Chapter 13.2: Topographic Maps [1]

A ***map*** is a model or representation of objects and terrain in the actual environment. There are numerous types of maps. Some of the types of maps include mental, planimetric, topographic, and even treasure maps. The concept of mapping was introduced in the section using natural features. Maps are created for numerous purposes. A treasure map is used to find the buried treasure. Topographic maps were originally used for military purposes. Today, they have been used for planning and recreational purposes. Although other types of maps are mentioned, the primary focus of this section is on topographic maps.

Types of Maps

Mental Maps – The mind makes mental maps all the time. You drive to the grocery store. You turn right onto the boulevard. You identify a street sign, building or other landmark and know where this is where you turn. You have made a mental map. This was discussed under using natural features.

Planimetric Maps – A planimetric map is a two dimensional representation of objects in the environment. Generally, planimetric maps do not include topographic representation. Road maps, Rand McNally ® and GoogleMaps ® (not GoogleEarth) are examples of planimetric maps.

Topographic Maps – Topographic maps show elevation or three-dimensional topography two dimensionally. Topographic maps use contour lines to show elevation. A ***chart*** refers to a nautical chart. Nautical charts are topographic maps in reverse. Rather than giving elevation, they provide equal levels of water depth.

Topographic Maps

Topographic maps show elevation or three-dimensional topography two dimensionally. Topographic maps use contour lines to show elevation. Originally, topographic maps were developed by the Army Corps of Engineers for military use. This is most evident in that green on the map indicates areas where troops can hide. Generally, these are forested areas and more specifically, areas where the vegetation is over six feet tall. Today, topographic maps are being used in numerous civilian applications including recreation. The following sections address the different components of a typical topographic map.

Color Coding – Most features on a topographic map are color coded. ***Black*** represents cultural elements including boundaries, building and the names of features. ***Brown*** indicates contour lines. Contour lines are point of equal elevation connected together. ***Blue*** indicates water and includes rivers, lakes, streams and wetlands. Most people consider ***green*** as forest. This is partially true. Originally, topographic maps were made by the Army Corps of Engineers for military purposes. Green areas are areas where the vegetation is over six feet tall. Six feet is the height of a soldier and green indicates areas where troops can hide. ***Purple*** indicates recent revisions without revising the topography. The new revisions are simply superimposed on the landscape without changing the contour lines.

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[1] This section was written by Robert B. Kauffman who is solely responsible for its content. This section is copyrighted © Robert B. Kauffman, 2015. Robert B. Kauffman, Professor of Recreation and Parks Management, Frostburg State University, Frostburg, MD 21532. e: rkauffman@frostburg.edu.

North – Generally, there are three norths (Figure 13.18). These are found in the lower left hand corner of the topographic map. The first is ***True North*** (★) or the North Pole. This is represented by the star. The second north is ***Grid North*** (**GN**). Grid north is where the lines of longitude converge. Unlike the lines of latitude which circle the earth horizontally and which are parallel to each other, the lines of longitude are not parallel to each other. The third north is ***Magnetic North*** (**MN**). Magnetic north is the place to where the magnetic compass needle points. The location of magnetic north is not fixed and moves. The date when magnetic north was read is provided (1960) and the movement is noted also.

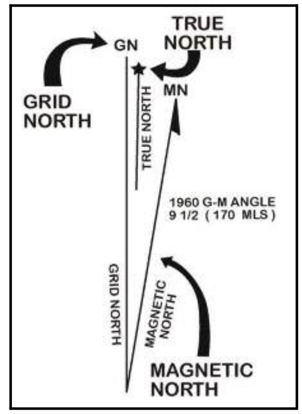

Figure 13.18: North.

Declination – The angle created by the difference between the lines of longitude pointing to grid north and magnetic north is ***declination*** (Figure 13.19). It differs with location. Figure 13.19 provides the relative correction for the error between magnetic north and grid north. Declination becomes important when finding the bearing of travel on the map and then finding the same bearing of travel in reality. The difference in declination needs to be corrected since the bearing to grid north and magnetic north are different.

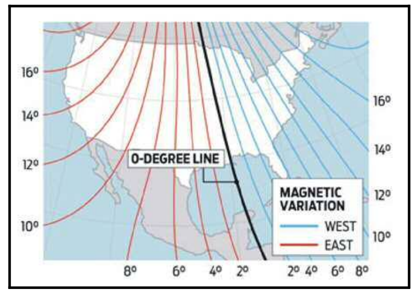

Figure 13.19: Declination.

