PART 1  Basic Land Navigation

LAND NAVIGATION

Why Learn Land Navigation?

- Tracking present location (Where am I?)
- Determining Distance (How far is it and am I there yet?)
- Sense of direction (Where do I want to go and where am I actually going?)
- How to read a topographic map (Do I understand the map?)
- Terrain and map association (What hill or river am I looking at?)
- Spatial skills (Can I mentally visualize the landscape in 3D?)
- Planning safe, practical routes (Take a long safe route or a short risky route?)
- And more navigational skills

The best way to learn land navigation is to get "dirt time," that is, get out there with a map and compass! Navigation is not about finding yourself after you are lost (although that's what happens sometimes); it's about keeping track of your position as you move away from a known point. As you move you have to remain cognizant of the terrain you are leaving, of the terrain you are passing, and of the terrain that is ahead.

Navigation in the wilderness means knowing your starting point, your destination, and your route to get there. These skills will allow you to venture farther off the beaten path than you ever thought before.

PART 1  Basic Land Navigation

- The Lensatic Compass
  - Description
  - Parts and Features
- The Topographic Map
  - Description
  - How to Read
- The Land
  - Terrain Features
  - Terrain and Map Association

LAND NAVIGATION WITH MAP AND LENSATIC COMPASS

This presentation is divided into four parts:

PART 1  Basic Land Navigation

- The Lensatic Compass
- The Topographic Map

PART 2  Intermediate Land Navigation

- Making Sense of Direction
- Tracking Present Location
- Determining Travel Distance

PART 3  Advanced Land Navigation

- Planning to Navigate
- Navigation Methods to Stay On Course
- Additional Skills of Land Navigation

PART 4  Expert Land Navigation

- Navigation in Different Types of Terrain
- Night Navigation
- Sustainment

THE LENSATIC COMPASS

The genuine Lensatic compass differs from the type most hikers are familiar with, the traditional "orienteering" compasses. The Lensatic, a design preferred by military forces for its precision and durability, is designed to take hyper-accurate bearings for land navigation and directing artillery fire.
LENSATIC COMPASS

DESCRIPTION

• Preferred by military for its precision and durability, and its hyper-accuracy in land navigation and combat.

• Battle tested - shock, water, sand proof, and functional from -50ºF to +150ºF.

• Uses a retractable lens to read the bearing while simultaneously sighting an object.

• With the lensatic you can point and shoot one target and immediately move on to the next.

• Luminous Lights allow for navigation in low-light conditions and night navigation.

• Equipped with a magnifying lens, sight wire, and dial graduations in both degrees and mils to ensure accurate readings.

• Copper induction dampening system slows the rotation of the magnet without the use of liquids. Will divide time, lock for military bearing when closed to break wind and fare.

• Employs a "Card" type compass Dial, and this makes for single handed operation.

• A 'deep-well' design is used to allow the compass to be used globally with little or no effect in accuracy caused by a tilting compass dial.

• Lensatic sighting compasses are so simple and rugged and incredibly easy to use that is no wonder they are the standard type used for navigation by the U.S. Military.

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- Cover - Protects the floating dial and other parts of the compass when closed.

- Floating Dial Scale - Used mainly in artillery, tank, and mortar gunnery. Mils is also used for very accurate azimuth land navigation.

- Base - The main body of the compass. If for any reason, the lensatic compass were to malfunction, the base would be the piece that you would want to still work.

- Bezel Ring - device clicks when turned; full 360° rotation is 120 clicks; each click equals 3°.

- Luminous Bezel Line - Used to mark a course direction during day or night navigation.

- Floating Dial - black scale (mils), red scale (degrees), set in a deep tub for global use.

- Luminous Heading - to read azimuth heading in low-light or night conditions.

- Luminous Magnetic Arrow - always points to magnetic north.

- Thumb Loop - to hold compass with the thumb.

- Fixed Index Line - azimuth heading.

- Lanyard Ring - for string or rope.

NOTE:

The only way for the compass to malfunction is for the user to misuse and abuse the compass.

FLOATING DIAL SCALE

BLACK RING

Mils is used mainly in artillery, tank, and mortar gunnery. Mils is also used for very accurate azimuth land navigation.

