Map Design and Cartographic Techniques

1.1 What is a Good Map?

Map design is not concerned with the detail in a map; that part is supposed to be handled by the other data collection processes. Map design intends to use this detail to create maps that look beautiful.

If cartography is a form of communication, the measure of a good map is how well it conveys information to its readers to enlighten, convince, or persuade. Too often the pure aesthetic appeal of a map is equated with its communicational value. Aesthetic issues certainly play a role in effective cartography, but it is the issue of communication that holds the central role in cartographic design. To ask "what is a good map?" is to ask how well it communicates with its audience. You create a story for the map to tell. Then build the map to tell the story.

For example, the Revolutionary War French Naval Blockade of Yorktown map below tells the story of the defeat of Cornwallis. It makes its point clear from the title and the ornamentation/embellishment.

1.2 Map Design Processes

a) classification (grouping similar features) to reduce complexity and organise information

b) simplification

c) symbolization

These will be explained in the sections to follow

1.3 Map Design Considerations

A. Choose a map projection

For world or regional maps, select a projection that is appropriate and supports the map's purpose.

B. Color and tone

Well chosen color and tone can really enhance the map and draw attention. Consider contrasts in color and tone to differentiate different features such as land versus water or mountains versus plains. Considering the Revolutionary War French Naval Blockade of Yorktown Map presented under what is a good map - notice how even in a nearly monochrome palette color enhances the design. One color for the ocean, another for land. And red to emphasize cities.

C. Use an appropriate font for lettering

Consider style, size, and weight of the font to match the map design. A formal map imitating an antique would use an old-style serif font. A cartoon map would use a hand-written font. A map emulating contemporary design would use a sans-serif font. Again, the Revolutionary War French Naval Blockade of Yorktown map
demonstrates how font size and weight can emphasize the main areas and lesser weights demark less important areas still necessary for a complete geographical picture of the subject.

D. Use texture to enhance color and feel

Texture enhances color to give it life. Pure color in large doses is just to bland to hold interest. Patterns of darker colors, especially random patterns, make the color alive. Living color in turn gives life to the geographical feature. Patterned texture can make bodies of water shimmer.

E. Shape of the map and features on the map matter

Notice how Pinchon's Map of North Africa below uses both the shape of the land and the shape of the border.

The shape of north Africa is rounded at the top and is repeated in the shape of the border. The interest of the map is north Africa, so the bottom border effectively creates a magnifying lense that focuses on the point of the map. Shape is used to keep a sharp focus on north Africa.

F. Establish basic information with title or cartouche

The important thing is to tell the reader what the story is. Consider it the map's introduction. It may also be decorated to the point of being the main decoration on the map.

G. Indicate direction with a north arrow, compass rose, or border labels

Maps show spatial relationships. A north arrow, compass rose, or some other way of showing direction makes a map instantly identifiable. When embellished it can create a beautiful decoration.

H. Provide well understood symbols for natural features

Natural feature symbols give a feeling for the land. Is it mountainous? Are there rivers? Forests? Including natural features differentiates desert from forest and mountains from plains.

I. Create informative symbols for man-made features

Man-made features give a point of access for people. Cities, roads, railways, and boundaries are part of the human experience. Including these features tell the reader where people live, how they can travel, and how they define their region.

J. Add additional views or information with insets

Including bird's-eye city views, pictures of architectural features, and other additional information enables the map artist to provide cultural context to the land. Sure, there are cities marked on the map. But what are they like? What do the buildings look like. Insets can answer these questions with specifics.

K. Include a touch of whimsy with figures, animals, monsters, ships, architectural features, winds, or heraldic devices

Added with taste, these can add enormously to a map's enjoyment. They can also be used to de-mark interesting historic events, points of interest, or any other information important to the purpose of the map.

L. Orientation
Although maps oriented with north at the top are by far the most common, consider the shape of the area you are mapping in your design choice. Sometimes a different orientation can make a map design both unique and striking.

1.4 Issues to Consider at beginning of map Design

This means that one always begins a project by considering the message to be conveyed and the audience to be addressed. This raises a series of questions that must be addresses at the start of a project:

a) What is the motive, intent, or goal of the map?
In effect, the question asks what the reader should gain from the map or how the reader should respond. Motives vary greatly. Many maps are intended solely to convey accurate information about spatial relationships, others to sway public debate. Obviously, the motive will have a great bearing on the content of the map (the information included) and its form (the cartographic strategies employed).

b) Who will read the map?
A cartographer must be able to identify the type of reader being addressed for two principal reasons. First, it is important to have an idea about what the audience is likely to know about the subject matter of the map. Second, it is useful to know how much background the readers have in using maps. A map intended for specialists who have a background in cartography might be organized far differently than one intended for use as a prop in a public debate.

c) Where will the map be used?
An audience is always addressed within a particular context or frame of reference which has a bearing on map design. Maps may be published alone, or in newspapers, magazines, journals, books, or atlases. They may appear in reports, term papers, theses, and dissertations. They may be used in lectures, briefings, presentations, speeches, and announcements. Some maps are used only once and then discarded. Others are intended to be used for reference for decades or centuries. For these reasons, context can influence both the form and content of a map in ways both great and small.

d) What data is available for the composition of the map?
Decisions about map design are tempered greatly by source materials themselves, by what is available and how easily it can be communicated. Sometimes our source materials have limitations or are incomplete. They may present special problems of presentation because of technical terminology or because of the quantities of detail required to make a point. Some data needs to be qualified. These limitations must be considered from the very start of a project so that they can be addressed in the design of the map.

e) What resources are available in terms of both time and equipment?
Finally, one must consider the twin questions of how much time to invest in a project and what systems to use, whether manual or automated and, if automated, what type of software. Both questions are, of course, best addressed with experience. However, it is important to realize that production time drops dramatically with practice. Sometimes scholars avoid using maps because of the time expense involved in their production. Yet once a person has a learned a few basics, this expense is greatly reduced. Computer systems have also made it much easier to produce maps, but, again, practice is required. Situations remain where manual or semi-manual production remains time effective. One must also remain aware of the strengths and weaknesses of various automated systems and that, in practice, a variety of software systems may be used together to achieve the desired results.
1.5 Prerequisites of Map Design

In order to produce a good map design, there are certain imperative concepts with which one needs to be familiar. Let's look at the quickly.

1.5.1 Types of maps

This has already been explained, but for the sake of completeness, here's the essence. Broadly, there are two types of maps: topographic/reference maps and thematic maps. Reference maps are those that give information about a place, or show the details in some way. For example, a road map, a political map, etc., are examples of reference maps. On the other hand, thematic maps are used to show the pattern or distribution of something on a map. For instance, world GDP map, climate map, literacy map, etc., are all thematic maps. Of course there is no limit to the type of thematic maps you can create. You can have maps on number of neighbor fights around the world, if you so wish!

1.5.2 Scale

You already know what a map scale is. But its implications are important for the map designer. Consider the simple fact that there is only limited area to print the map, and so one is confronted with the choice of scale. You can include more of a map if you keep the scale large, but then you lose much detail. Which of the information on the map is most useful? Which parts of the map are the most useful? How large is the finished map going to be? Will it be able to focus properly on its goal?

This may sound something trivial, but the scale is actually the most important factor. Choosing a wrong scale will ruin the whole map, no matter how good the printing quality and other processes happen to be.

Understanding Map Scale

Some people have trouble understanding map scale. They think that a map that is drawn on a small scale should naturally have more detail. But if they compare two maps with different scales, it leads to confusion.

The thing to be understood here is the nature of the scaling factor. Scale is nothing more than the zoom-in factor. A smaller scale would mean that we are not zoomed-in that much, and hence we can represent a larger portion of the land on the same area. A larger scale, however, means that we are zoomed in a lot more, which means that only a smaller portion of the land would get drawn on the map. On the plus side, this allows us to plot much more detail in the given area.

Finally, the scale should not be directly understood from the numerical value given in the map. A scale factor of, let's say, 1:300,000 is small scale, and not large scale. This is where the confusion comes in, and should be avoided at all costs.