Scale – The scale is located in the bottom center of the topographic map (Figure 13.20). On a 7.5 minute topographic quadrangle map, one inch on the map equals 24,000 inches or 2,000 feet in the real world (24,000"/12" per 1 ft). Another way of thinking about scale is that objects on the map have been reduced to 1/24,000th of their original size. Beneath the scale, distance in miles, feet and kilometers are also provided. These are generally more useful since they provide a measure of usable distances. The the contour interval of 20 feet on this map is also listed. Last, the information or data on the map was originally determined in 1929.

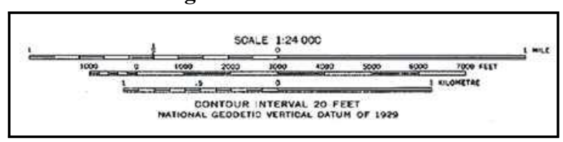

Figure 13.20: Scale.

Contour Lines – Contour lines are lines of equal elevation (Figure 13.21). They provide a method of representing three-dimensional space or topography two-dimensionally. By definition, contour lines cannot intersect each other. The closer the contour lines are together, the steeper the slope. The further apart the contour lines, the more gentle the slope. Contour lines are brown in color. The intervals can vary based on the purpose of the map and on the surrounding topography. Generally, the contour line are in 20 foot intervals. In mountainous terrain they can be 50 foot or 100 foot intervals. In site planning, the planners normally use one or two foot intervals.

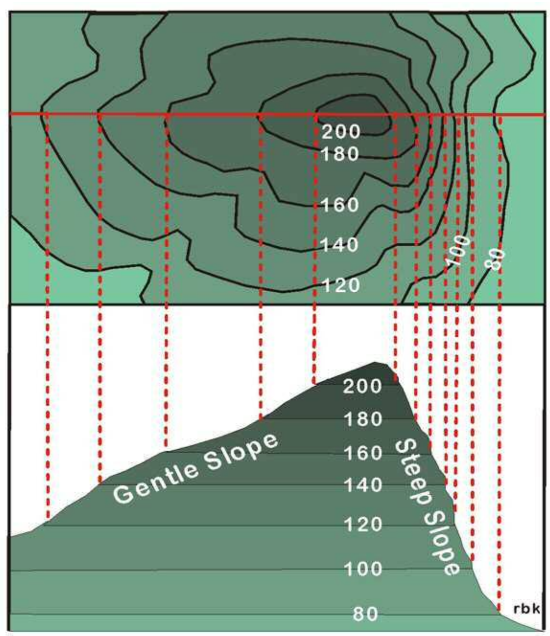

Figure 13.21: Contour Lines.

With nautical charts, the depth of the water is represented by contour lines also. Again, they are lines of equal depth and their color is blue.

Stream Flow – The contour lines are necessary to determine which way a stream flows (Figure 13.22). As noted, contour lines are points of equal elevation. Contour lines tend to create “Vs.” The rule is that the stream flows out of the “V.” A “V” without a stream is a ridge extending outward (not shown).

Symbols – Generally, most symbols are cultural and colored black on a topographic map. A sampling of symbols used on topographic maps is presented in Figure 13.23. These include building, roads, water features, railroads, and benchmarks. A benchmark is a small monument placed by the USGS indicating a documented or known elevation at this point. Benchmarks are usually affixed to permanent objects such as rock out croppings, bridge abutments, concrete slaps, etc.

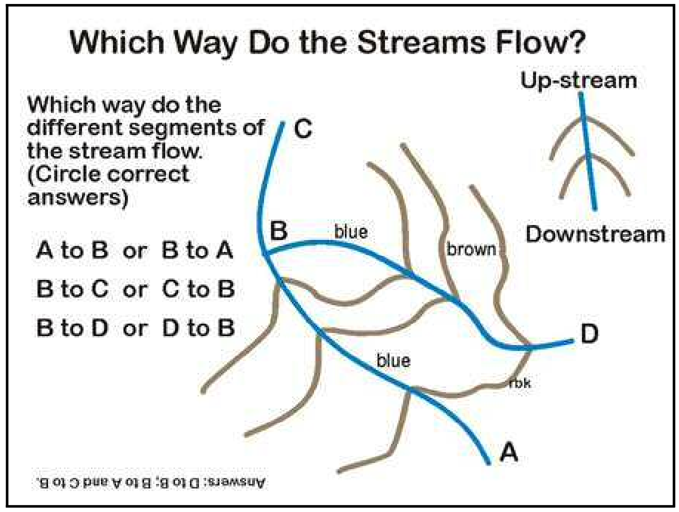

Figure 13.22: Which way do the streams flow?

