وزارة التعليم العالي والبحث العلمي في العراق

الجامعة التقنية الشمالية

الكلية التقنية/كركوك

قسم هندسة تقنيات المساحة

المرحلة الثانية

الخرائط

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Surveying Engineering Dept

Second Year

CARTOGRAPHY

Prepared by subject lecturer

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Subject	Target students	Hours in a week			Units
		Theory	Practical	Total	
CARTOGRAPHY	second students	٢	٤	٦	٨

The Aims

١. **General aims:**

The student learns the meaning of the map, the student learns the contents of the map, and learns the map's usefulness in practical life. The student learns about the types of maps.

٢. **Special aims:** The students can be able to;

A – The student learns the meaning of the map.

B – The student also recognizes the map content from symbols and how to write the title

C – Students learn to calculate the appropriate drawing scale for each map.

E- Calculate Area and Distance through a scale of map.

توزيع الدرجات خلال السنة:

- الفصل الأول: ويتضمن ١٠ درجة امتحان فصلي نظري و ١٠ درجة عملي فصلي. (نصف السنة).
- الفصل الثاني: ويتضمن ١٠ درجة امتحان فصلي نظري و ١٠ درجة عملي فصلي. (نصف السنة).
- أعمال السنة: ١٠ درجات (امتحانات سريعة + حضور الطالب)

(فيكون السعي السنوي من ٥٠ درجة)

- الامتحان النهائي: ٥٠ درجة

(فتكون الدرجة النهائية من ١٠٠ درجة)

المنهاج:

الأسبوع	التأريخ	المادة النظرية	المادة العملية	الملاحظات
١		مقدمة حول علم الخرائط واستخدام الخرائط الطبوغرافية كنموذج في المشاريع الهندسية	ممارسة تقنية التحبير	
٢		طبيعة علم الخرائط وتصميم الخرائط واتقنيات المستخدمة والفنون الترسيمية والادراك المرئي	رسم الرموز القياسية الطبوغرافية الموقعية	
٣		انواع الخرائط واستخداماتها	رسم الرموز القياسية الطبوغرافية االخطية	
٤		علاقة علم الخرائط بعلم المساحة والاستشعار عن بعد	رسم الرموز القياسية الطبوغرافية المساحية	
٥		طرق تصحيح الاخطاء القياس وانواعها وقوانينها	رسم خارطة طبوغرافية بمقياس معين	
٦		انتاج الخرائط في العراق والترميز وتوقيع المعالم الموقعية	رسم خارطة طبوغرافية بمقياس معين	
٧		الترميز - توقيع المعالم الخطية	رسم خارطة طبوغرافية بمقياس معين	
٨		الترميز - توقيع المعالم المساحية	التلخيص الخرائطي – تلخيص الخطوط الكنتورية ورسمها	
٩		جداول الرموز القياسية المستخدم في الخرائط الطبوغرافية	التلخيص الخرائطي – تلخيص الانهار ورسمها	
١٠		التلخيص (التعميم) الخرائطي اسبابه ومقاصده	التلخيص الخرائطي – تلخيص الشوارع ورسمها	
١١		عمليات التلخيص الخرائطي	التلخيص الخرائطي – تلخيص المباني والمنشآت ورسمها	
١٢		تطبيق عمليات التلخيص في الخرائط الطوبوغرافية والموضوعية	تصميم الخرائط – التنظيم الداخلي لعناصرها –العنوان – جدول الترميز- المقياس -الاحداثيات	
١٣		تصميم الخرائط – المقدمة ,نظرية الايصال	تصميم الخرائط – التنظيم الداخلي لعناصرها –العنوان – جدول الترميز- المقياس -الاحداثيات	
١٤		تصميم الخرائط – ادراك الخرائط	تصميم الخريطة –الالوان –اختيار الالوان وتنسيقها حسب الجداول القياسية	
١٥		تصميم الخرائط – الالوان	تصميم الخريطة –الالوان –اختيار الالوان وتنسيقها حسب الجداول القياسية	
١٦		تصميم الخرائط – الانماط	تصميم الخرطة والانماط النوعية والانماط الكمية	

١٧		تصميم الخرائط – الخط	تصميم الخرطة والانماط النوعية والانماط الكمية	
١٨		تصميم الخرائط الطوبوغرافية العراقية	الخط- توزيع الخط في لوحة الخارطة	
١٩		تصميم الخرائط الموضوعية	الخط- توزيع الخط في لوحة الخارطة	
٢٠		تمثيل التضاريس الارضية	تصميم خارطة طوبوغرافية	
٢١		المقدمة ,طرائق تمثيل التضاريس في الخرائط المختلفة	تصميم خارطة طوبوغرافية	
٢٢		طريقة الخطوط الكنتورية	تصميم خارطة موضوعية	
٢٣		طريقة التضليل	تصميم خارطة موضوعية	
٢٤		تحليل التضاريس الارضية	تمثيل التضاريس الارضية بطريقة التضليل	
٢٥		تقويم الخرائط الطوبوغرافية من النواح الهندسية والفنية	تمثيل التضاريس الارضية بطريقة التضليل	
٢٦		تحليل وتفسير الخارطة الطبوغرافية للأغراض الهندسية	تحليل الخارطة الطوبوغرافية	
٢٧		تحليل وتفسير الخارطة الطبوغرافية للأغراض الهندسية	تحليل الخارطة الطوبوغرافية	
٢٨		تقنية التحبير	تفسير الخارطة الطوبوغرافية للأغراض الهندسية	
٢٩		تقنية الحفر	تفسير الخارطة الطوبوغرافية للأغراض الهندسية	
٣٠		تقنية الحفر	تنفيذ تقنية الحفر	

المصادر:

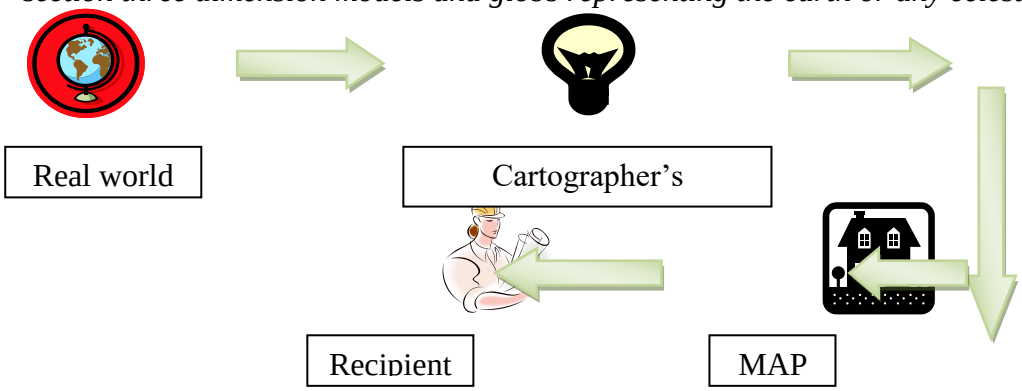
١- " Element of cartography by Robinson.

Cartography

It is a technique fundamentally concerned with reducing the spatial characteristic of large area – apportion or all of the earth or other celestial body and putting it in a form that make it more observable.