Selecting a Map Scale

While the map designer is generally free to pick any scale he chooses, the scale of the map must correspond to that of the data available. This is not to say that you can't create the map on a different scale. You can, but there will be side-effects: 1) You will lose a good amount of detail on the map; and 2) The map will look weird. The latter part is a natural consequence of not having enough data to plot the terrain.

1.5.3 Map Projections

A map designer must be aware of the final utility of the map, and needs to select a relevant projection. While the UTM and Miller projections are the most famous one, we already know that it introduces severe distortion near the poles. Which means that a map designer must be aware of these issues and choose wisely.
1.6 Principles of graphical excellence

a) show the data

b) induce the reader to think about the substance rather than the methodology, graphic design, gee-whiz technology

c) avoid distorting what the data have to say

d) present many numbers in a small space

e) make large datasets coherent

f) encourage the eye to compare different pieces of data

g) reveal the data at several levels of detail, from broad overview to the fine structure

h) serve a reasonably clear purpose: description, exploration, tabulation or decoration

i) be closely integrated with the statistical and verbal descriptions of a dataset

1.7 Map Design as Communication

Almost all maps include a "frame" design (titles, color bars, etc.) as well as an actual geographic picture - some may also include narrative text, charts, graphs, etc. Use these communication principles to give your "map products" careful design so that they achieve your overall intent.

A. Begin by defining your purpose and your audience: All maps are selective - they show what their maker intends. Have a clear objective and message in mind when you go to produce your map. Even if it is very technical, work out what you want the viewer to remember most. Then ask, who will see this map product and under what circumstances? Will it mainly be used in a small working group, handed out as a flyer at public meetings, or used as a backdrop for a press conference? Is the audience technically knowledgeable? Be specific about the type and number of people who most matter to your project. Common pitfalls: assuming that your map just shows "data" rather than having a message; or, developing a map for your own taste, rather than understanding what your audience needs.

B. Make your map a story: Design a map product that takes the reader on a journey. Unfold your messages in layers, not all at once. As the viewer looks more closely, additional information beyond your primary message should emerge. Don’t force the viewer to read this information when they first see the map. Look at newspaper front pages for examples of how to combine graphic elements in an overall story. Common pitfall: use all the same size and color fonts for title and map labels.

C. Keep it simple: A map should have one primary message that is instantly clear to most people who see it – show your map to someone who has never seen it and ask them to tell you what it says five seconds after they look at it. Remove all information from the map that is not essential. Common pitfall: drawing attention first to a utility element such as a large or centrally placed scale bar or north arrow, or an overlarge legend; or, hiding the title in small fonts.

D. Direct the viewer’s eye: The frame of your map (title, graphics, legend, etc.) should integrate with your map to draw the viewer’s eye to your messages in order of importance. Again, have someone look at it from the map’s intended viewing distance and tell you what draws their eye in the first few seconds, then when they
look a bit longer, etc. Use your strongest colors for the most important features. *Common pitfall:* making lakes and other background water features a very rich and dark royal blue, which will dominate the viewer’s perception.

**E. Design for a viewing distance:** Every map has an optimal viewing distance. For a page map, it may be only a foot or two; for a large poster it could be 10 feet or more. Place your map at its intended viewing distance and assess its impact. *Common pitfall:* reviewing a poster map only from a foot or two viewing distance, which prevents seeing larger patterns in the full map.

Use these communication principles to judge the effectiveness of your map – and compare others’ maps to see what works and doesn’t.

### 1.8 Principles of Map Design

We all know that there are good maps and bad maps, the problem is defining which is which. The reason for this is that whenever we discuss the principles of map design, we have to admit that we don’t know what they are. The following principles are different from rules such as those for placement of type. Whilst contributing to the design process, rules are not principles."

It is vital to note the following statements

a) The purpose of design is to focus the attention of the user

b) The Principles of Cartographic Design are Timeless, the Results are not

c) The Rules of Cartographic Design can be taught and learnt, principles and concepts have to be acquired

The five principles of map design are

1. **Concept before Compilation**
   - Without a grasp of concept, the whole of the design process is negated. The parts embarrass the whole. Once concept is understood, no design or content feature will be included which does not fit it. Design the whole before the part. Design comes in two stages, concept and parameters, and detail in execution. Design once, devise, design again. User first, user last. What does the user want from this map? What can the user get from this map? Is that what they want? If a map were a building, it shouldn't fall over.

2. **Hierarchy with Harmony**
   - Important things must look important, and the most important thing should look the most important. "They also serve who only stand and wait." Lesser things have their place and should serve to complement the important. From the whole to the part, and all the parts, contributing to the whole. Associated items must have associated treatment. Harmony is to do with the whole map being happy with itself. Successful harmony leads to repose. Perfect harmony of elements leads to a neutral bloom. Harmony is subliminal.

3. **Simplicity from Sacrifice**
   - Great design tends towards simplicity (Bertin). Its not what you put in that makes a great map but what you take out. The map design stage is complete when you can take nothing else out. Running the film of an explosion backwards, all possibilities rush to one point. They become the right point. This is the designer's skill. Content may determine scale or scale may determine content, and each determines the level of generalization (sacrifice).
4. **Maximum Information at Minimum Cost (after Ziff)**
How much information can be gained from this map, at a glance. Functionality not utility. Design makes utility functional. All designs are a compromise, just as a new born baby is a compromise between its father and mother. The spark which makes a map special often only comes when the map is complete.

5. **Engage the Emotion to Engage the Understanding**
Design with emotion to engage the emotion. Only by feeling what the user feels can we see what the user sees. Good designers use Cartographic fictions, Cartographic impressions, Cartographic illusions to make a map. All of these have emotive contents. The image is the message. Good design is a result of the tension between the environment (the facts) and the designer. Only when the reader engages the emotion, the desire, will they be receptive to the map's message. Design uses aesthetics but the principles of aesthetics are not those of design. We are not just prettying maps up. The philosophy is simple, beauty (aesthetics) focuses the attention. Focusing the attention is the purpose of map design!

1.9 **Map Design Ethnics**

C-R-A-P is the achronym used by Robin Williams in The Non-Designer's Design and Type Books, Deluxe Edition. The letters stand for **Contrast**, **Repetition**, **Alignment**, and **Proximity**.

1.9.1 **Contrast**
The point is to avoid **similarity**. This means making **clear distinctions** of features for...

- **Colors** including tone and saturation.
- **Symbols** and what they represent.
- **Lettering** including font style, weight, color, and size.

Similarity leads to confusion. The reader wonders if lettering that varies only by 2 points is a mistake or a meaningful difference. Likewise, colors that are too similar leaves the reader confused.

Contrast can also be used to draw attention to a certain map area. For example, a straight line or square box on a map of curved lines and polygons instantly grabs the reader's attention because it is different.

1.9.2 **Repetition**
Repeating themes, colors, shapes, textures, lettering, or other map objects gives the map an overall feeling of completeness and professionalism. It makes the map whole. It also joins objects or areas of similar attributes together, even if separated by large map distances.

1.9.3 **Alignment**
Visual connections between map elements are reinforced by aligning edges. Alignment also provides visual organization that is pleasing to readers.

1.9.4 **Proximity**
Related items should be placed together to create grouped elements. This logical grouping helps organize map objects and provides structure to the map.
1.10 Design Principles for Cartography

Cartographers apply many design principles when compiling their maps and constructing page layouts. Five of the main design principles are legibility, visual contrast, figure-ground, hierarchical organization, and balance. Together these form a system for seeing and understanding the relative importance of the content in the map and on the page. Without these, map-based communication will fail. Together visual contrast and legibility provide the basis for seeing the contents on the map. Figure-ground, hierarchical organization and balance lead the map reader through the contents to determine the importance of things and ultimately find patterns. It’s worth noting that these principles are not applied in isolation but instead are complementary to each other. Collectively they help cartographers create maps that successfully communicate geographic/spatial information.