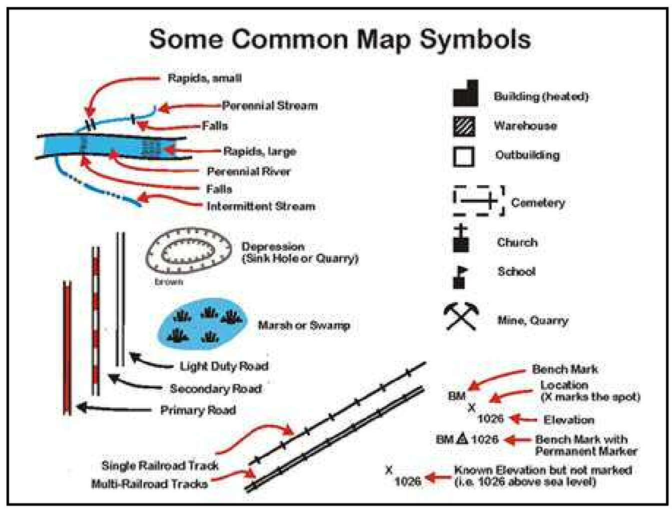

Figure 13.23: Some common map symbols.

Summary:

A ***map*** is a model or representation of objects and terrain in the actual environment. There are numerous types of maps. Some of the types of maps include mental, planimetric, topographic, and even treasure maps. Topographic maps show elevation. Although they were originally used for military purposes, they have been used for planning and recreational purposes. The basic principles involved with topographic maps were presented and will be utilized in the next section.

Chapter 13.3: Compass

This section focuses on the use of a compass for navigation and orientation. The purpose of this section is to cover the traditional use of a compass in navigation. It complements the use of topographic maps in the next section (i.e. Map and Compass).

Essentially, there are two ways to use a traditional compass. The first is given a bearing, find an object on that bearing and travel to it. The second is given an object in the real world environment, determine the bearing to the object. These are the only two ways to use a compass.

Compass

The traditional compass is pictured in Figure 13.24. The parts of the compass include the transparent base, direction of travel arrow, compass housing, orientating arrow and compass needle (magnetic needle). The mm (millimeter) and inch marks are used with reading distance on maps. There are many other types of compasses. The primary difference between different types of compasses is the sighting mechanism used to determine the bearing or direction of travel. The common element of all compasses is that they contain a magnetic compass needle and the magnetic needle points to magnetic north.

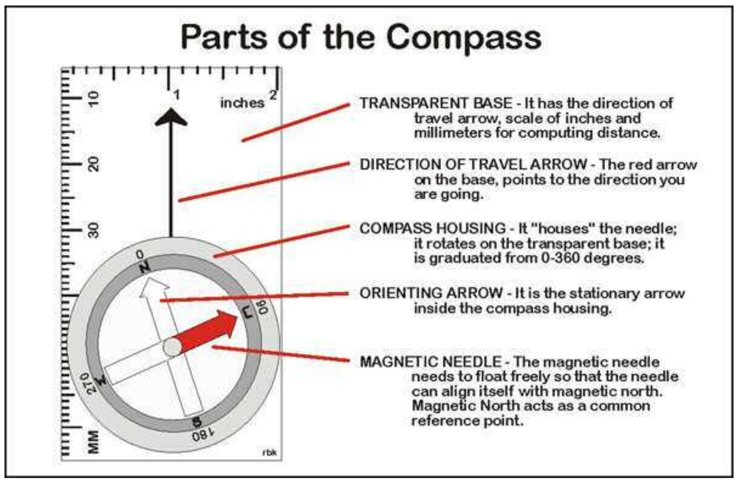

Figure 13.24: Parts of a Compass.

If you want to determine north, this can be done two ways. First, let the magnetic needle float freely within the compass housing. It will point magnetic north. Magnetic north is a reference point. It is a reference point that enables you to orient everything else in the environment. Second, rotate the direction of travel arrow to north or zero degrees. Rotate everything including yourself until the magnetic needle is superimposed over the orienting arrow in the compass housing. The direction of travel will be pointing to magnetic north.

<u>Finding a Bearing to an Object</u> – There are two ways to use a compass. The first is to find the bearing to an object in the environment and is covered in this section. The object can be a tree, building, mountain peak, river cut, or any prominent object. Remember that objects will change in terms of their relative size, color and relationship to their surrounding the closer that you get to the object. A typical use of this method is to triangulate two or three objects to determine your specific location on a map. You determine the bearings to two or more known objects in the environment and where the bearing lines intersect on the map is your location. The following steps are used to find a bearing to an object in the real environment.

Step #1 – The first step is to point the direction of travel arrow toward the object in the real environment (Figure 13.25). During this phase, the magnetic needle and orientation arrow in the compass housing will normally not be aligned.

Step #2 – Next, rotate the compass housing until the orientation arrow in the compass housing is aligned underneath the magnetic needle (Figure 13.26). Be sure that the red portion of both arrows are aligned. Also, be sure that the direction of travel arrow is still pointing to the object in the environment. Read the bearing off the compass housing. This bearing is your direction of travel to the object. It is also the bearing to an object even if you aren't going to travel to that object.