Technical term in Cartography defines:

The art science and technology of making maps, together with their study as scientific documents and works of art , in this context maps may be regard as including all types of maps , plan , charts , and section three dimension models and globs representing the earth or any celestial body at any scale.



Tasks of Cartographer:

- *The choice of scale: because it sets on the information that can included in the map , and on the degree of reality which it can be delineated (is the map use in book)*
- *Employ transformation of spherical surface that changes it into plane, such a radical transformation introduces some an avoidable change in direction , distance , area , and shape.*
- *Generalization: is the one of the most difficult of cartographer's tasks.*
- *Design the graphic characteristic of map, the map must be legible; the symbols must be suited to the objective of the map.*
- *Actual construction or drawing of the map and its reproduction.*

Information sources of produce maps

Information sources of produce maps

Land surveying	المساحة الارضية
Aerial photography	التصوير الجوي
Remote sensing	التحسس عن بعد
Global information system (GIS)	النظام العالمي الجغرافي

The definition of map:

Because of wide variation in the character of these spatial representation is not easy to define the term map in way that will make its meaning clear in all contexts, the best definition of map is ; it is a vertical projection of any part of earth on the base of a suitable scale , and its content symbols , lines and color represent all natural and artificial phenomena.

The classes of map:

Because there are many different kinds of map, it is useful to classify them as with many groups of diver's objects, moon approach is perfectly satisfactory. In order to provide a better Base for the appreciation of similarities and difference among maps and cartographers, we will look at maps from three points of view:

- *Scale.*
- *Communication objective.*
- *Subject matter and functions.*

First classification of map is defined on scale so we have ٢ types of maps;

- *Large scale map.*
- *Small scale map.*

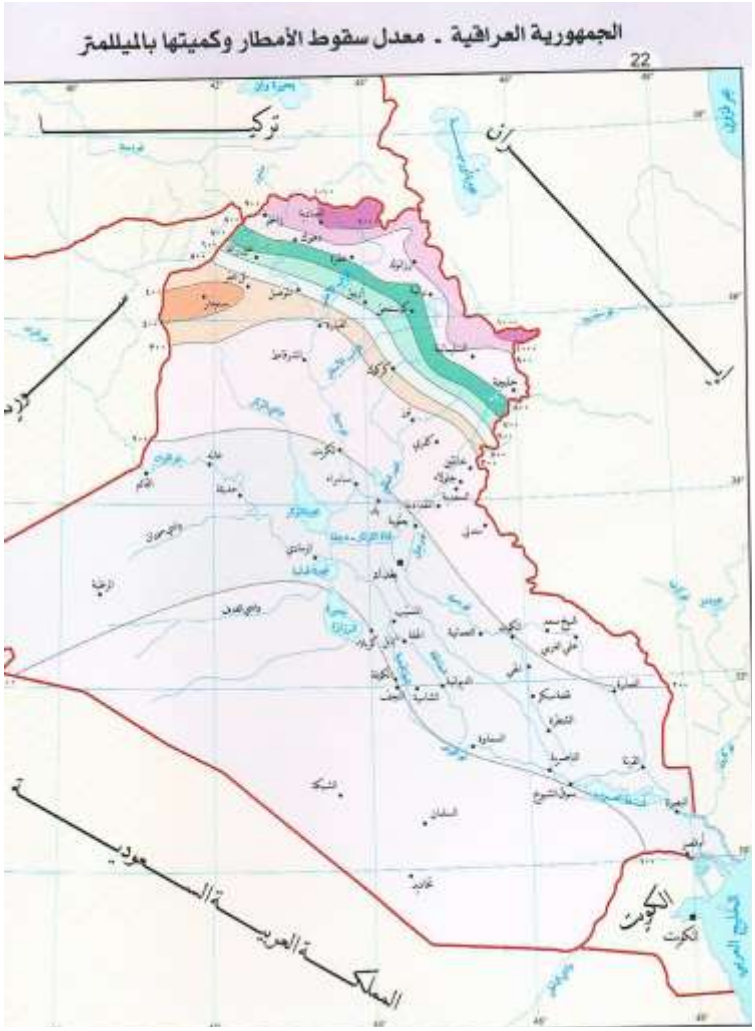
The difference point between them:

Large scale map	***Small scale map***
It is need a little reduction such as building.	***It is need a greet reduction, most linear object and other small features can't be shown.***
The reality isn't in simplification manner.	***The reality is in simplification manner.***
Usually not much generalized.	***Must always be generalized.***
Commonly large scale map is general map.	***Commonly small scale map is thematic map.***

The another classification of maps depend on the subject matter of map we have ٢ types of these map:

- *General map.*
- *Thematic map.*

General maps: are those which the objective is to portray the spatial diverse geographical phenomena things, such as road, settlements, boundaries, elevation coastlines and bodies of water, we chosen to portray on general map. General maps are usually called "topographic maps", it is required for sit location and other engineering purpose.
Thematic maps: consternate on the spatial variation of a single phenomena or the relationship between phenomena's, for example the average annual atmospheric pressure, grain production.
Just because the maps deal largely with single class phenomena, it doesn't necessary mean that it is a thematic map.
Maps that showing the diversity of soils, bed rock geology or population density can properly classified as general maps, if the primary objective is simple to show the location of soil types.



The difference point between general & thematic maps:

General maps	*Thematic maps*
Large scale map.	***Small scale map.***
Attempts to portray the positional relationship of difference geographic phenomena.	***Consternate on the spatial variations of a single phenomena or the relationship between phenomena's.***
Accuracy is more.	***Accuracy is less.***

The properties of thematic maps:

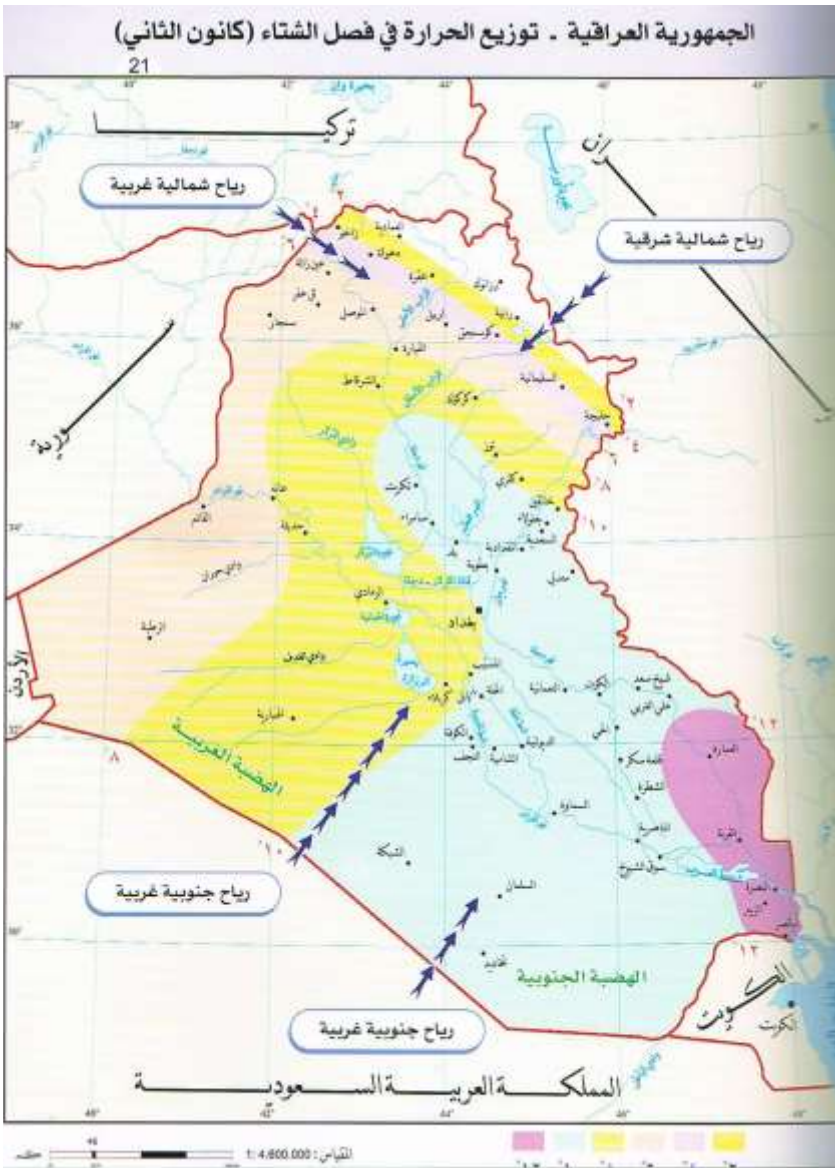
- *There is no limit to the subject matter of the thematic maps there are typified by maps of :*