1.10.1 Visual Contrast

Visual contrast which relates to how map features and page elements contrast with each other and their background. To understand this principle at work, consider your inability to see well in a dark environment. Your eyes are not receiving much reflected light so there is little visual contrast between features and you cannot easily distinguish objects from one another or from their surroundings. Add more light and you are now able to contrast features from the background. This concept of visual contrast also applies in cartography. A well-designed map with a high degree of visual contrast can result in a crisp, clean, sharp-looking map. The higher the contrast between features, the more something will stand out, usually the feature that is darker or brighter. Conversely, a map that has low visual contrast can be used to promote a more subtle impression. Features that have less contrast will appear to belong together.

1.10.2 Legibility

Legibility is “the ability to be seen and understood”. Many people work to make their map contents and page elements easily seen, but it is also important that they can be understood. Legibility depends on good decision-making for selecting symbols that are familiar and choosing appropriate sizes so that the results are effortlessly seen and easily understood. Geometric symbols are easier to read at smaller sizes; more complex symbols require larger amounts of space to be legible.

Visual contrast and legibility are the basis for seeing. In addition to being able to distinguish features from one another and the background, the features need to be large enough to be seen and to be understood in order for your mind to decipher what you eyes are detecting. Visual contrast and legibility can also be used to promote the other design principles: figure-ground, hierarchical organization, and balance.

1.10.3 Figure-ground

Figure-ground organization is the spontaneous separation of the figure in the foreground from an “amorphous” background. Cartographers use this design principle to help their map readers find the area of the map or page to focus on. There are many to promote figure-ground organization, such as adding detail to the map or using a white wash, a drop shadow, or feathering.

1.10.4 Hierarchical Organization
Hierarchical organization on reference maps (those that show the location of a variety of physical and cultural features, such as terrain, roads, boundaries, and settlements) works differently than on thematic maps (maps that concentrate on the distribution of a single attribute or the relationship among several attributes). For reference maps, many of the features should be no more important than one another and so, visually, they should lie on essentially the same visual plane. In reference maps, hierarchy is usually more subtle and the map reader brings elements to the forefront by focusing attention on them. For thematic maps, the theme is more important than the base that provides geographic context.

1.10.5 Balance

Balance involves the organization of the map and other elements on the page. A well-balanced map page results in an impression of equilibrium and harmony. We can also use balance in different ways to promote “edginess” or “tension” or create an impression that is more “organic”. Balance results from two primary factors, visual weight and visual direction. If you imagine that the center of your map page is balancing on a fulcrum, the factors that will “tip” the map in a particular direction include the relative location, shape, size, and subject matter of elements on the page.

Together these five design principles have a significant impact on your map. How they are used will either draw the attention of your map readers or potentially repel them. Giving careful thought to the design of your maps using these principles will help you to assure that your maps are ones people will want to look at!

1.11 Rules of Cartographic Representation

It is obvious that the content of the map has to be adapted according to the target audience and the purpose of the map!

Map Size

Suppose you want to create a topographic map of Uganda and you want to show the whole country on A1 paper. It is obvious that there will be too many elements in the map. You would not be able to read the text elements that are contained by the map.

There is need optimize the map so that it contain less information than the original or topographic map. Some adaptations have to be made to the original map. Otherwise the map's content will be illegible.

Simplification and Generalization

To make the map usage, need to simplify and generalize how certain features are present for example instead of using symbols to show all the details on the ground, you can pick the dominant features and it is those that are included on the map. Also
Distances between map elements and minimum sizes should be chosen so that features can be differentiated. The information density should be adapted according to the enlargement of the symbolization. the geometry of map elements must be generalized for legibility. the point density of lines must be reduced as well as text labels have to be adapted.

**Minimum Dimensions**

Unnecessary dimensions on a map should not be included as the compete with the map details. Also focus on line widths, minimum sizes for point symbols and minimum distances between graphical elements.

**Fonts**

A font must be easily legible and should also be optically pleasing. A font for maps should respect the following criteria:

- Legibility at small sizes. A font should still look crisp when displayed
- Simple and open forms. Simply formed characters with wide openings are more legible
- Little space requirements. A good font for any map should take only little space, in order to minimize conflicts with other map elements.

**Colors**

Use colors that give hierarchical organization.

**Scale**

Better to use a scale bar or a Cartesian grid instead of a ratio as it changes as the map varies.

**Use lower case**

Words set in capital letters are less legible than in lower case when reading text. The difference is usually attributed to the distinctive shape of lower case words, but lower case setting also emphasizes capital letters at the start of sentences and for proper names.

**1.12 Cartographic Design Elements**

**Cartographic design** is the visual representation of geographic and spatial information on a map. The purpose of Cartographic Design is to create a map that is visually appealing and effectively communicates pertinent information to the audience. Cartographic design consists of planning and layout. During preliminary designing phases, the cartographer determines the elements that will enhance the map's. As a mapmaker begin composition of maps, the basic elements need to be worked on, such as the subject area, the title, the legend, the scale indicator, color schemes, the north arrow, labeling/supplementary text, frame/border, and insets. A map does not always contain all of these elements. Cartographic design is subjective to the cartographer's idea of a "good" map.

“We all know that there are good maps and bad maps, the problem is defining which is which. The reason for this is that whenever we discuss the principles of map design, we have to admit that we don't know what they are.” Despite cartographic design's inherent subjectivity, there are at least 6 definable elements that separate a good map from a bad map:

- **clarity** (eliminating unimportant elements),
1.12.1 Legend

A **Legend** (also referred to as a map key) is a small box used to explain unclear symbology on the map. They do this by describing each symbol (point, line, or polygon) exactly the way it appears on the map (size, orientation, color, etc.). Because map symbols’ meanings vary from region to region, a clear and concise legend is critical for conveying the distinctive characteristics of the map. Not all symbols should be included in the legend; Symbols that are intuitive do not need to be defined in the legend. Any symbols that are not central to the map's theme can also be omitted from the legend.

When designing a legend for a map it should be approached the same way that you would approach designing a map or any other kind of graphical representation. The legend is a graphical representation of information. The only difference is that it is related to the information on the map it is connected to. Therefore it is important to remember the layout design concepts such as harmony, visual balance, clarity, visual logic, logical groupings, and unambiguous references to create a legend that is effective in relationship to the map. Creating a well laid out legend will only enhance the overall Gestalt of the maps visual appearance. Often times a well designed map can appear bad because of a poorly designed legend. It is important for map makers to keep an open and creative mind when designing the legend, and to make sure that it connects well to the map.

The appearance of a legend should be simple. A subtle border and definition next to each symbol in the legend make it useful and aesthetically pleasing. The symbols inside the legend should be identical to the corresponding symbols on the map in size, shape, color, etc. The position of a legend depends largely on the open space available in the map. It should be centered in an area of open space. It should be large enough to be easily legible but small enough to keep from drawing too much attention away from the map.

1.12.2 Representing Scale

There are three common ways to represent scale on a map: Scale Bar, Representative Fraction, and Verbal Scale. Maps are smaller than the part of the earth's surface they depict. Cartographic scale expresses this relationship, traditionally in one of three ways. A verbal scale statement expresses the amount of distance on the map that represents a particular distance on the earth's surface in words, e.g., 'one inch equals a...
mile.' The representative fraction (RF) expresses scale as a numerical ratio of map distance to earth distance, e.g., '1:63,360.' The RF has the advantage of being a unitless measure. Finally, a graphic scale bar uses a line of particular length drawn on the map and annotated to show how much earth distance it represents. A graphic scale bar has the advantage that it changes size appropriately when the map is enlarged or reduced. Alternatively, all three expressions of scale may refer to areal measurements rather than linear measurement.

A scale bar, also called a bar scale, linear scale, graphic scale, or graphical scale, is a means of visually showing the scale of a map, nautical chart, engineering drawing, or architectural drawing.

Representative fraction (often times referred to as RF) is a simple ratio that represents the scale on a map, usually written in this way 1:24000. A scale of this amount would mean that one unit on the printed map would equal 24,000 of the same units in the real world. A disadvantage of this type of representation is that it can be difficult to visualize.

A Verbal Scale or a Word Scale is when the scale is written out in a sentence or an equation, such as "1 inch = 16 miles", or "1 inch represents 16 miles". When using a verbal scale, numbers are often rounded to get a more desirable result.