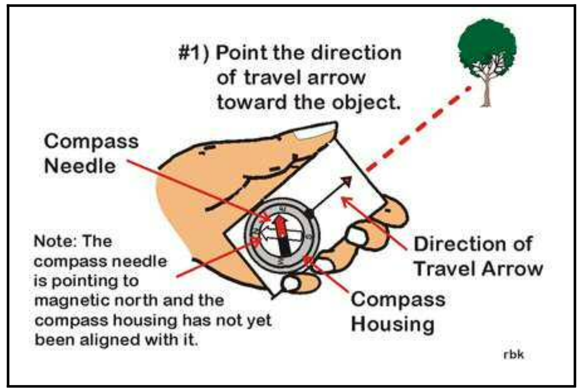

Figure 13.25: Finding a bearing to an object (Part 1).

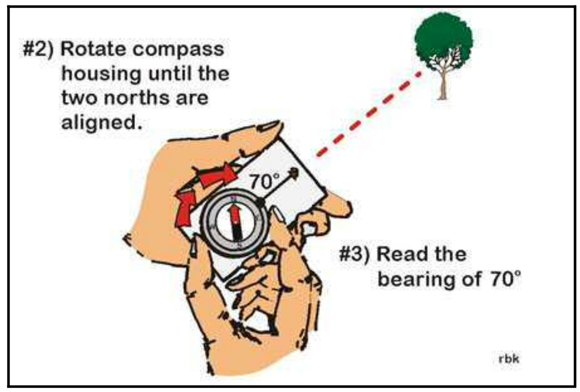

Figure 13.26: Finding a bearing to an object (Part 2).

<u>Given a Bearing, Find an Object</u> – The second way to use a compass is given a bearing, find an object in the environment (Figure 13.27). A typical use of this method is to determine the bearing from a topographic map or nautical chart and then travel on that bearing. However, more on this in the Map and Compass section. The following are the steps on how to find an object in the real environment when given a bearing. The following steps are used to find an object in the environment given a bearing.

Step #1 – Given a bearing, rotate the compass housing until the bearing on the compass housing aligns with the direction of travel arrow.

Step #2 – Rotate both you and the compass until north on the magnetic needle (red portion) is aligned on top the compass housing north. Often many people find this to be difficult because they want to remain stationary. However, it is important to rotate both the compass and yourself.

Step #3 – With your line of sight, follow the direction of travel arrow, look up and find an object in the environment that the arrow is pointing at. If you travel toward that object, you will be traveling on the bearing.

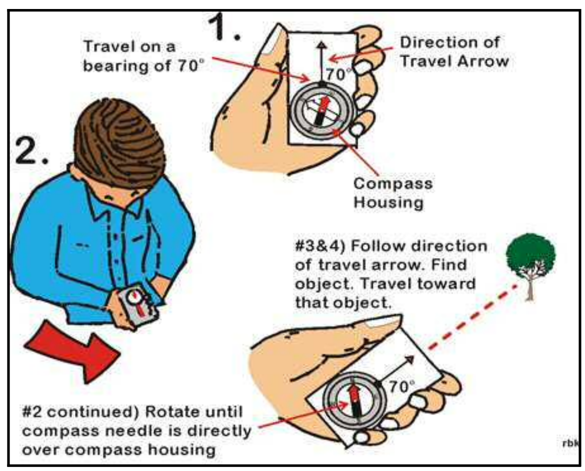

Figure 13.27: Given an object, find an object in the environment.

Summary:

Magnetic north is a global reference point. The magnetic needle in a compass points to this location pretty much anywhere. Since it is a global reference point, magnetic north aids in orientation and navigation. A compass can be used two way. First to find the bearing to an object in the real world and second, given an object in the real world to find a bearing to it. The trick is to integrate the use of the compass with topographic maps or nautical charts which is a topic in the next section.

Chapter 13.4: Map and Compass

The purpose of this section is to combine map and compass to navigate or orient yourself. It combines and integrates the previous sections (i.e. compass and topographic maps). As with the compass, there are two ways to use a map and compass. The first is given a bearing, find an object in the real world on that bearing. The second is given an object in the real world, find the bearing to it. Integrating topographic maps, the first approach is to find the direction to an object on the map and then find that direction or bearing to the same object in the real world. The second approach is to find the direction in the real world and then determine it on the map.