١. *Average annual precipitation.*
٢. *Temperature.*
٣. *Population's atmospheric pressure.*
٤. *Land form, land use.*

- *In thematic maps the communication objective is to portray the structure of distribution.*
- *The maps that can show the :*

١. *Diversity of soil.*
٢. *Bed rock geology.*
٣. *Population density.*

Can be properly classified as general maps not thematic maps.



The national map accuracy standards:

The necessary of the national accuracy come from its important in boundary determination on large scale map that we can use it as a legal document; therefore we have two types of accuracy:

- *Horizontal accuracy: for maps published at large scale than (١: ٢٠٠٠٠) not more than (١٠٪) while for maps published at smaller than (١: ٢٠٠٠٠) the error limit shall be more than (١٠٪).*
- *Vertical accuracy: for contour maps at all publication scale not more than one-half the contour interval.*

The standard error can be calculated by:

$$d = \frac{\sqrt{\Sigma e^{\wedge ٢}}}{n}$$

Where d= the standard error
e= the error
n= the number of station observation

The other classification of maps:

- *Topographical maps: it's a results of initial survey ,line aerial survey or surface survey that consist of topographical phenomena and its deal with the elevation determining of reliefs its scale ranged between (١:١٠٠٠٠- ١:٢٠٠٠٠٠).*
- *Plano metric maps: it is like a topographic map, but it isn't referring to the relief.*
- *Geographical maps: it is prepare from topographic map, with additional reference, its characteristic by maximum scale not more than (١:١٠٠٠٠٠٠).*
- *Cadastral maps: it is uses to clear the distribution of geographical properties the scale of these types of map ranged between (١:١٠٠٠٠- ١:٢٥٠٠٠٠), it may be refer to elevations and it may be excluded other necessary topographical details.*
- *Special maps: the production of these types of maps are to limit things and some of them may be without scale ,like statistical map, nautical maps(marine and aerial), geological map, soil map and also traffic maps , and ٤ maps depend on their object :*

١. *Topographical maps.*
٢. *Marine nautical.*
٣. *Aerial maps.*
٤. *Geographical maps.*
٥. *General maps.*
٦. *Cadastral map.*
٧. *Special maps.*

Classification of maps depends on its scale:

- *Topographical maps there scale ranged between (١: ١٠٠٠٠ - ١: ٢٠٠٠٠٠).*
- *Geographical maps there scale is not more than (١:١٠٠٠٠٠٠).*
- *Plans there scale is more than (١:١٠٠٠٠).*

Classification of maps depends on its scale & contents:

- *Central maps which consist of:*

١. *Topographical maps.*
٢. *Plano metric maps.*
٣. *Maps of region & continents.*

- *Special maps consist of :*

١. *Charts of navigation.*
٢. *Single factor maps like geological maps, soil maps, and statistical maps.*
٣. *Cities map.*
٤. *Political map.*
٥. *Horizontal map.*
٦. *Climate map.*
٧. *Propaganda map.*
٨. *Cadastral map.*

- *Globes & models.*

How to use the topographic map as a research model in civil engineering purpose:

In civil engineering the researcher need quantitative relationship ; therefore the topographic maps are used as a base in research model in civil engineering , because in topographic map we found the representation of topographic phenomena with different reliefs that's represented by contour lines which can give to user quantitative relationship.

The topographic map can be uses in the several engineering operation these are:

- *To draw section (transverse, longitudinal) to road and rivers foundation.*
- *To evaluation of celerity of view.*
- *To evaluation the inclination & degree of steepness in addition to the altitude of them.*
- *To estimate the area of any part of lands.*
- *To extent or fixed surface section.*
- *To estimation of soil quantitative.*
- *To design the drainage pattern, road foundation, also to suggest the best position to the dam foundation.*

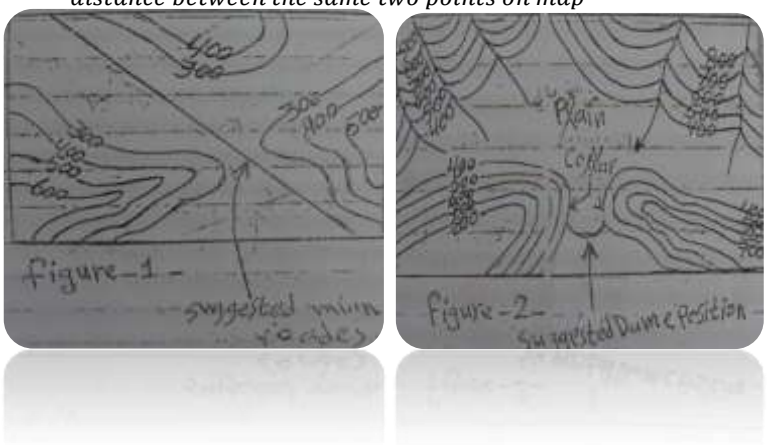
The examples of using the topographic map as research model in civil engineering:

- *Example ١: to Foundation Street in any place characteristic by high relief (mountain). to choice a suitable place to foundation and extant any road we need topographic map , due to its content from contour lines that provides an easy method to estimate the amount and the attitude of inclination in addition to the ability of section drawing . all these things are useful in the civil engineering operation , therefore the classification were made for this object ,one of these classification as mention below illustrate the relation between the degree of inclination & the types of roads that we can able to found it in that place :*

No	Inclination degree	Types of road
١	٢٥	Rail way
٢	٤٥	Numbers of high way
٣	٥٥	Main of high way
٤	٦٥	The work shop or station way and car service

It's important to refer to the relationship between the inclination amount & the percentage of steepness degree, this degree can be calculated by the following equation:

$$steepness\ degree\ \% = \frac{difference\ in\ height\ between\ two\ points\ on\ map}{distance\ between\ the\ same\ two\ points\ on\ map} \times ١٠٠$$



The advantage of this relationship is to give a best decision to choice the road ability. to this case a table was made , this table as mention below can give a good information that can serve the civil engineering operation in foundation & construction any project in any place through the knowledge of what they needs from the equipment and also could give a good service to the researcher and tourist or to foundation a scientific village on a high relief .