1.12.3 Inset

An inset map is a smaller map featured on the same page as the main map. Traditionally, inset maps are shown at a larger scale (smaller area) than the main map. In this, they differ from locator maps, which show the primary map at a smaller scale (larger area) in the context of a region. Inset maps are used by cartographers to highlight information that would be difficult to perceive at the scale of the main map. This highlighted information may include symbols or points of interest that add to the purpose of the map and address its audience. This technique should be done for a highlighted area of significance, as the viewer will attach greater importance to the inset map. An effective inset map follows the same design principles as any map, even though it is featured in a smaller frame. The inset should be placed away from the visual center of the map but in a balanced location where the viewer will be able to clearly see it and recognize it is not an extension of the main map (this may be done with a border or text distinction). A good inset should include use similar colors and text as the main map, and should include a legend and scale bar unless the cartographer makes these two clear in some other way.

Reasons for including an inset map within the main map can be to clarify a certain subject within the map, enlarge or focus on a small area of the map, or to provide a reference for an area presumed to be unfamiliar to the reader. Another reason for using inset maps is to show irregular shapes that don't easily fit into a given format. Inset maps are a great asset to cartographic design, but if overused will create a choppy, cluttered appearance and the design will not appear unified.

1.12.4 Balance

Balance within cartography creates an overall stability. Applying correct balancing technique can greatly enhance the clarity of the map. An essential part of correctly balancing a map is knowing how different map features are weighted. A weight is applied based on how quickly an element draws the readers attention. Heavier elements tend be dark, brightly colored, and larger. Lighter map features are generally dull colors, small, and lighter. When balance is poor, map readers might be distracted. When balance is achieved, map readers will focus on the content of the map. Visual balance results from two major factors: weight and direction.
1.12.5 Negative Space

Negative space is the space around and between the subject of an image. Negative space may be most evident when the space around a subject, and not the subject itself, forms an interesting or artistically relevant shape. Negative space in maps is useful in drawing attention to places where you want your audience to look. Oceans and other large bodies of water are good examples of negative space because they can either draw attention away from the purpose of the map if done incorrectly or they can be represented without taking over the visual hierarchy.

Using negative space properly will greatly affect the balance and aesthetic value of an image. By working with negative space in the image instead of positive space, one may find that they are better able to accurately portray the subject or positive space in a visually pleasing and complete manner. One way to understand the negative space in an image is to represent the subject in white and the rest of the image with black. This allows you to creatively work with space in order to find the right balance between negative and positive space.

1.12.6 Aesthetics

Aesthetics deals with beauty or artistic appeal. In cartography, the aesthetic aspects of a work influence the overall quality of that work. It is important for cartographic works to have aesthetic features because the aesthetic quality of a work has a significant impact on the overall quality and user friendliness of that work. When choosing between two similar maps, one usually chooses the map that has more aesthetic appeal. As cartographer Felix Ortag said, “A beautiful map is not necessarily a good map, but a good map should be beautiful.”

Aesthetics in cartography can take one of two forms:
1. Responses to the map itself as an aesthetic object. This can be accomplished through details the cartographer chooses to put emphasis on, the color or combination of colors included in the map, or artistic form the map takes.
2. The subject of the map symbolized. An example of this would be the cartographer creating an expression of terrain which forms an imagined visual experience.

With these two forms in mind, a cartographer must always be aware of the audience the map is to be created for. Just as important as the audience is the theme of the map. Cartographers make aesthetic judgments when designing maps to ensure that the content forms a clear expression of the theme(s).

1.12.7 Map symbology

The quality of a map’s design affects its reader’s ability to extract information and to learn from the map. Cartographic symbology has been developed in an effort to portray the world accurately and effectively convey information to the map reader. A legend explains the pictorial language of the map, known as its symbology. The title indicates the region the map portrays; the map image portrays the region and so on. Although every map element serves some purpose, convention only dictates inclusion of some elements, while others are considered optional. A menu of map elements includes the neatline (border), compass rose or north arrow, overview map, scale bar, projection and information about the map sources, accuracy and publication.
When examining a landscape, scale can be intuited from trees, houses and cars. Not so with a map. Even such a simple thing as a north arrow is crucial. It may seem obvious that the top of a map should point north, but this might not be the case.

### 1.12.8 Color

"Color is a cartographic quagmire." Color, likewise, is equally important. How the cartographer displays the data in different hues can greatly affect the understanding or feel of the map. Different intensities of hue portray different objectives the cartographer is attempting to get across to the audience. Additionally, there are certain accepted color associations for representing certain features on a map. For example, blue is traditionally used for bodies of water, green for natural areas, black to denote political boundaries. Not following these conventions when designing a map would lead to a confusing product.

Color can be a powerful tool when designing a map to display important information. It can help show increasing or decreasing values, definite borders, land type and a plethora of other uses. Because color can be utilized by computers so easily, problems have arisen. Namely:

1. There is no single standard for using colors in maps.
2. There are many different ways to define or specify colors.
3. Effective map making can be done using only blacks and greys.

When using color, such things as value, or shade, and contrast should be considered. Adjusting the hue, or gradation, of the color will help the reader of the map understand the changing values on the map better than using completely different colors. Understanding hues that are sharper or more pure than others can also help convey the map's information. Such colors as green, red, and blue show a stark contrast to each other as compared to orange and purple. This also helps with the overall aesthetics of the map. Color contrast can actually muddle the information. Certain colors when placed together can cause a bleeding effect. It is an optical illusion where one color appears to bleed into the other color.

In design, and cartographic design in particular, it is helpful to have colors that can be distinguished from each other. This helps the viewer to see what the creator is trying to show. Color is one of the many tools that cartographers use to explain their perspective and focus attention on the most important items of a map.

Quantitative symbols give a visual measure of the relative size/importance/number that a symbol represents and to symbolize this data on a map, there are two major classes of symbols used for portraying quantitative properties. Proportional symbols change their visual weight according to a quantitative property. These are appropriate for extensive statistics. Choropleth maps portray data collection areas, such as counties or census tracts, with color. Using color this way, the darkness and intensity (or value) of the color is evaluated by the eye as a measure of intensity or concentration (Harvard Graduate School of Design, 2005).

- Colour perception is a combination of physiological (sensing in the eye and cognitive processing) and psychological reactions.
- Colour evoke emotions. subjective reaction to colour
- Warm colours (red, orange, yellows)
- Cool colours (violet, blue, greens)

Defining - hue, saturation, value (HSV) model

- **hue** - basic colour we perceive, eg 12 step wheel
• value - lightness or darkness. Can be hard to perceive variations in value
• saturation - intensity or purity compared to a neutral gray

Color gives structure and readability  
  Developing figure and ground relationships - warm colour better for figures.  
  Said to ‘advance’ to viewer. Cool colours tend to recede  
  Perceptual grouping of like features through colour  
  Colour contrasts. using value or saturation to represent data on thematic maps  
  Qualitative conventions - blue for water, green for lush vegetation; red = warm and blue = cool in temperatures; hill shading

1.12.9 Lettering

Labeling Point Features  
Cartographers should avoid overprinting underlying graphics, which is to place a label on top of a map feature. Labels for points should not be placed directly to the right or the left of the point. The preferred position of labels for points is to the upper right of the point. The second best location is to the lower right. Labeling on the left side in a like manner is also acceptable, but less preferred. Do not allow other map features to come between the point and its label because this may cause confusion for the map reader. Consider using a mask or a halo if the preferred locations of the point label doesn’t work. Use leader lines if a mask or halo doesn’t suit the point. Leader lines should be thin and should not touch the point or its label. Multiple line labels should be centered and placed in the preferred location of point labels.

Map Legends  
- A legend or key on the map is used to tell the reader what the symbols and colors of the map mean. Map Legends should contain examples of symbols found on the map and labels explaining each symbol. A map legend is should be easy to identify and is usually located in one of the corners of the map. A legend may also include notes from the map maker so as to make the map more valuable.