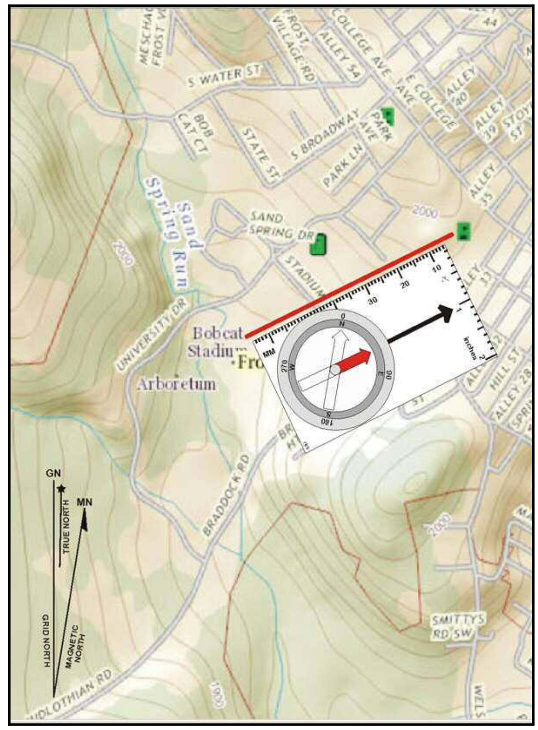

Figure 13.28: Determining the direction of travel on the map.

Map and Compass (from map to compass bearing)

The first scenario is to determine the direction from point A on the map to point B and then find the direction in the real world to point B. The purpose of this exercise is to determine the bearing or angle of travel on the map and then to convert the bearing into an actual bearing of travel in the real world. The following directions are used to accomplish this task.

<u>Step #1: Determine the direction of travel on the map</u> – For the purposes of this exercise, lines are drawn on the map to illustrate the different steps used to find the bearing. The first step is to determine where you are on the map and where you want to go (Figure 13.28).

<u>Steps</u>:

1) You want to travel from the Bobcat Stadium to Old Main.
2) Using the compass base, draw a line from the Bobcat Stadium to Old Main.
3) This line is the direction of travel on the map.

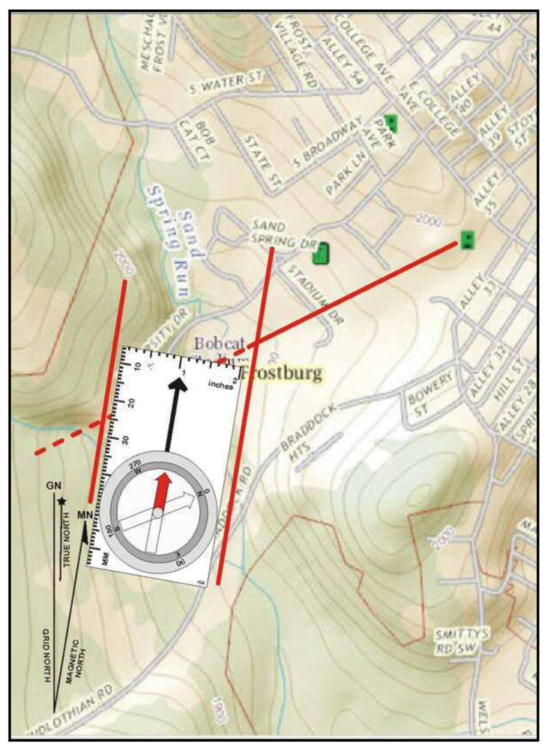

Figure 13.29: Extend MN and direction of travel lines until they intersect.

<u>Step #2: Extend the MN and direction of travel lines until they intersect</u> – The second step is to extend the magnetic north arrow and direction of travel lines until they intersect (Figure 13.29). Use the base of the compass or a ruler to accomplish this task. Because you are extending the magnetic north arrow on the map, there is no need to correct for declination (i.e. the angle between

MN and GN).

Steps:

1) Using the compass base, extend the line from the Bobcat Stadium to Old Main (dotted line) and extend the MN upward until the two lines intersect.
2) Note: As shown, both sides of the compass base can be used to extend the lines.
3) The intersection of the two lines creates an angle. This angle is the bearing.

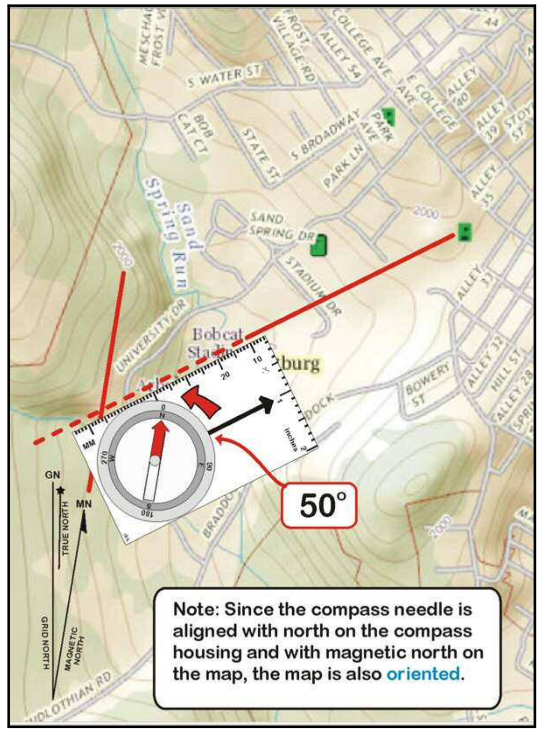

Figure 13.30: Determine the angle (bearing).