- Distance Between Small Marks = 20 Mils
- Distance Between Big Marks = 100 Mils
- Distance Between Red Numbers = 200 Mils

N = 0°
E = 90°
S = 180°
W = 270°

8.89 Mils = ½ Degree
17.78 Mils = 1 Degree

RED RING

Degrees - common unit of measure in the degree (°)

- 360 Degrees to a Circle
- Distance Between Small Marks = 5 Degrees
- Distance Between Big Marks = 10°
- Distance Between Red Numbers = 20°
Exactly 1 cm (every 5 ticks)

NEARLY 1 inch (every 13 ticks)

Used to take distance measurements from point "A" to point "B" on maps, in conjunction with the distance bar scales on the map.

NOTE: When used on a 1:50,000 map, each tick mark on the edge represents 100 meters (107 yards) of ground distance.

LENSATIC COMPASS

HANDLING A COMPASS

When using a compass check . . .
- That the dial does not stick
- Sighting wire is not bent
- Glass and other parts are not broken
- Numbers on the dial are legible
- Check for accuracy along a known line of direction
- Lensatic compass is accurate to a ½° degree (better when using the mils scale).

EFFECTS OF METAL AND ELECTRICITY—these sources affect the performance of a compass during use.
- 180 feet / 55 meters—High tension power lines
- 33 feet / 10 meters—Truck, car, dressed wires
- 6 feet / 2 meter—Hunting rifle
- 1 feet / ½ meter—Knife, flashlight, binoculars, camera
- Inches / centimeters—Belt buckle, paper clip, jewelry etc.
- Misc distances—Any local geological magnetic rocks.

HOW TO SIGHT A LENSATIC COMPASS

Compass-to-Cheek method for taking a target azimuth bearing
- The compass-to-cheek technique is used almost exclusively for sighting, and it is the best technique for this purpose.
- It is the most efficient technique for taking an accurate azimuth bearing.

NOTE: The Lens Rear Sight also serves as a locking device and locks the dial jeweled bearing to protect from wear and tear when closed. Also the rear sight must be opened more than 45° to allow dial to float freely.

When traveling make sure that the rear sight is totally folded down as this will lock the floating dial and prevent vibration, as well as protect the crystal and rear sight from being damaged.
Compass-to-Cheek method for taking a target azimuth bearing

- This compass-to-cheek technique is used almost exclusively for sighting, and it is the best technique for this purpose.
- It is the most efficient technique for taking an accurate azimuth bearing.

65° AZIMUTH
(11.5m = 1,150mils)
The center-hold technique is less precise, but is faster to use and can be used under all conditions of visibility.

1. Open the cover until it forms a straight edge with the base.
2. Pull the rear sight to the rear most position, allowing the dial to float freely.
3. Next, place your thumb through the thumb loop, form a steady base with your third and fourth fingers, and extend your index finger along the side of the compass.
4. Place the thumb of the other hand between the rear sight and the bezel ring; extend the index finger along the remaining side of the compass, and the remaining fingers around the fingers of the other hand.
5. Pull your elbows firmly into your sides; this will place the compass between your chin and your belt.
6. To measure azimuth, turn entire body toward the object, pointing the compass cover directly at the object.
7. Once you are pointing at the object, look down and read the azimuth from the fixed black index line.

**Center-Hold method for following an azimuth bearing**

1. Using the center-hold technique to hold the compass to your body.
2. Turn your body till desired azimuth is aligned with black index line. Example 25º.
3. Without turning compass, rotate bezel ring till luminous bezel line is aligned with north arrow.
4. Once bezel is set, leave it there. (Till you are ready to change heading, then start the process over again.)
5. Keeping north arrow aligned with luminous bezel line, proceed forward in the direction of the desired azimuth 25º.
TOPOGRAPHIC MAP DESCRIPTION

- Reading maps is a language composed of lines, colors, and symbols.
- Five basic colors are used for Topographic Maps.
  - Brown (Contour Lines)
  - Black (Man Made Features, Roads, Trails)
  - Blue (Water Features)
  - Green (Vegetation)
  - Red (Highway and Land Grids)
- Two minor colors
  - Pink (Built up area, civilization)
  - Purple (Updated Map Information)
- Symbols are used to represent the natural and man-made features of the earth.
- Lines show relief and elevation; it indicates variations in terrain features and heights of natural features.
- Every map has marginal information about the map.
- Maps come in three scale sizes: SMALL, MEDIUM, and LARGE, which affects the amount of area covered and detail that will be shown.

A map is read for four basic kinds of information.

- Direction
- Distance
- Position
- Identification

Maps must be taken care of and properly folded for field use.