Type or Typography is the art of working with, processing, and designing typeface. A lot of work goes into designing font, style, and making unique typeface. In cartographic design type often plays a large role in getting an idea across. Components of type include weight, size, kerning, leading and many others. The basic category of type design is the typeface. Type measurement is done in the unit of points. The design of typeface comes from the an alphabet, including the serif shape, x-height, length of ascenders and descenders, variation of stroke weight, and any other characteristics that differentiate it from any other design.

1.12.10 Map generalization

A good map has to provide a compromise between portraying the items of interest (or themes) in the right place for the map scale used, against the need to annotate that item with text or a symbol, which takes up space on the map medium and very likely will cause some other item of interest to be displaced. The cartographer is thus constantly making judgments about what to include, what to leave out and what to show in a slightly incorrect place - because of the demands of the annotation. This issue assumes more importance as the scale of the map gets smaller (i.e. the map shows a larger area), because relatively, the annotation on the map takes up more space on the ground.

1.12.11 Representing Terrain on Maps  
Cartographic relief depiction, or representing terrain on maps, can be done with a variety of methods, each with different benefits and drawbacks. One of the most
common methods is using Contour lines to show locations of equal elevation. Other methods include Shaded Relief, Hypsometric Tinting, and Tanaka contours.

1.1 The Cartographer's Palette: The Semiotics of Cartography

Cartographers employ symbols to represent location, direction, distance, movement, function, process, and correlation. These features of the real world are abstracted and symbolized on maps as points, lines, and areas. A tremendous amount of practice and skill is involved in choosing effective strategies for symbolization. One of the best ways to learn about these strategies is to consider the sorts of visual resources available to the cartographer.

1.1.1 The range of visual resources

As cartographers reduce the world to points, lines, and areas, they use a variety of visual resources. Jacques Bertin in his book *The Semiology of Graphics* (1983), inventories these resources using the categories of size, shape, value, texture or pattern, hue, orientation, and shape.

Cartographers can apply these resources to points, lines, and areas in a variety of ways.

Each of these resources can be used individually to draw attention to map features, or they may be used in combination. Sometimes cartographers deploy several of these resources simultaneously to stress particularly important information or to improve its legibility.

1.1.2 Strategies of symbolization

With such a range of resources available, the question arises as to what strategies to use in assigning these resources to points, lines, and areas. The strategies employed vary greatly depending on the nature of the phenomena being mapped. We distinguish among four levels of measurement in describing real-world phenomena:

a) **Nominal data** is information that is simply grouped into categories on the basis of qualitative considerations: a road distinguished from a river or a forest distinguished from an open field.

b) **Ordinal data** is grouped by rank on the basis of some quantitative measure: small, medium, and large cities or single-lane, double-lane, and four-lane roads.

c) **Interval data** is information that can be arranged using a standard scale along which operations of addition and subtraction have meaning. Temperature is an example of an interval measure.

d) **Ratio data** is information that, like interval data, can be arranged along a scale but, in addition, the scale begins at a non-arbitrary zero point. At the zero point, no features are present. The operations of multiplication and division can be employed with ratio data to consider proportions and magnitudes. Elevation above sea level, precipitation, and population are all examples of ratio data.

These resources can be used in a wide variety of ways and several may be used at once to highlight or reinforce a single relationship. Thus, for example, if only a single ordinal variable is being mapped, several visual resources may be deployed at once. If several ordinal variables are being displayed, the visual resources may have to be used more selectively.
1.1.3 Typography and lettering

Adding text to a map is one of the cartographer’s most demanding tasks. The cartographer must be concerned both with the content and the form of the text, that is the wording and the way the text is displayed on the map. Indeed, the verbal content of a map is one of the most powerful communicational resources available to the cartographer. Its effective use is often the point of difference between high-quality, professional maps and less skillfully executed maps. Compare the following maps and notice how much difference lettering makes to overall readability. Pay special attention to the differences—the size of the lettering, how it is aligned, and the fonts and cases used.

A. Content

Concise, carefully formulated captions and annotations make a tremendous difference to a map. One way to test the effectiveness of your text is to ask others to read and interpret a draft of your map. If they are confused or misinterpret the theme, rewording is essential. You should also check your map for redundancies so as to avoid repeating yourself in the title, legend, and annotations. That is, consider all of the map text together and balance its content to convey your message without being repetitious. Finally, avoid using abbreviations unless you are certain your audience will be familiar with their meaning.

B. Form

Bertin's semiotic resources apply to text just as they do to points, lines, and areas. However, with respect to text, some of these resources are given special names. Font refers to the shape and pattern of letters. Hundreds of fonts have been created since the invention of the printing press and are available using automated systems. Fonts are often grouped into several broad categories. A distinction is made between and fonts, as well as between Roman and Italic fonts. The weight of text is classified as , or .

fonts can be scanned more rapidly by most readers, although less information seems to be retained than would be the case if the same text was displayed with a font. Italic fonts are used for the titles of books and journals and for some proper names. Since it was impossible to print italic characters with typewriters, was used to indicate the placement of italic characters. It is no longer necessary to employ this convention with automated systems capable of printing italic characters. Traditionally the size of lettering was measured in picas or point size. Increasingly, automated systems measure size using conventional units such as inches and millimeters. The horizontal and vertical distances between lettering are traditionally referred to as leading, but increasingly today as inter-character and inter-line spacing.

Although automated systems offer a wealth of fonts and sizes, good practice dictates that these resources be used sparingly. Too many fonts (and sizes) can potentially confuse the reader. Traditionally, typographers try to use no more than four fonts or font sizes on a given page of print. Apply the same principle to your maps. Use different fonts and sizes only when you have a compelling reason to do so.

Lettering is also distinguished by case: UPPER CASE, lower case, and Mixed Case.

If you consider professionally produced maps, you find that font, size, and case are used very carefully to encode text. In effect, the text is used to group information into useful categories that reflect the theme of the map.

Special attention must be paid to the orientation of text with respect to the features being labeled. In this respect, text can be used as an important cue to different map
features.

Point features—lettering "points" to feature, but try to avoid lettering across boundaries.

Linear features—lettering shows shape, but watch out for ambiguities.

Area features—lettering occupies the area.

In following these guidelines, conflicts will always emerge. On maps crowded with information it is nearly impossible to arrange all text without striking compromises among these principles. The point is to follow the guidelines as much as possible and, when conflicts do arise, consider options carefully in light of the map theme and competing cartographic elements.

Quite apart from labeling features, text is used for convey other information about the map--sources, date, methods of compilation, projection, and cartographer. This ancillary information is usually placed in a subordinate position within the frame of the map. However, the readability of your map will be improved if you position this text in relation to the major map elements. That is, your map can be composed with implicit margins and tabs that can be used as a means of alignment for subsidiary text.

1.1.4 Foreground-background (figure-ground) relationships

Good cartography involves bringing the most important map information into the foreground of the reader's attention, even though other detail must be displayed in the background to make the map intelligible. Differences between the foreground and background are critical to some maps where clear distinctions must be made between certain types of features like the boundaries between land and water bodies. Cartographers employ a number of devices to make it easier for readers to distinguish between these features and to sort out a map's most important message.

The key to resolving foreground-background relationships is to use color, value, and patterning to "raise" some map features into the foreground. In some respects this is like using color, value, and patterning to produce a sort of three-dimensional effect in which certain key features appear to rise off the map's two-dimensional surface. In fact, these resources can be used to create a sort of three-dimensional visual hierarchy.

This idea can be put to practical use in a wide range of situations where the reader would otherwise have difficulty sorting out information displayed on a map.

Understanding the dynamics of foreground-background relationships can also help resolve certain ambiguities that sometimes arise in mapmaking. Consider the following example:

In this map it is difficult to distinguish between water and land because both are arrayed at the same level of the visual hierarchy. This ambiguity can be resolved in several ways: shading, adding a graticule, vignetting, and lettering.

Depending on the map and mapping system you employ, any of the options might be used either singly or in combination.

1.1.5 Highlighting the theme

The theme of your map must rise to the foreground. Now that you are aware of the cartographic resources available, you can use them to highlight the most important thematic information. This may involve using a vivid or saturated color to bring the information forward, using heavier line weights, or a contrasting, bold pattern. These resources can, of course, be used in combination.
1.2 Map Lettering

1.2.1 Considerations in Lettering

**General rule:** Lettering is an extension of the symbol itself, and should be ‘automatically’ attached to it in the mind of the map user, both in design and positioning: 'good lettering' is barely noticed.