Step #3: Determine the angle (bearing) – The third step determines the angle in degrees between the magnetic north line and the direction of travel line (Figure 13.30). Place the compass base on the direction of travel and rotate the compass housing until the orientation arrow in the compass housing is parallel with the magnetic north line on the map. Read the bearing off the compass housing where the direction of travel arrow intersects the compass housing. This is the bearing of travel. If you find it easier, you can place the direction of travel arrow directly over the line of travel on the map. The base of the compass housing and the direction of travel are parallel and create a parallelogram.

At this time ignore the magnetic compass needle in the compass housing. You are using the compass as a protractor at this point and not as a compass. If you line up the magnetic compass needle with the orientation arrow in the compass housing the map will be ***oriented*** also. This means that all the elements on the map are in the same general location as they are in the real world.

Steps:

1) Place the compass base parallel to the direction of travel. (Note: The direction of travel can be placed directly over the line also)
2) Rotate the compass housing until the orientation arrow in the compass housing is aligned or parallel with the MN line.
3) Read the bearing off the compass housing. This is where the direction of travel intersects the compass housing.
4) The direction travel is 50º East.

Step #4: Travel on a bearing – Now that you have a bearing of travel from the Bobcat Stadium to Old Main on the map, you can use that bearing to travel to Old Main in the real world (Figure 13.31). Hold the compass in your hand. Rotate the compass and yourself until the compass housing orientation angle lies directly underneath the magnetic north needle. Be sure the magnetic needle is floating freely. Do not move the compass housing. Rotate everything. Pick an object and travel to it. Repeat the process until that object is Old Main. You can hold both the map and compass together or hold just the compass. Either way will work.

Steps:

1) This is the same process as described under using a compass – "given a bearing, find an object in the real world."
2) You are standing at the Bobcat Stadium. You will travel on a 50o East bearing (from Step #3). Find an object in the real world and travel to that object.
3) Be sure that the magnetic needle and the north arrow in the compass housing remain aligned.

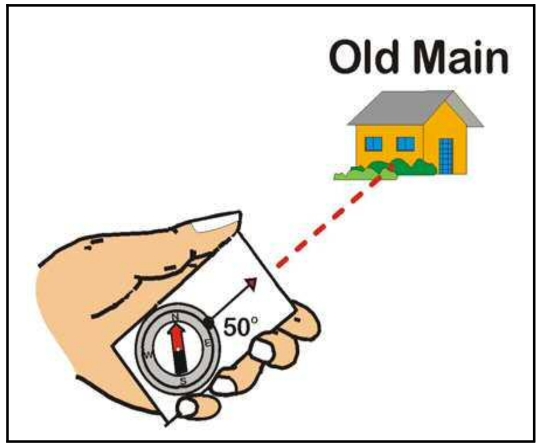

Figure 13.31: Travel on a bearing.

Map and Compass (Triangulation)

The second scenario works in reverse. This is where you find your location on the map based on bearings to known objects in the real world. In the example below, a bearing will be found to two objects in the real world (Old Main and the intersection of Loop and Braddock Roads). Using these bearing, lines will be drawn on the map on these bearings. Your location is the intersection of the two lines. Triangulation is the process of taking the bearing to two or more objects in the real world and then working in reverse to find your location on the map.

Step #1: Determine a bearing to two or more objects – In the triangulation process, the first step is to take a bearing to two or more known or identifiable locations (Figure 13.32). Generally, the wider the angle between the two objects the more accurate the determination of your location.

Step #1:

1) You think you are at the Bobcat Stadium but you are not sure?
2) Take a bearing to Old Main. It is a 50° East bearing.
3) Take a second bearing to the intersection of Loop Road and Braddock Road. It is a 180° South bearing.
4) Next, you will determine your location on the map from these two bearings.