Inclination degree	Steepness degree	Road ability

١٥- ١٠	١٪- ٢٧٪ ***Mild steepness***	***All types of car can be uses in this place***
٢٥- ١٥	٢٧٪- ٤٧٪ ***Moderate steepness***	***Some types of car with walker & horseman***
٤٥- ٢٥	٤٧٪- ١٠٠٪ ***High steepness***	***Only walker & horseman***

- *Example ٢ : to foundation dams characteristic by its good geomorphologic phenomena , the choice of the place to construction any dam depend on the existence a good height topography or high relief to use them as a collar , also the existence of huge \plain area before the suggested position to construction the dam to use it as water store house .*

Note : the topographic map that can be uses in research model it must be characterized by the scale equal to (١:٢٥٠٠٠) with contour interval gradation by (١m- ٥m) or (٣m- ١٠m) , the horizontal plane and details of cross section could be draw in scale either (١:١٠٠٠٠) or (١:٢٥٠٠٠) for contour intervals gradation (١m- ٣m) and the sheet dimension is equal to (٨٠cm× ٤٥cm) .

Cartographic generalization:

In cartography we are vitally interested in way in which we can increase the effectiveness of cartographic communication by counteracting the undesirable consequences of reduction, there are a variety of modification that can and must be carried out as a result of reduction they range from the essentially mechanical process to intellectual exercise . These modifications collectively were called cartographic generalization. Also we can define generalization by other words; it's a reduction of some details from the source map after changing the scale to small one. The effectiveness of generalization increase with changing the scale of the source map to small the details of maps consist of ٢ basic elements these are:

- *Position.*
- *Content.*

Both of them are suffer from the generalization.
Cartographic generalization is born of the necessity to communicate. It's impossible to portray everything; therefore we need the selection of the information to be communicated by the map. A selection of available information is make that is constant with purpose of the map. it's important to refer to the fact that the selection isn't a part of cartographic generalization as we define because cartographic generalization is the modification of specific data in order to increase the effectiveness of communication by the counteracting the undesirable consequence of reduction .

The elements of cartographic generalization:

- *Simplification: determine of important characteristic of the data, the retention & possible exaggeration of these important characteristics & elimination of unwanted details.*
- *Classification: the ordering or scaling and grouping the data.*
- *Symbolization: the graphic coding of scale or grouped essential characteristic comparative significances and relative positions.*
- *Induction: the application in cartography of the logical process of generalization.*

The control points cartographic generalization:

- *The objective: the purpose from the map.*
- *The scale : the ration between the map & the earth*
- *Graphic limits: the capacity of the systems employed for communication and the perceptual capacity of the map user.*
- *Quality of data: the reliability and the precision of vary kind of data being mapped.*

Topfer & pillewizer had developed a law or principles of simplification that stats in general terms "the amount of details that can be shown at different scale it was called the radical law or the principles of selection " this law can be expressed by :

$$nf = na\sqrt{\frac{ma}{mf}}$$

nf = is the number of the items on the newly compiled map.
na = is the number of the items on the source map.
ma = the scale denominator of the source map.
mf = the scale denominator of the newly compiled map.
The equation of radical law must be modified depending on the nature of the phenomena being compiled. The modification is make be introducing ٢ constant (Cb , Cz) the right side of basic equation .
The constant (Cb) is called the constant of symbolic exaggeration and takes ٣ forms:

- *Cb ١= ١,٠ for normal symbolization the elements are appears without exaggeration.*
- *Cb ٢ = $\sqrt{\frac{mf}{ma}}$ for features of area extent shown in the outline without exaggeration such as lakes & island.*
- *Cb ٣ = $\sqrt{\frac{ma}{mf}}$ for symbolization involving great exaggeration of the area required on a compiled map such as the settlement symbols with its associated name.*

Where the constant (Cz) is call the constant of the symbolic form and also it take ٣ forms:

- *Cz ١ = ١,٠ for symbols compiled without essential change.*
- *Cz ٢ = $\frac{Sa}{Sf}\sqrt{\frac{ma}{mf}}$ for liner symbols in which the width of the lines on the source map (Sa) and on the newly compiled map (Sf) are important items in the generalization.*
- *Cz ٣ = $\frac{Fa}{Ff}\sqrt{\left(\frac{ma}{mf}\right)}$ for area symbols in which the area of symbols on the source map (Fa) and on the newly compiled map (Ff) are important items in the generalization.*

Notes:

١. *Cannot for most thematic maps make simplification of the features with in a class such as rivers or cities on purely objective ground such as size.*

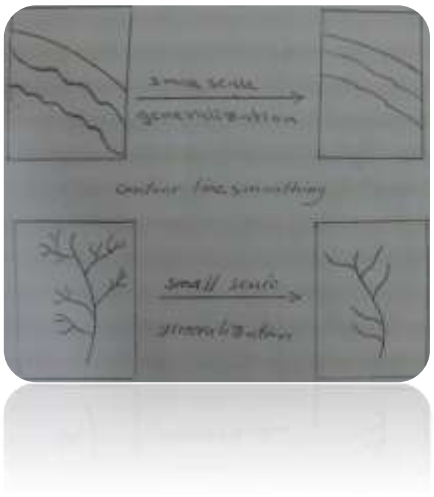
٢. *In the scientific maps like distribution of the soil types , the soil type that occupied an area smaller than the basic mapping unit will disappear from the newly compiled map due to its complex from the basic mapping unit is either (٥×٥)mm or (٢×١٠)mm .*

The relationship between the map scale & generalization:

- *The representation of independent buildings and un straight ways in the city can be prove on the topographic maps with scale fraction (١:٢٠٠٠٠) while some of the ways and blocks can be*

represent on the map with scale fraction ranged between (١:٥٠٠٠٠ to ١:٢٠٠٠٠٠) in the smaller case than the above scales only the outlines of the cities can be clear on the newly compiled map.