**A: Visual Design Variables: Qualitative**

i. **Shape**
   - (Font = 'style'): classic (serif e.g. Times), sans serif (e.g. Geneva), or decorative (e.g. Joker)
   - **Variants:** bold or plain (e.g. Vanderhoof vs. Vanderhoof) - another variant is wide or condensed

   **Form: italic** or upright, UPPER or lower case
   - Type faces represent a nominal difference, used mostly by choice not association
   - *Italics* are reserved for hydrographic features (rivers, lakes, etc.)
   - Use upper case sparingly; it is less readable than lower case due to the information provided by 'ascenders' and 'descenders'

   **Note:** Bold and UPPER CASE imply more major features and hence imply QUANTITY

   ii. **Colour (hue):** .. is mostly used associatively. However red lettering is associated with importance.

   *Blue:* hydrography (e.g.. Fraser River) **Brown:** contours (e.g.. ~1500~)

   *Black:* standard (e.g.. Chetwynd) **Red:** important (e.g.. Airport)

**B. Visual Design Variables: Quantitative**

i. **Size:** size denotes importance
   - It is most commonly measured in 'points': 72 points = (almost) 1", minimum size = 6 points

   Larger size text is associated with larger or more important features. What is 'more important' may be linked to the map purpose
   - Larger is a simple ordinal or interval association; large lettering should not be overpowering

   ii. **Colour Tone / chroma:** toned (screened) lettering is used for background features
   - Bold and also Upper Case (implying greater size) are reserved for important or larger features

**1.2.2 Principles of Lettering**

- **Legibility:** the distinction between letters in the alphabet scary
- **Visibility:** the contrast between lettering and background
- **Aesthetics:** avoid ugly letter proportions and faces (Don't use Courier font!)
- **Consistency**: lettering within a class should be the same (e.g. all major rivers)
- **Contrast**: should be higher between major classes than within a class type
- **Harmony**: avoid many type faces; use variants instead
- **Overall**: names should be read as part of symbol automatically
  b. Automated: a wide choice of fonts, variants and sizes (e.g. as in word processing), labelled by class (attribute)

Think about different types of lettering styles and placement/orientations used and the effects it has as per man below

Some considerations

- Legibility of individual letters is of paramount importance, especially in smaller type sizes. Choose a typeface in where there is little chance of confusion between c and e and i and j
- select a typeface with a relatively large base height
- avoid extremely bold forms
- choose a typeface that has softer shading; extreme vertical shading is more difficult to read than rounder forms
- do not use decorative typefaces on the map as they are difficult to read

1.2.3 Rules of Positioning Letters

Positioning is an extra visual variable that other symbols don't have:

- Minimize ambiguity as to what the name refers to
- Horizontal lettering where possible, except:
  - If there is no space available (point symbols)
  - Feature is not horizontal (areas/lines)
  - * AND if lettering is not horizontal, it should be clearly not horizontal (not an accident!)
- Lettering should never be beyond the vertical (and preferably not vertical); the only exception is applied to some contour lines, where the lettering tops 'point uphill' to show terrain form
- Choose minimum interference with other map elements: lettering is movable, symbols are not
- Use locational arrows only as a last resort

Point Symbols

a. There are 8 possible positions for names, some are better than others.
Top right is usually best but be consistent
b. Angle lettering if names run into each other, or map elements
c. Space between names and the symbol should be half the size of the lettering
d. Splitting two word names is OK for Mountains but not two word towns (why?)

Line Symbols

a. Follow orientation of line (river, road, etc.)
b. Find a relatively straight piece to label
c. Label above the line is preferred, far enough away so descenders don't run into the line.

Area Symbols
a. Lettering totally inside the area where possible
b. If area is too small, label as if a point symbol
c. Name should fit inside with minimum 1.5 letter width on either side
d. Orient lettering to fit shape of area, curve if appropriate (preferably upwards NOT down)
e. Space lettering if area is large, but not more than 4 x letter height, always evenly
f. Serifs are useful in spaced names     NOTE: lettering to the right should be in ITALICS !

Summary of dominant rules

Point symbols:    horizontal lettering, close to the point, top right preferred
Line symbols:    along line and above it, following orientation of line
Area symbols:    centred in area, indicating orientation and space

Additional points

a. ABBREVIATIONS
Some are acceptable and conventional: e.g. R. for River, L. for Lake, Mt. for Mount

b. TOPONYMIC SITUATIONS
Where a place name has two alternate spellings/versions, give the first (more common) in one form, the second below it in brackets and a lighter variant or lower case,   e.g. Beijing (Peking).   (this is an old example)
Closer to home:   Nadsilnich (West) Lake    (or is it vice versa ?)

c. AUTOMATED NAME PLACEMENT
The rules are applied easily by a well trained cartographer, but lettering placement remains one of the toughest applications for computer mapping and GIS. Lettering was the weakest component of early mapping programs initially in font options and later in angling and curving lettering. Lettering positioning remains the most challenging component for automation, owing to the need for human rule interpretation and principles of placement.

1.2.4 Lettering Procedure

a)  Begin with the title
The title is important to set the mood and point of the map and go far to enliven and identify the map both geographically and culturally.

The title should have contrast with the rest of the map to draw attention, whether the title contrasts in color or contrasts in form and shape.

Use a font style that reinforces the map's purpose... a serif font for an antique-style map, a sans-serif for a contemporary-style map, or a unique font that captures the feel of a culture such as Papyrus for a map of Greece.

b)  Next add large land regions and oceans
These labels need to be of sufficient weight to draw attention, yet not be so overbearing they draw too much attention. Balance is the key. And balance can be difficult to achieve.
They should almost form a background that balance natural features such as mountains and forest.

You also need to consider direction...

- Straight or curved?
- Horizontal, diagonal, or vertical?

c) **Finish with feature names**

Again, balance is the key. The weight of the font should be consistent with the weight and size of the feature representations. If contrast clearly separates objects, similarity joins objects... in this case the feature and its name.

Don't forget proximity. The label should be clearly next to the object it labels.

### 1.2.5 About lettering and maps

Lettering requires three considerations...

- **Style** Choose a style that matches the look of your map. Oldstyle, modern, sans serif, hand-written, script, decorative. There are a great number of type styles to choose from.
- **Size** Make sure all sizes of type on your map are readable. But not so big they overpower. 10- or 11-point is good for labeling features such as cities. 14-point for more conspicuous features such as rivers and mountain ranges. 18- to 24-point for regional features such as the name of an island or ocean. And a large 24- to 36-point for the map title.
- **Weight** Size affects the visual impact of lettering. But so does the weight of the type. Light, normal, or bold works in combination with size to give an overall impact. Choose size first, then weight to match the overall map composition.

### 1.3 Ancillary and Meta Data

In addition to the 'map content', maps usually need additional or 'ancillary' information to fully explain the map contents. Digital datasets include this ancillary information in a metadata text file. They may not need all the items below, but all MUST have the first two

#### 1.3.1 Title

This tells us the map purpose and content, and should be prominent, usually at the top of the map. It should be complete but not too lengthy; use subtitles if necessary, e.g. Population density, Uganda (note: in a book or article, the title may be a caption)

*Title needs the following components: ... but not 'MAP OF'*

- Geographic area, nothing more for 'general maps'
- Type of map data for thematic maps
- Date, if data changes through time

**How not to do a title:**

"The ratio of annual snowfall in cm to the amount of rainfall in cm of total precipitation in BC for 1935-75"  ....  This might better be: **Precipitation in BC (1935-75)**

#### 1.3.2 Map Scale

Scale must be given on the map, otherwise it is a diagram; it is usually placed near the bottom of the map.
It is both impossible and impractical to represent a section of the earth's surface at its full size. Therefore maps and GIS data show a scaled portion of the earth's surface

**Scale**: the amount of reduction expressed as a ratio e.g. 1:1000 implies a reduction in size/detail by 1000 times. A large scale is reduced by a lesser amount. Hence a scale of 1:50,000 is larger scale than 1:250,000

### Common map scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>Description</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:10,000,000</td>
<td>Very small</td>
<td>Global</td>
</tr>
<tr>
<td>1:1,000,000</td>
<td>Small</td>
<td>National</td>
</tr>
<tr>
<td>1:250,000</td>
<td>Medium</td>
<td>Regional</td>
</tr>
<tr>
<td>1:50,000</td>
<td>Large</td>
<td>Local</td>
</tr>
<tr>
<td>1:5,000</td>
<td>Very large</td>
<td>Cadastral</td>
</tr>
</tbody>
</table>

GIS does not actually use scale directly in its operations, but it is important in determining data quality. GIS products can produce almost any desired scale, but care must be taken to maintain acceptable quality.