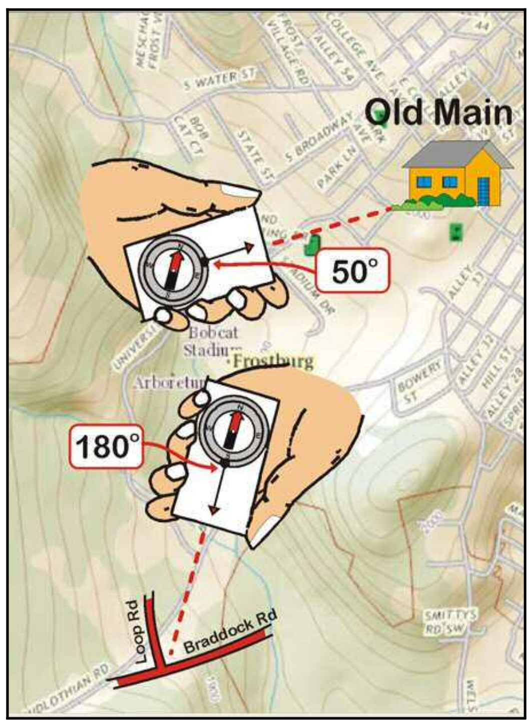

Figure 15.32: Determine a bearing to two or more objects.

Step #2: Transfer the first bearing to the map – In the second step, you are going to transfer the bearing from the real world to the map (Figure 13.33). You will need to identify both Old Main and the intersection of Loop and Braddock Roads on the map. You will be working backward. Place the direction of travel pointing to Old Main and using the compass as a protractor, rotate the compass until north in the compass housing is aligned (parallel) with magnetic north on the map. Be sure to keep the direction of travel pointing toward Old Main. Draw a line on the map from Old Main. You are located somewhere on this line. Step #3 will provide an intersecting line and an exact location.

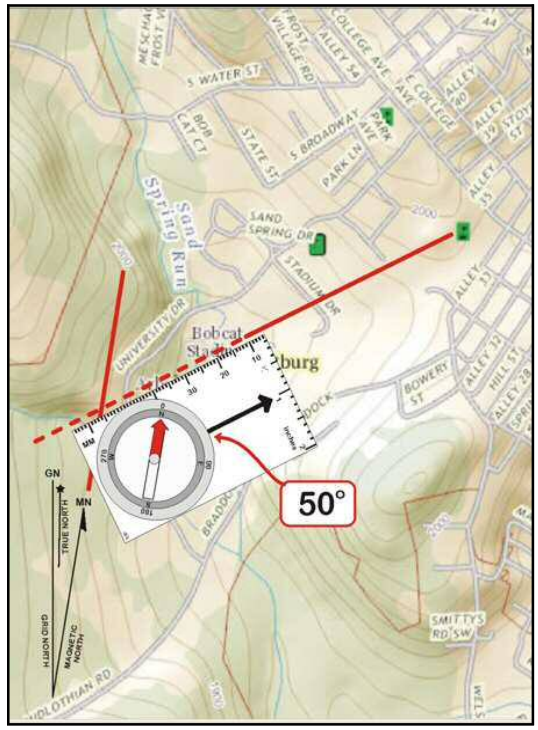

Figure 13.33: Transfer the first bearing to the map.

Step #2:

1) Place the compass base or direction of travel arrow on the map so that it is pointing to Old Main.
2) Rotate the entire compass until the orientation arrow in the compass housing is aligned or parallel with the MN line. DO NOT ROTATE THE COMPASS HOUSING.
3) Draw a line on the map westward from Old Main. This is the bearing of 50º East on the map.
4) You are located somewhere on this line. The second bearing will tell you exactly where.

Step #3: Transfer the second bearing to the map – This step is identical to Step #2 except it is the transfer of the bearing to the intersection of Loop and Braddock Roads to the map (Figure 13.34). This is tricky because there is a temptation to readjust the compass. AGAIN, DO NOT ROTATE THE COMPASS HOUSING.

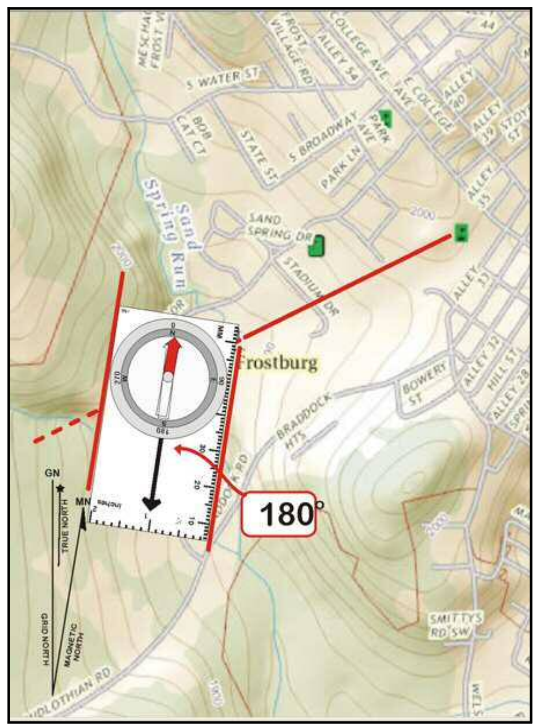

Figure 13.34: Transfer the second bearing to the map.