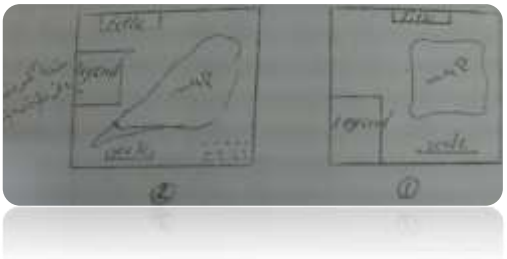
- *The representation of the details of mountain series and hills can be prove on topographic map with scale fraction (١:٢٥٠٠٠) while its represent on the smaller scale need to the smoothing (reduction) some of its details due to generalization.*
- *The agricultural fields suffer from the generalization and when it represent on the map with scale fraction (١:٥٠٠٠٠) its need to simplification from its complex form, but without its geographical properties.*
- *The river generalization and un straight ways need a good knowledge about the nature of these phenomena. The cartographer do the smoothing the secondary curvature of them; therefore he prepare the small scale map, this operation can be applicative on the contour lines.*



Planning of map design:

Thoughtful and effective communication of complex relationship demands careful planning when graphic means are employed this display must be as carefully organized and planed as any other sort of communication. The steps of planning are:

- *Design the outline "graphic outline" when we plan to write something we first prepare an outline, we use the term outline in this broad series as a brief characterization of essential features of communication.*
- *Design the title a title serves as a variety of function sometimes it in form the reader about the subject of the map or the area on it; therefore it's very important. The title may be useful to the designer as a shape to be used to help the balance of map composition.*
- *Design the legend map legend can be emphasized or subordinated by the shape, size or value. Today the legend are inner important than the outline. In the past it was the custom to enclosed legend in fancy ornate outlines called "cartouches" it is give attention to the reader.*



- *The scale : the scale of the map so varies in important from to map on map showing linear symbols or other phenomena that involves distance concepts , the scale is an important factor , the best place of the statement of the scale is the middle part at the base of map . The method of representing the scale may vary, for large scale the representative fraction (RF) is useful because it is give the reader a great detail about the amount of generalization. On small scale map the "graphic scale" or "bar scale" is much more common.*

Communication theory:

The base of this theory is the map design, the map design can be define as "it is a general planning to map details, which its consist of the elegance & organization the map elements in addition to the selection of the suitable symbols to its details " the selection of the map elements (lettering, symbols, colors & patterns) need elegance on the base of scientific object that depend on the engineering and mathematical science in addition to the art science.

The job of design:

Consist of the communication of the information that the map includes it to the user in effectual manner; therefore this job can be content all factors and the condition that effect on it:

- *The scientific level of the map user.*
- *The range of the map necessity.*
- *The object from using it.*
- *The complexity degree of its content.*
- *The graphical limit and its cost.*

To obtain a good design there are ٢ necessary points it must we do them:

- *Limitation the general elements that can effect on the map appearance and its content preparation.*
- *Details decision must be taking about the different symbols that represent the information as a graphical format.*

Map design:

Design in the graphic context is both as a noun and verb , as the noun the term is refer to the visual qualities of display with attention paid to the appearance of individual components and the character of their arrangement .As a verb the term refer to the planning and decision making involved .graphic design is a vital part of cartographic process because the effective communication requires that various marks (lines , tones , colors , patterns & lettering) in the sense the cartographer prepare functional structure , the cartographers objective is to evoke in his mind of a viewer the desired image of the spatial environment appropriate to the intended purpose of the map .

The design process:

- *Imagination: here the map maker scans the various possibilities and consider all the ways of problem solutions. At this stage the cartographer is being most creative in design process. The result is a general idea such as the map format (size & shape).*
- *The development of specific graphic plan here the decisions are made regarding particular kinds of symbols, color use, topographical relationships.*
- *Preparing the specific plans and specifications , which involves :*

١. *The preparation of compilation worksheet where everything is put in proper plane metric relationship.*
٢. *The preparation of detailed specifications for construction of the art work, all line weight, screen values, ink color & lettering size.*

Control of map design:

- *Objective: it's obvious that the communicative purpose, for which the map is being made, is the essential determinant of its final form. All aspects of symbolization of graphic design must be consciously fitted with the purpose as careful as possible.*
- *Reality: the overall geographical dimension and character of the distribution being mapped are given the reality.*
- *Scale : its prescribed by the format and by its relation to the area being mapped , from a conceptual point of view , the smaller the scale , the smaller the line weight and lettering sizes should be proper ate with small scale .*
- *Audience: both general and thematic maps are made for Variety of audience, this range from the young school, children to college students. The function of audience as a control may be extended to include the conditions under which a map may be uses.*
- *Technical limits: how a map is to be constructed and reproduce will affect the graphic design in several ways. is it use color or to be mono chrome , scribed or draft by ink, hand letter or uses printed types material like computer , or stick up lettering .*

Graphic elements of map design:

- *Clarity and legibility: These ٢ terms are bored and many of its techniques and principles considered in other parts of text book are important factor in obtaining these qualities in representation. farther more a considerable portion of the task of achieving clearing and legibility will have accomplish if the map maker has made sure that the intellectual aspects of the map are not open to doubt or misiuter partition clarity and legibility in the representation can obtained by the proper choice of lines , shapes ,color and by sharp, uniform colors , patterns , and shading must be easily distinguishable and properly registered , and the shape with other characteristics of the various symbols must not be confusing .*
- *Visual contrast: is the basic of seeing and assuming that each component of the map is large enough to be seen, the manner in which a mark differ from its back ground and the adjacent marks determines its visibility. Constant is achieved by modulating the visual variables (position, shapes, sizes, hue, value, patterns and direction).*
- *Balance: is the positioning of the various visual components in such a way that their relationship appears logical. In a well balanced design nothing is too light, or too dark, too long or too short or in the wrong place too close to the edge of the paper too small or too large.*

Positional data:

A point is a simply a non dimensional location. positional or point data meaning things that exist at individual place even some summary characteristic of considerable region , such as the average annual of state or country can be thought of as being representation by some central location within the boundary . The distinguishing character of the positional data is the conception of the existence at a single location; however abstract that conception may be classified as:

- *Pictorial symbols: these symbols uses for the representation of nominally scaled positional data. the pictorial symbols then err into ٢ important respects :*

١. *The symbols aren't easily distinguished one from another.*
٢. *Too many symbols of roughly equivalent size are uses, a legend isn't necessary to the pictorial symbols.*

- *Associative symbols: the symbols in this class employ a combination of geometric & pictorial characteristics to produce an easily identifiable symbol that's highly recommended for the maps that employ Associative symbols.*
- *Geometric symbols: the most common geometric symbols uses to show nominally scaled positional data are circles, triangles, squares, diamond & stars. The dimension of the shape obviously the most important factor. A legend is required on the map that employs geometric symbols.*

Symbols:

The map is symbol represent (matter) some thing. the coast of the sea or river drainage and swamps in addition to the roads and hills can't be represent on the map as in the in nature , but it can be represent on the map as a symbols refer to them. Only this representation is the deferent between the aerial photograph and maps; therefore the cartography most gives a big attention to the symbols & its effect in the representation of the phenomena. The shape of the symbols would be fixed with the time, especially in the maps characterized by its large scale (topographic maps); the stability of symbols shape as standard symbols is the most important things because the symbols are the language of the map. The preprinted symbols that are available to adhesive on map papers or sheet could help the fixing of the symbols shape. also the design of the symbols is very necessary to specially prepared scientific maps on the base of the object of maps likewise soil maps these map contain a table of special standard represent the topographic phenomena .

