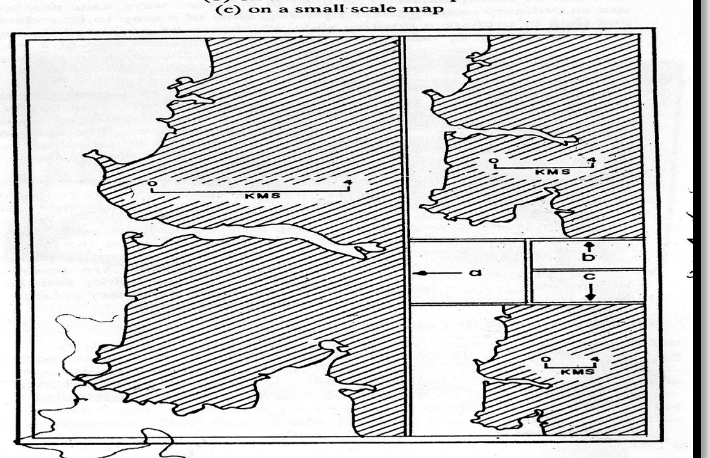
This sorting out is necessary because the reduction of scale means the reduction in the length and breadth of the details to be shown and crowding together of details. The purpose of a map is to convey information. The crowding of details certainly does not serve this purpose. Hence, some of the details have to be removed. Cartographers have to use their judgement in doing so : those items which must be there to serve the purpose of the map should not be removed.

A cartographer should think entirely in terms of how the details he is selecting would look when they appear on the reproduced map. It is necessary to choose only those details which depict the essential features of a large area. Names are not lettered on a pull-up but the cartographer must bear in mind that they will be superimposed on the final copy.

(a) on a large scale map
(b) on a medium scale map
(c) on a small scale map

Since the symbols bear direct relationship to the scale of the source, it is quite essential to reduce them in relation to the scale of the pull-up. For example, a circle with 0.6 inch diameter on a scale of 1:200,000 will appear with a diameter of 0.24 inch on 1:50,000 pull. In the case of solid lines, they must be heavy enough to accommodate reduction. Sufficient "light" or open space should be kept between symbols so that they do not coalesce on reduction.

Fig.131. Generalization of the coastline
(a) on a large scale map
(b) on a medium scale map
(c) on a small scale map



Generalization:

While compiling maps from other maps, cartographers are often required to generalize the outlines and other details. Some of the problems of generalization are discussed below. Generalization of the coastline is often a difficult task. Different maps of the same area give different coastlines yet all of them may be correct. The hydrographic charts are made with reference to the mean sea level. But the mean sea level and the actual sea level are not the same, and it is to be expected that there will be a difference in the resulting outline of the land (Fig.131). In some cases the changing coastline may also pose a problem. The generalization of such water features like swamps, flood plains and tanks also is problematic.

Parts of these features are under water and parts above water in different seasons. Moreover, the data given on a map are not always comparable. A map drawn on Mercator's projection gives more detailed coastline in areas away from the equator. In certain areas, like polar areas, the coastlines are not well known. One has to keep in view that the generalized outline resembles the outline shown in the map being reduced.

Generalization of boundaries is equally difficult. On a small scale map, a little movement of the hand may give large chunks of land to the neighboring countries or states. In some cases two neighboring countries don't agree on their common boundaries resulting in international disputes. The adoption of any of the two boundaries may stop the entry of the map in one of the countries.

A case in point is the Indo-Pakistan and Sino-Indian boundaries. Here again the cartographer has to use his judgement and discretion. At times the boundaries also change with changes in the location of certain physical features. A boundary may pass through the middle of a river But if the river has changed its course, one side has to lose and hence a dispute occurs

The degree of generalization differs from map to map, there can, therefore, be no set standards for this purpose Here lies the creative role of a cartographer It must be remembered that the importance given to various details is the result of subjective analysis A thorough knowledge of the subject matter of the map and of the area being mapped is, therefore, indispensable for good and Intelligent generalization.

Even in the process of direct copying from the source, one should not waste much time in drawing minute curves etc .Because they will look like blots after reduction Hence, it is far better to strive for smooth curves that suggest the details rather than mirror the images of the base source. Drafting enlarged symbols of the features that are very close together on the source map would necessitate a "piggy back ride for one of them. But this technique is not acceptable. In order to draft the enlarged symbol in a pull, it is necessary to displace one or several of them They, thus remain in their true relationship but not true location on reduction .

As regards the positional priority, drainage is held to its true position followed by cultural features and contours. In general, it may be pointed out that on the final compilation each feature should be shown in the same relative position to the rest of the features as it was on the original source.