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A map could be compared to any piece of equipment, so before it is passed into operation the user must read the instructions.

It is important that you know how to read these instructions.

The most logical place to begin is the marginal information and symbols, where useful information telling about the map is located and explained.

All maps are not the same, so it becomes necessary every time a different map is used to examine the marginal information carefully.

Map Margin Information

The top left corner of all USGS topographic maps carries the imprint of the authority responsible for the mapping.

In the upper right corner is the complete quadrangle name. The state is also given, as may be the county. Also included is the area covered and the type of map.

In the bottom right corner of the map is a key to roads on the map.

At bottom center is the map scale ratio - size of area covered and terrain detail.

The contour interval. The contours are the brown lines.
Map Margin Information

In the lower left corner is the credit legend, a complex of information. And the following:

- The magnetic declination.
- The star indicates true north: the direction of the North (rotational) Pole.
- "MH" indicates the direction of the North Magnetic Pole.
- "GN" (Grid North), the Universal Transverse Mercator (UTM) grid.

Additional information is distributed around the entire map margin. (Only “need to know” items are circled)

- (1) Names for adjoining quadrangle maps (in black). Adjacent to corners and centers of the map sides.
- (2) In red are the distances by road to the nearest towns.
- (3) The spherical grid; latitude and longitude, complete coordinates are given at each corner of the map.
- (4) The UTM (in black lettering with blue tics) and the UTM grid is in kilometers.

Map Scale

- Map scale is the relationship between distance on a map and the corresponding distance on the ground. Scale is expressed as a ratio, such as 1:24,000, and shown graphically by the bar scales marked in feet and miles or meters and kilometers.

You must know the scale to determine ground distances between objects or locations on the map, the size of the area covered, and how the scale may affect the amount of detail being shown.

The terms "small scale," "medium scale," and "large scale" may be confusing when read in conjunction with the number.

However, if the number is viewed as a fraction, it quickly becomes apparent that 1:600,000 of something is smaller than 1:75,000 of the same thing. Therefore, the larger the number after 1: the smaller the scale of the map.

1. Small: Maps with scales of 1:1,000,000 and smaller are used for general planning and for strategic studies. The standard small-scale map is 1:1,000,000 (1 inch = 16 miles). This map covers a very large land area at the expense of less detail.

2. Medium: Maps with scales larger than 1:1,000,000 but smaller than 1:75,000 are used for operational planning. They contain a moderate amount of detail, but terrain analysis is best done with the large-scale maps. The standard medium-scale map is 1:250,000 (1 inch = 4 miles). Medium-scale maps of 1:150,000 are also frequently encountered.

3. Large: Maps with scales of 1:75,000 and larger are used for tactical, administrative, and logistical planning. These are the maps that you as a leader or junior leader must depend on in exercises. The standard large-scale map is 1:24,000. However, many areas have been mapped at a scale of 1:12,000 (1 inch = 2,000 feet). Lots of detail is shown on this type of map.

Map Symbols

Symbols are used to represent the natural and man-made features of the earth. It is a map language that is simple to read and understand. BUT you must first know what the map symbols represent, in order to understand, read and speak map language to others.
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Map Symbols

VEGETATION
- Woods
- Shrub
- Orchard
- Vineyard
- Mangrove

 autres
- Perennial stream
- Intermittent stream
- Perennial lake or pond
- Dry lake
- Well or spring
- Dam
- Canal

CONTOUR LINES
- Contour Interval: The contour interval is the distance between each contour line. The contour interval is found along the bottom edge, center of the map.
- Intermediate Contour: a broken line on a topographic map and represents a line of equal elevation.
- Index Contour: a bold black line that has the elevation value instead of various intervals as a part of the line.

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Map Symbols

RIVER, LAKES, AND CANALS
- Intermittent stream
- Perennial stream
- Intermittent river
- Perennial river
- Small falls; small rapids
- Large falls; large rapids

PART 1  Basic Land Navigation

Map Symbols

MINI-MADE FEATURES and HIGHWAY & LAND GRIDS
- Highway
- Road
- School
- Church
- Airport
- Landing Strip
- Bridge
- Canal
- Mine
- Grave Pit

PART 1  Basic Land Navigation

Map Symbols

CONTOUR LINES
- There is a dimension to establishing position which does depend on map reading skills.
- This is the vertical dimension. On a map it is referred to as "relief.
- Knowledge of the relief of an area is extremely important to a wilderness navigator.
- If you were to walk a contour line you would never go down hill and never up hill, and eventually you
  would come back where you started.