Types of the symbols:

The symbols may be divided in to ٢ types in respect to its representation of phenomena:

١. *Quantitative symbols.*
٢. *Qualitative symbols.*

Also it can be divided in to ٣ parts, these are:

١. *Point symbols.*
٢. *Area symbols.*
٣. *Linear symbols.*

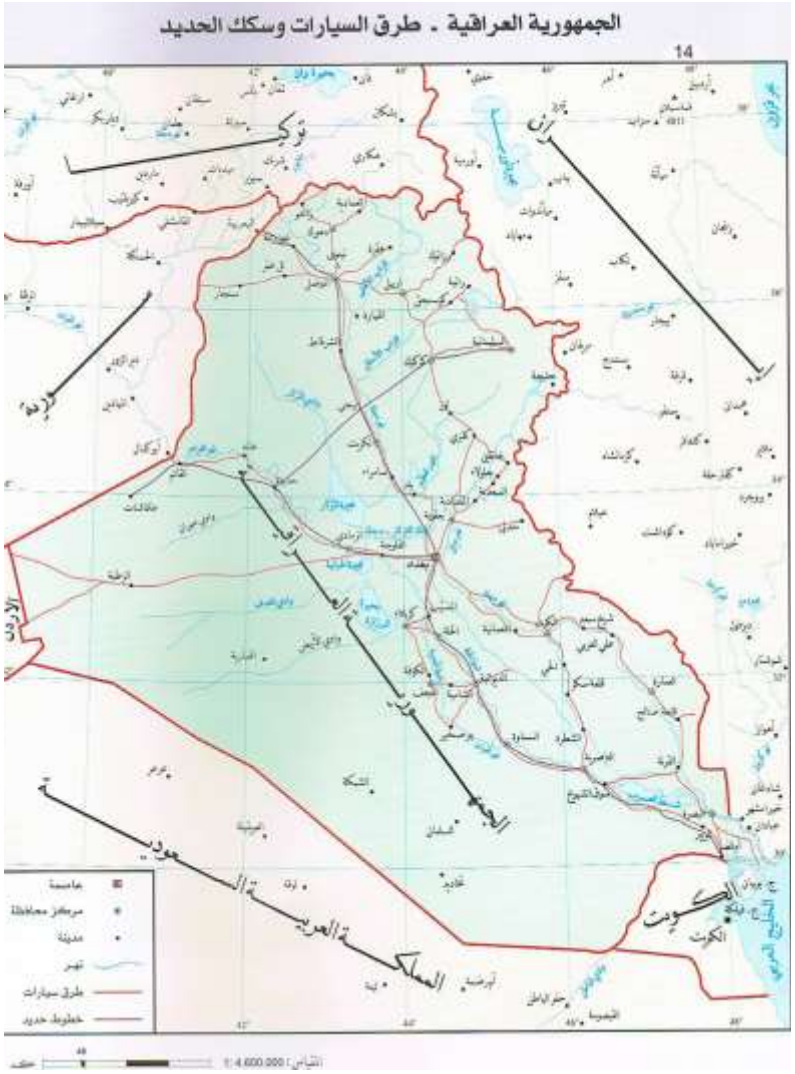
In addition to the symbols of the topographic maps which were divided in to ٤ classes these are:

١. *The symbols of the roads, railways and airports.*
٢. *The symbols of the water bodies.*
٣. *The symbols of the relief.*
٤. *The symbols of the planet.*

We can recognize ٤ basic categories of spatial phenomena (geographical phenomena), these are:

- *Positional data: a point is simply a non dimensional location, things that exist at individual place.*
- *Linear data: some kind of the geographical phenomena are linear the distinguished characteristic being the quality of ١ dimensionality. even though a phenomena many have significant width such as roads, river its coarse and the relative length are its dominant attributes that allow as to think of it simply a line .*

- *Areal data: conceptually areal data are ٢ dimensional, and focus of interest is the areal extent of the phenomena such as climatic data and soil character all fall in the class of areal data.*
- *Volumetric data: geographical volumetric things that have ٣ dimensional in concept likewise the population of city, volume of the precipitation that falls on area.*



The system that we can uses it to differentiate the variety in one category to the following scales:

١. *Nominal scales: these scales can be uses to classification the geographical phenomena qualitatively likewise differentiate among the centers of the governors.*
٢. *Ordinal scales: can be uses to classification the phenomena on the base of the absolute quantity likewise differentiate among towns, big or small towns or between the types of the climate temperature.*
٣. *Interval scales: this scale can uses to the standard units to refer to the quantitative difference among the geographical phenomena like using the square meter to the area….etc.*
٤. *Cross scales: also we can use the cross classification among these scales and the categories (٤ categories). The advantage from using this cross classification is to using the symbols and to differentiate among the various phenomena.*

The scale of the visual significance:

Consist of ٥ points these are:

١. *The big difference between the representation symbols and the real pictures of the phenomena can give more attraction to the map user.*
٢. *The relative complexity of the symbols can give more attraction to the map user.*
٣. *The relative big size of the symbols can give more attraction to the map user.*
٤. *The relative clarity of the symbols can give more attraction to the map user.*
٥. *The position of the symbols in relative to the other map content central part or any point on the map can give more attraction to the map user.*

Color in the cartography:

The advantages of the color on maps can be clear in a few points, these are :

١. *Allows great details.*
٢. *It adds visual interest.*
٣. *It increases the design potentialities.*
٤. *Add greatly to the possibilities for graphic.*
٥. *It is a great aid to the clarity.*

To increase the communication effective. The colors are relatively expensive, and its uses for special treatments in the map construction & reproduction. The cartographer has employed the color in creating an effective graphic communication on the base of aspects as sensitivity visual acuity and contrast.

Dimension of the color:

Color is a complex response to the variety of the physical stimulates our perceptual processing of them. The phenomena of the color may be sub divided into ٣ attributes these are:

١. *Hue : associated with wave length difference in the wave length when we identify something as red , yellow we are describe there hue : there found the infinite numbers of hues , because the wave lengths combined in various proportion . Found many type from color additive primary color (light) R, G, B subtractive primaries color (cyan, yellow, and magenta).*
The subtractive primaries are consisting of blue (cyan), yellow and red (magenta) and any color can be created by a suitable mixture of these pigments.
٢. *Value: all colors may be ranged in the terms of the brightness and darkness which called gray scale situation. In summary the value mean the sensation of brightness or darkness as rated on the gray scale , the gray scale consist of ١٠ degree from white color to the black , the first one have the degree of (٠) , while the end one have (٩) , and between them there are range of color represent the mixture of white & black colors .*
٣. *Intensity : chrome , purity color similar to value chrome , saturation and purity employed to describe this attribute which are refer to the any color to do with its richness some are brilliant in hue such as strong red , while the same red hue may be quite weak .*

The Color system:

There are ٢ systems these are:

- *CIE system: it's based on instrument and the mathematical analysis of the physical characteristic of light. This system allows the precise specification of any color in numerical terms.*

The advantages of CIE system:

١. *Any color may be precisely defined in physical terms.*
٢. *It must emphasize that it's based on the characteristic of the additives light.*
٣. *This system provides regular methods for analyzing and specifying color that is extremely useful in the production and research.*
٤. *It's also necessary for the cartographer to well requiring with the system based on the human rate.*