- Data collected at a specific scale suitable only for similar scales.
  - ✓ At smaller scales, large scale data are too complex

There are three methods:

- **a. Verbal statement**
  - e.g. 1" = 1 mile, 2cm=1km (requires units)
- **b. Scale Bar**
  - traditional scale bar (requires units)
- **c. RF (ratio):**
  - e.g. 1:63,360, 1:100,000 (unit-free)

**Verbal Scale:**

"1 centimetre on the map represents 500m on the ground" is a verbal scale. Clearly here a distance of 1cm on the map corresponds to 500m on the earth's surface. So if you plan a route with a total distance of 22cm on the map, that would imply that you'll be traveling (22cm x 500m) / 1cm = 11000m or 11km on the ground.

**Representative Fraction (RF) - Fractional Scale - Ratio Scale:**

1:50000 represents the map scale as a mathematical ratio or fraction, thus the name ratio scale or fractional scale. 1:50000 can be shown as 1/50000 as well. Here such a scale means that one unit of measurement on the map is equal to 50000 of the same unit on the ground. Such a unit can be anything such as centimetre, meter, feet, inches, your finger length, half a length of a pencil, etc. Also we can say that any distance on the map is 1/50000 of its true value on the ground. Therefore 1cm on the map is equal to 50000cm on the ground, that is 1cm on the map is equal to (50000cm x 1m) / 100cm = 500m or 0.5km on the ground. Again a 22cm route on the map can be calculated to be equal 22 x 50000cm = 1100000cm on the ground or (1100000cm x 1m) / 100cm = 11000m.

**Bar Scale - Graphic Scale - Linear Scale:**
**Bar scale** also known as scale bar, linear scale or graphical scale visually shows the relationship between distances on the map and the real world. Usually more than one bar scale is shown on the side of the map, each using a different unit of measurement.

You can conveniently measure distances between any two points on topographic maps by using the distance and bearing tool in the [Geokov Map Maker](https://sites.google.com/site/wadembere/cartography/cartography/map-design-and-cartographic-techniques). Simply enter the coordinates (latitude / longitude or UTM) of the points and choose the desired distance unit. Alternatively the line tool of the Map Maker can be used to draw a line along a feature or between points; the length of the line (distance) will be shown in the legend to the left of the map.

**Small Scale vs. Large Scale Maps**

As mentioned above maps come in variety of scales. Large or small scale maps can be distinguished by the use of fractional or ratio expressions. A map covering a large area (e.g. country or state) with a small scale fraction is a small scale map (e.g. 1:1000000), whereas a map covering a smaller area (town) with a large scale fraction is a large scale map (e.g. 1:10000). Most times the comparison of large scale and small scale maps can be relative. For example a 1:250000 map is smaller scale than a 1:50000 map. When confused, just carry out the division: 1/250000 < 1/50000; larger denominator results in a smaller number. The smaller scale the topo map is, there will be less detail with more generalization, and the harder it will be to detect terrain features. Therefore a map at a scale of 1:250000 while adequate for bike touring and car camping will not be useful for hiking or mountaineering trip planning.

When dealing with digital maps, it is normal for the map to be resized during printing in order for it to fit the page. A digital map's size might also get altered by saving it to another format (e.g. jpg, png, pdf). The same problem applies when a hard copy map is reproduced by photocopying. Note that in such situations the original ratio scale (or verbal scale) of the map would not be accurate anymore. However the advantage of bar scale is that it would shrink or expand consistently with the map in case of any resizing, and therefore will remain an accurate representation of the map scale. Also differing monitor resolutions and zoom levels make ratio/verbal scales for digital maps unreliable.

Another point worth considering is that while you can view a digital map at any scale by zooming in/out on the computer screen, you should note that when a map is produced at a certain scale with a certain level of accuracy (or level of error), changing its scale would not affect the original level of accuracy. For example when zooming in a 1:50000 topographic map so that its scale changes to 1:25000 or 1:10000, the level of accuracy of the map will remain at the original level designed for the 1:50000 map. In other words your zoomed in map (to 1:10000 scale) would not possess the same level of accuracy as an originally published 1:10000 map.

1.3.3 **Legend**

This is an extension of the title and map, and is located on the side or where there is space.

- Symbols should be in the legend unless explained by lettering
- Symbols must appear in legend **exactly** as on map, same size etc..
- Usually symbols on the left, labels on the right and lined up
- Draw boxes around area symbols, use 3/2 'golden rectangle' dimensions (not a square)
- Line symbols should be a straight or gently curved section, **NOT** a 'zig-zag' as in some software
- Capitalise the first letter only; lettering should not be too visually dominant
- The word 'legend' is not usually needed - especially if a legend box is used

1.3.4 **Direction**

- A North arrow is **optional** if it is clear that North is to the top
- If North is not to the top, a North arrow is a **MUST**
• A North arrow is redundant or wrong for some maps (there is not ‘one’ north)

1.3.5 Location

This can be indicated in one of three ways:

a. Direction and distance indicators (e.g. to Vancouver-->, 100 miles)
b. Inset or locator maps, including scale of inset / locator
c. Grids showing latitude and longitude .. at least two of each, mark the ticks on map edges

1.3.6 Source

A set of statements usually at the bottom (right) in small text explains how the data were derived.
Thematic data: collection agency and methods, (topographic base need not be sourced)
Topographic data: date (usually of photography from which data were interpreted)

Digital mapping and 'metadata'

Since a digital dataset does not necessarily include printed output, the 'source' should be supplied in an attached text file, noting dates, collection agencies, scale, etc.. This is known as metadata = 'data about data'.
The date can be crucial in GIS studies of change detection and mapping e.g. development of road systems, glaciers.

1.3.7 Overall layout

- Some (not all) occasions call for a 'neatline' around the map as a whole and/or the legend to hold them together.
- A rectangle 3 x 2 ('landscape' or 'portrait') is generally preferable to a square.
- Don't cram but don't waste space .. look for natural spaces to fit ancillary info.

<table>
<thead>
<tr>
<th>Item</th>
<th>Best Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE</td>
<td>what?</td>
</tr>
<tr>
<td></td>
<td>Prominant, near top</td>
</tr>
<tr>
<td>SCALE</td>
<td>how big?</td>
</tr>
<tr>
<td></td>
<td>Near bottom</td>
</tr>
<tr>
<td>LEGEND</td>
<td>what (details)?</td>
</tr>
<tr>
<td></td>
<td>On side, may be boxed</td>
</tr>
<tr>
<td>DIRECTION</td>
<td>which way?</td>
</tr>
<tr>
<td></td>
<td>Side</td>
</tr>
<tr>
<td>LOCATION</td>
<td>where?</td>
</tr>
<tr>
<td></td>
<td>Side ticks, or insert</td>
</tr>
<tr>
<td>SOURCE</td>
<td>where from?</td>
</tr>
<tr>
<td></td>
<td>Very bottom, inconspicuous</td>
</tr>
<tr>
<td>LAYOUT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overall</td>
</tr>
</tbody>
</table>

1.3.8 Layout & 'Figure-Ground'
a. Gestalt and Figure-Ground

Cartographers have likened map design to other types of graphic images, where the elements need to be taken in overall context as a ‘Gestalt’ (from the Gestalt school of psychology) as they are affected by each other.