Step #3:

1) You know the actual compass bearing to the intersection is 180º South.
2) Place the compass base or direction of travel arrow on the map so that it is pointing to the intersection and rotate the entire compass until the orientation arrow in the compass housing is aligned or parallel with the MN line. DO NOT ROTATE THE COMPASS HOUSING.
3) Draw a line on the map northward from the road intersection. This is on a bearing of 180 degrees north.

<u>Step #4: Your location is the intersection of the two lines</u> – Your location is the intersection of the two bearing lines (Figure 13.35). In the real world you will know that you are at the Bobcat Stadium because you will be standing next to the stadium. In this case, it provides a check of your work. In most places on the East Coast, there are sufficient buildings and features that the map can be oriented by simply rotating the map until the known objects on the map are aligned with their relative position in the real world (Figure 13.36).

<u>Step #4</u>:

1) Line #1 is the bearing of 50º east from Old Main (a known location).
2) Line #2 is the 180º south from the intersection of Loop and Braddock Roads (a second known location).
3) You have determined your location. It is the intersection of the two bearings. And, yes, it is Bobcat Stadium.
4) Triangulation suggests three bearings. Actually, only two bearing are needed to find your location.

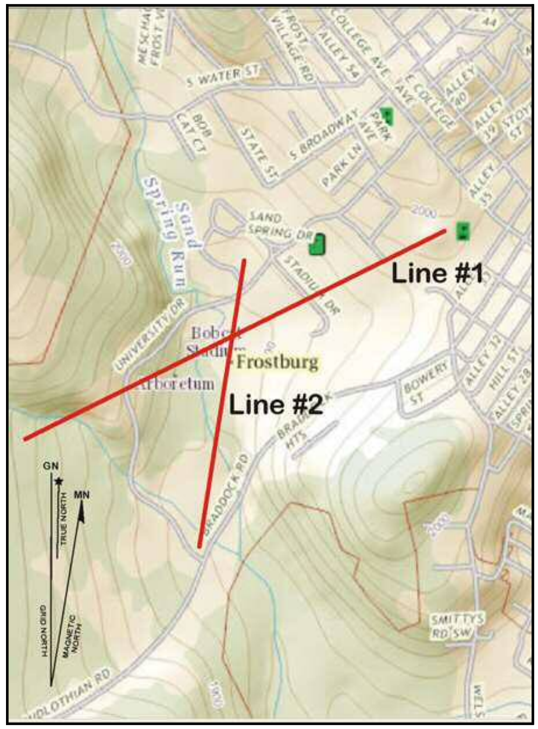

Figure 13.35: Your location is the intersection of the two lines.

Summary

The purpose of this section is to combine map and compass to navigate or orient yourself. It combines and integrates the previous sections (i.e. compass and topographic maps). As with the compass, there are two ways to use a map and compass. The first is given a bearing, find an object in the real world on that bearing. The second is given an object in the real world, find the bearing to it. Integrating topographic maps, the first approach is to find the direction to an object on the map and then find that direction or bearing to the same object in the real world. The second approach is a triangulation approach where you find the direction in the real world and then determine it on the map.

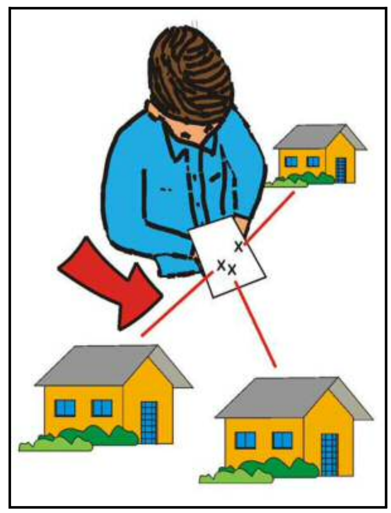
Figure 13.36: Orientating the map.

References:

Burns, B., and Burns, M., (2004). Wilderness Navigation – Finding your way using map, compass altimeter & GPS. Seattle, Washington: Mountaineers Books.

Fear, G., and Mitchell, J., (1977). Fundamentals of Outdoor Enjoyment, Tacoma, Washington: National Search and Rescue.

Gatty H. (1983). *Finding Your Way Without Map or Compass*. Mineola, New York: Dover Publications, Inc.

Kauffman, R. (1992). *Handout: How to use map and compass.* Unpublished handout.

Kjellstrom, B.,(2010) *Be Expert with Map and Compass.* Hoboken, New Jersey: John Wiley & Sons, Inc.

Seidman, D., (2001). *Wilderness Navigator*. Camden, Maine: Ragged Mountain Press.