- *The Munsell color system :the system a named for its American painter originator A.H Munsell , identify a color in term of ٣ dimension these are :*
  ١. *Hue: equally spaced from one to another the sense of equal visual steps from the one hue to the next. there are ١٠ major hues which are consist of ١٠٠ hues that are arranged in a circle shape , each hue is perceptually related to the next , the ١٠ major hues consisting of ٥ principles & ٥ intermediates may be refer to their initials (R=Red , BG=Blue Green).*
  ٢. *The value scale: all color is ranked in relation to arrange of the chromatic grays from black to the lighter grays and then to the white, this is call the value scale which refer to the black (٠) value while white has a high value (١٠) value. The spacing on the munsell value scale is perceptual and isn't the same as a photographic gray scale.*
  ٣. *The chrome : these mean the dimension of the chrome in the munsell system , is the degree to which the hue is departs from the neutral gray of the same value its analogous to the descriptive term intensity and to the concept of the purity (saturation) in the CIE system.*

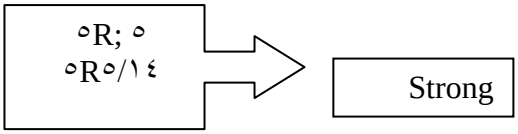
The advantages of munsell system:

١. *It's the basis for the standardized color system.*
٢. *It's widely used for many applications such as range from matching soil color, the color in the photogrammetric purposes survey work or in the color coding of the wires in electronics.*

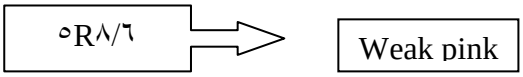
The munsell notation:

The relationship among the ٣ dimension of color in the munsell system can be visualized. In the munsell notation the designation of the particular is given symbolically by(Hv/c); in which H is the hue, v is the value scale and c is chrome.

Example ١:



Example ٢:



The difference point between the CIE system & munsell color system:

CIE SYSTEM	MUNSELL SYSTEM
It's based on the instrumentation and the mathematical analysis of the physical characteristic of the light .	***It's based on the human perceptual reaction to the light and its color.***
The white has a low value as its arranged on the gray scale while the black has a high value.	***The white has a high value while the black has low value on the value scale of the munsell scale dimension.***

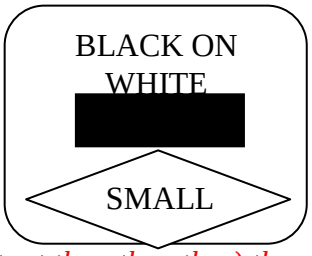
The generally accepted broad conventional uses of hue:

١. *Blue: such as water, positive numerical values.*
٢. *Green: such as vegetation, low land.*
٣. *Brown: such as land form (mountains, hills and contour lines).*
٤. *Yellow : such as (dryness , pan city of vegetation and intermediate elevation)*
٥. *Red: such as worm import items (road and cities) negative numerical value.*

Note ١:

The employment of the value on the maps, which occurs especially black on white background, will appear slightly smaller than the reverse case.

Note ٢:



Also if there is no ranking involved (no area are important than the other) the color must be selected that carry no magnitude implication, while the darker & more intents color inherently carry a magnitude implication.

The principles of color separation:

The basic of the color separation is the uses of the colored filter; a filter transmits light of its color and absorbs the light rays of most other colors. for ex. if white light strikes a prism used a blue filter the blue wave length are allowed to pass through to expose the film and the other wave length are blocked . The resulting negative is must dense in blue areas and least dense in the green & red (yellow light) areas. The positive printing plate made from this negative will print most ink in green and red areas and then it's inked with yellow. If green filter transmit green light and blocks blue and red areas magenta ink is used. Finally red filter pass red light and absorbs green and blue (cyan light).

The employment of pattern in cartography:

Pattern : it's the term that are uses to describe the perceptual impression provided by any visible more or less systematic repetition of marks that covers any area on graphic display .

Kinds or types or classes of the pattern:

In cartography we are concerned with the pattern as graphic symbols. It's one of the visual variables there are several kinds or classes of pattern:

١. *Dot pattern: it's composed from dots arranged either in rectangular or triangular array; the irregular arranged is call "stippling".*
٢. *Line pattern: it's composed from straight parallel lines, the lines may be of any width and space, if ٢ sets are crossed its call "cross hatching".*
٣. *Miscellaneous pattern: ranging from grass symbols that commonly to show swamps or other marks.*

The four basic attributes of pattern:

١. *Texture: the spacing of marks.*
٢. *Arrangement: the relation of the position of marks.*
٣. *Orientation.*
٤. *Value.*

Note ١: For single color map we use either dot or line pattern types.
Note ٢: if we use a line pattern the space between ٢ lines must be equal to ٢ times of the width of ١ line.

The ink types selection:

The selection of the ink types depend on the following points:

١. *Base material: uses in drawing and drafting.*
٢. *Climate: humidity and temperature condition.*
٣. *Drawer taste.*

The method of lettering:

١. *Free hand lettering: its need a best knowledge of the hand lettering principles and its design.*
٢. *Stick up lettering : this type is very old type of the lettering methods and its used duo to the large numbers and types of produced maps , in addition least number from available drawers and good writers , the stick up lettering may be positive or negative picture that can be adhere on the map sheet .*
٣. *Lettering templates: in this method we use in addition to the templates inking pen. the " Leroy " tool may be uses to write the letters , this tool consist of template that have gravers letters capital and lower case (small) letters can be obtained by templates and inking pen . The types of the letters that can be obtained by Leroy are "gothic "without serif.*
٤. *Photo setting : this method can be divided into ٢ mechanism these are :*
   - *Taking the image of name of the map detail by camera and cutting it (after developing) and adhere the letters and words in a suitable place on the map sheet or polyester sheet.*
   - *Preparing film (equal to the map dimension) content all map details from name, numbers in a given place on the map for each one .this film develop with original copy of the map on printing plate. the photo setting method can be obtain by the following tools these are :*

- *Typonoto .*
- *Kartolux .*
- *Letter photo.*
- *Concord.*

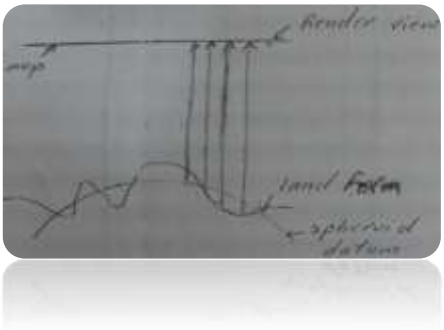
The positioning of letters:

The positioning of the letters on the map sheet very important because it's affected on the power of map design. The basic law of letters positioning can be clear with the following examples:

١. *The letter must be parallel to the parallel line of the grid system of map.*
٢. *The letter of ocean and mountain names must be suitable distance to cover the phenomena in a straight line or curve form.*
٣. *The letters of rivers name must be separated as a single letter with direction of the water flow.*
٤. *The name of the colored phenomena as lake must be inside of the form of the phenomena.*

Contour lines form:

Representation of the land form by mean of contours is the most common surable system yet devised contours are the trace obtained by passing parallel planes through the ٣ dimensional land surface and projection these trace orthogonal to the plane of map ; therefore contour is an isarithm of equal elevation above some sea level or other assumed horizontal surface of zero elevation called the datum plane , this surface is essentially that which would be assumed by world winded ocean that wasn't modified by localized variations in gravity . Contours on a topographic map are remarkable expressive symbols if they have been correctly located and the interval between them is relative small. The most obvious expression is that of elevation but the spacing and the orientation of contour lines provide some visual clues to form.