Gestalt Psychology: “... the whole is greater than the sum of the parts”

Furthermore, any visual image such as a painting, photo or map is composed of two distinct parts:

- **Figure**: has form or shape and is seen as a component between viewer and the background
- **Ground**: the homogenous background behind the figure (and has no shape)

The figure-ground concept has been explained using 'reversible' figure-ground diagrams, well known in psychology.

Separation of figure and ground is an automatic response making this a primary consideration in graphic design. For example, it is important to be able to distinguish land from water on maps. In Cartography, we want to avoid ambiguous figure-grounds so that the map structure is seen clearly, such as land versus water.

**Final product with good use of figure ground differentiation**

b. Gestalt Laws of Visual Organization

*What determines whether something is seen as figure or ground?*

- **Meaning**: does this have shape?
- **Closedness**: closed areas becomes figure
- **Area**: smaller area usually is figure
- **Proximity**: close together features are grouped as figure
- **Continuity**: continuous features become figure
- **Texture**: detail enhances figure
- **Contrast**: difference from surroundings enhances figure

Hence in the examples above, we might see the straits between Vancouver Island and the Mainland as 'figure' or land as the water is thinner than the land on either side, but in the last example, the straits are seen clearly as water thanks to the details (texture) added to the land, and the underlying grid which enhances the land as figure through continuity. Extending the map slightly further south to include the whole island would have enforced 'closedness' and 'meaning'.

c. Use of the Visual Variables to Improve 'Gestalt'

- **Shape and pattern**: those more detailed stand out (as figure)
- **Texture**: coarser patterns stand out (as figure)
- **Size**: larger symbols appear closer, and stand up as figure
- **Tone**: darker = higher; dark areas have poor ground qualities
- **Color**: red advances, higher tints advance, (and lower values)

Note that most point and line symbols tend to be figure, and areas tend more to be as ground.

d. Visual Levels of Hierarchy in Maps

On most maps, there is not simply one 'figure' and one 'ground' but a hierarchical series of visual levels, with each level a figure on a ground (except for the lowest visual level).

i. Thematic maps

Figure-ground is used in two ways:

- to emphasize thematic data above base and ancillary info, e.g. by ‘screening’ (using lighter tones);
- to make larger thematic values more predominant in size or chroma e.g. population densities.

ii. Topographic maps
These must involve a more subtle differentiation, as design is balanced; generally, we might visualize several layers, from bottom to top:

- Sea
- Other water features
- Land (relief)
- Cultural - towns/roads
- Place Names

In both thematic and topographic maps, some data are subsidiary, such as the ancillary information; these are provided on the map, but visually subdued to be obviously secondary (with the exception of the title)

**e. Context in Maps**

The purpose of the map determines the main content, but other information gives context. A background relief can help explain thematic distributions (see lecture on relief depiction). A method such as hill-shading forms a better general background and presents better 'ground' qualities compared to line methods like contours, which can form conflicting 'figures'. Any features may form a 'contextual framework' for better understanding where map elements are and why, e.g. roads and railways on population maps, rivers and lakes for animal habitats.

### 1.4 The Visual Design Variables

After features have been identified and generalised for suitable scales, they are displayed using symbols, which can be varied in many ways. Most symbol design is common sense and good logic in the use of the visual design variables. *Whether a feature is represented by points, lines or areas (polygons) is mostly fixed by scale and generalisation.*

<table>
<thead>
<tr>
<th>Visual Design Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shape:</strong> the detail or outline of a point</td>
</tr>
<tr>
<td><strong>Pattern:</strong> regular repetition of shapes in a line or area</td>
</tr>
<tr>
<td><strong>Texture:</strong> variation of tones or lines in an area</td>
</tr>
<tr>
<td><strong>Orientation:</strong> direction of markings in a point or area</td>
</tr>
<tr>
<td><strong>Size:</strong> size in a point, or width of a line or area boundary</td>
</tr>
<tr>
<td><strong>Tone:</strong> shade of gray (printing = % of black ink)</td>
</tr>
<tr>
<td><strong>Colour:</strong> Has three 'dimensions'</td>
</tr>
<tr>
<td>- hue: &quot;the visual sensations from wavelengths of light&quot; (e.g red, blue) - seen in a rainbow</td>
</tr>
<tr>
<td>- chroma: saturation or intensity = tints, e.g. pale v solid blue</td>
</tr>
<tr>
<td>- value: purity or lightness = shades, e.g. blue, blue/black</td>
</tr>
</tbody>
</table>

**1.4.1 Design Criteria**

*How do we choose which variables to use and when?*  
*Symbols should be easily read for optimum communication and clarity of design*

**a. Association**

General: Symbols should be 'associated' with the features they represent, by physical appearance / function / psychology:
e.g. Green - forests, brown - contours, crossed swords - battlefield, triangles -camping, red - danger, etc..

**Points:**
Generally, letters are not used, rather, *'iconic'* symbols are preferred (that visually resemble the feature)

exceptions: H for Hospital, P for Parking and i for Information (why the 'lower case' 'i'?)

**Lines:**
- Features which are *'permanent' physical* parts of the landscape are shown as solid. e.g. rivers, roads.
- Features less certain are shown in broken lines. e.g. intermittent rivers, trails
- Administrative boundaries (which exist only in human brains) use an alternating dot-dash pattern.

**Areas:**
Choice of area fill or outline colour / thickness
Choice of colours and patterns, e.g. blue for water, swamps

**b. Convention**
Some symbols are based on developed conventions, especially in map series, although most conventions are based on association e.g. blue for water, while others are less obvious, e.g. light red for urban.

**c. Qualitative versus quantitative data**
The visual variables imply either a nominal (qualitative) difference based on 'type' or an ordinal / interval (quantitative) distinction based on size or importance:

- Qualitative (nominal): shape, pattern, orientation, hue* e.g. soil types, schools versus churches
- Quantitative (ord / int): size, tone, chroma, value e.g. population densities, city sizes

* RED is usually reserved for features of importance due to its visual impact (and why it is used on STOP signs)

**d. Contrast**
The variables have different levels of visual power. Symbols that belong to the same general group (e.g. hydrographic features) should contrast more strongly with symbols from another group (such as cultural features).

The hierarchy is as follows (most powerful first)
- Qualitative: 1. hue 2. shape / pattern 3. texture / orientation
- Quantitative: 1. size 2. chroma / value / tone

In other words, we might use 'hue' to distinguish water features from cultural, and pattern between different types of water features - lakes, swamps etc.

**e. Overall map purpose**
Purpose determines which features should be more prominent. e.g. roads are thick and red on road maps
.. note the effect of background colours and what about the cost of colour?

Purden Lake (northern BC parks) using 'iconic' symbols with regular frame

**f. Graphic & perceptual limits**
While desirable to retain some detail in symbols to ‘mimic’ shapes from their real world counterpart, this complicates printing: two subtly different symbols may be indistinguishable unless they are located side by side. There are also some major differences between how a map image appears onscreen and in print e.g. colour saturation. The human eye can only comfortably distinguish between 5 tints or shades of one hue, while colour palettes can design many more.

1.4.2 Symbol Design Rules summary: symbols library

a. Points
   - should be associative, but simple and stand out more than area pattern elements

b. Lines
   - real ground features (e.g. roads, rivers) should be solid
   - real but less permanent (e.g. trails, intermittent streams) should be dashed
   - non-ground features (e.g. administrative) should be patterned
   - lines should be clearly distinguished from area boundaries

c. Areas
   - may be symbolized by a boundary line or a filled pattern depending on map ‘clutter’
   - outside boundary line may be omitted if a fill is used (and if boundary is ‘hazy’)
   - fill patterns distinguish areas from linear features, but should be simple
   - fill patterns should be light and fine texture as background for points and lines

1.5 Map Design Summary

The key issues to consider during map design

1.5.1 Harmony

It is the relationships between map elements (Color, Texture, Size and shape)

Figure 2: Bad Harmony Map

1.5.2 Composition

- Reducing complexity
- Excluding irrelevant components
- Arrangement and organization

1.5.3 Clarity

- Ease of recognition
- Scale and area
- Font

Comments

You do not have permission to add comments.