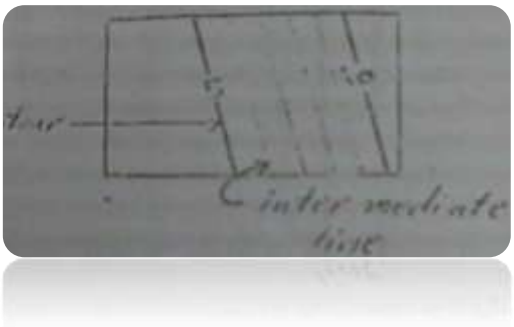


The characteristics of contour lines:

١. *The plane that consists of contour lines always parallel and it is perpendicular on the earth axis.*
٢. *All contour lines are close only at the map boundaries they are open.*
٣. *The contour lines converge at steepness valley or cliff and inverse.*
٤. *All contour lines make inverse "V "shape along the river (water) flow on the steepness valley.*
٥. *The contour lines that represent a small or secondary hill may be generalized.*

Types of contour lines:

١. *Index contour line: this type of contour line represents the fourth or fifth one from the contours which is characterized by its width in comparable with other contour lines in the same map.*



Note: In small scale map the fifth one from the contour lines represent the index type from contour line.

٢. *Intermediate contour line : these line of contour line represented by the lines between the index contour lines and characterized by its thin width where its comparable with index one .*
٣. *Supplementary contour lines: these lines of contour represented by dash lines or cloted lines, the separation distance among these lines equal to (٠,٥ or ٠,٢٥ and ٠,٢٠) of the basic interval.*
٤. *Carren contour lines : these type of contour lines refer to that case of contour lines where its represented cliff (when the separation distance between the contour lines is very small)*

Contour interval:

The choice of contour interval is very important things and it's depending on the following points:

١. *The object of the map.*
٢. *The accuracy that we need it.*
٣. *The data conformable.*
٤. *The map scale.*
٥. *The cost of map reproduction.*
٦. *The nature of relief.*

The accuracy in contour interval:

١. *In area characterized by high relief the contour interval are ranged among (١٥- ٣٠- ٦٠) meter.*
٢. *In area characterized by medium relief the best interval ranged among (٢- ٥- ١٠) m.*
٣. *In area characterized by flat relief the interval is ١ meter or small than ١ m.*
٤. *In map which design to agricultural object the interval ranged between (٢٥– ٥٠) cm.*

Note : the accuracy of contour line in the international coed specially in USA system are not more than (١٠ %) from the tested ground points (BM) , with in error number more than half of contour interval .

The understood of contour interval:

There are ٢ types of contour interval we convened with these are:

١. *The Imholf understood :*

The understood is to the minimum contour interval as a function of scale ١/٥ and the maximum inclination of slope (a) and the greats possible number of lines which be distinguished per unit of horizontal distance on the map (k)

$$I = \frac{S}{١٠٠٠ \times K} \tan a$$

Example : given the number of lines which may be distinguished per unit on map if the scale of map that we need to prepare it is ١:٢٥٠٠٠ and the slope is equal to ٥° in the horizontal distance about ٢ m ?

Sol:

$$I = \frac{٢٥٠٠٠}{١٠٠٠ \times ٢} \times tan\,٥^{\circ} = ١.٠٩$$

The Imholf table:

a°	K (m)	a°	K (m)
٥	١	٣٠	٧
١٠	٢	٣٥	٩
١٥	٣	٤٠	١١
٢٠	٥	٤٥	١٣
٢٥	٦	٥٠	١٥

Note: the distance is increase with increase the slope.

٢. *The understood of Robinson :*

The equation of Robinson is set below:

$$D = \frac{١٢\ h\ cos\,\theta}{S} \rightarrow h = \frac{D \times S}{١٢\ cos\,\theta}$$

Where:
D = the distance in cm between parallel line on the map.
h= contour interval.
S = denominator of scale.
θ = the angle of planes from horizontal.
Note: for flat terrain the θ = ٩٠°

The color:

The representation of different height in the small scale map cannot be by the contour lines where are generalizing this generalization make from this map useless certificate; therefore it is substitute by colors to represent the height value like the following table:

Elevation in (m)	Representative colors
< ٠	Olive green
١٥٠ _ ٠	green
٣٠٠ _ ١٥٠	Yellowish green
٦٠٠ _ ٣٠٠	yellow
٩٠٠ _ ٦٠٠	orange
١٥٠٠ _ ٩٠٠	Light brown
٢٤٠٠ _ ١٥٠٠	brown
٣٦٠٠ _ ٢٤٠٠	Reddish brown
٤٨٠٠ _ ٣٦٠٠	red
> ٤٨٠٠	white

Note: This method of land form representation is uses with "atlas map of world "and it primitive used in the Austria.

٣. Hachure line (hachuring) :

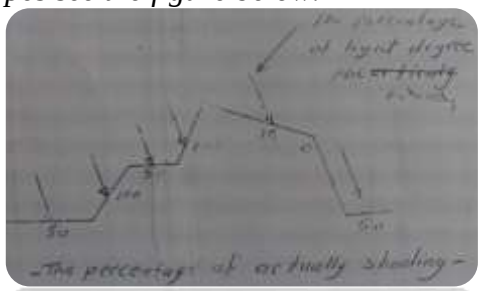
This method is used because it is not complex like contour line; it is used with large topographic map. in this method we use short parallel line it will be thin with big separated distance when it is represent the mild steepness , while it will be narrow and thick in representing the high steepness angle the distance be narrow and the lines are very thick . The disadvantages of this method is that we cannot determine the height value; therefore it is least important than contour line. The using of this method was very rare after using the half tone method in map production.

٤. Height points :

The height points represented on the map as triangle symbols with referring to its value in meter this points are distributed on the top of the mountain , hills and along the roads . The triangles points represent the bench mark in the topographic survey, this triangle points may clear together with contour lines on topographic maps.

٥. Plastic shading :

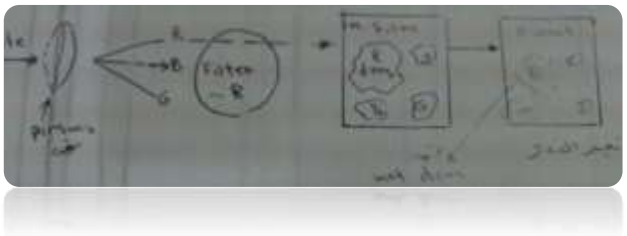
The base of this method is the lighting of ٣ dimension body that lead to different degree from light and darkness of its different slopes see the figure below.



Direction of light source give an important different in lightness degree. The direction of light can give maximum degree from lightness in case of horizontal surface, while the minimum degree from lightness can be obtained in case of vertical surface. The inclined lightness can give another case from lightness it's important to refer that the light source must be from "north west "

٦. Relief map :

After printing the topographic map on polyester sheet , the sheet can be put it on a punctuated negative gyps model to represent the relief we exposure the sheet to heat of electric light with sucking the air we obtain a model represent the relief in ٣ dimension .



(GOOD LUCK)