PART 1  Basic Land Navigation
### Terrain Relief Features

**Five Major**
- Ridge
- Hill
- Saddle
- Valley
- Depression

**Three Minor**
- Spur
- Draw
- Cliff

**Two Supplemental**
- Cut
- Fill
Terrain Features

Map Information – Direction

EXPRESSING DIRECTION

- You need a way of expressing direction that is accurate, adaptable to any part of the world, and has a common unit of measurement. Directions are expressed in units of angular measure and direction implies a reference point.
- The common reference point for maps is True North, and map direction is figured in degrees from that point.
- "Azimuth" is the direction from one point to another point (either on the map or on the ground) is measured in units of angular measure.
- Azimuths are given in degrees in a counterclockwise direction. They range from 0° to 360°. North is 0°, South is 180°, East is 90°, and West is 270°.
- Maps are laid out with the top toward the top of the earth – True North (geographic north) and map north. The side edges of the map are the only lines on the map guaranteed to run true north-south.
- The magnetic north on a map is the north pole of the earth’s magnetic field and may not be the same as true north.
- With compass and map you can know what direction you are heading.
Map Information – Direction

THREE TYPES OF DIRECTION
- True North: A line from any point on the earth's surface in the true north (in a steel compass).
- Magnetic North: The direction is found using a magnetic compass. It is the direction in which the magnetic needle points (usually north) when the compass is level and pointed towards the magnetic north pole.
- Grid North: This is the northward direction indicated by using the vertical grid lines on the map. It is used for military grid systems and does not necessarily align with true or magnetic north.

G-M ANGLE: The angular difference between GN and MN.

\[
\text{G-M Angle} = 12^\circ + 24^\circ = 36^\circ
\]

If you have MN LINES

1. Use a protractor and the map does NOT need to be oriented.
2. It is used to calculate direction from maps. The protractor is used to orient a grid point or a map to the true north.
3. You can:
   - Plotting azimuths
   - Plotting points
   - Plotting UTMs coordinates

NOTE: If you have only the G-M Angle on the map, you can align the protractor to 36°. Align the protractor with the G-M Angle and you must turn to the true north.

[Diagram showing map information and direction conversion]

Map Information – Direction

CONVERSION (three ways to remember)

- Left to right:
  - Subtract: \[ \text{G-M Angle} = 12^\circ + 24^\circ = 36^\circ \]

- When MN is to the east/right of GN
  - \( \text{G-M Angle} \) is positive
  - Add \( \text{G-M Angle} \) to GN

- When MN is to the west/left of GN
  - \( \text{G-M Angle} \) is negative
  - Subtract \( \text{G-M Angle} \) from GN

- From map to ground:
  1. You must know the bearing of a landmark on the map. In this case, it's 12° MN.
  2. Plot the bearing on the map as \( 12^\circ \).
  3. So GN to MN is \( 12^\circ + 24^\circ = 36^\circ \) (Plot this on your compass).

- From ground to map:
  1. You must know the bearing of a landmark on the ground with a compass. In this case, it's 12° MN.
  2. Plot the bearing on the map as \( 12^\circ \).
  3. So MN to GN is \( 12^\circ - 36^\circ = -24^\circ \) (Draw this on your map).

- From map to ground:
  1. You must know the bearing of a point on the map with a protractor (from above). In this case, it's 12° MN.
  2. Plot the bearing on the map as \( 12^\circ \).
  3. So GN to MN is \( 12^\circ - 36^\circ = -24^\circ \) (Add this on your map).
**Map Information – Direction**

**Orienting the Map with the Landscape (True North)**

- **TECHNIQUE # 1 (True North)**
  1. Identify several landmarks on the map and on the terrain.
  2. Visually orient the map landmarks with the terrain landmarks.
  3. The map is oriented to True North.

**Orienting the Map with the Landscape (Magnetic North)**

- **TECHNIQUE # 2**
  1. Select a terrain feature on the ground that you can find on the map, example the HILL.
  2. Lay the compass on the MN line on the map.
  3. Align the compass edge through the HILL on the map.
  4. The map is oriented MN.

**Orienting the Map with the Landscape (Magnetic North and True North)**

- **TECHNIQUE # 3**
  1. Find Magnetic Declination value in the map margin (bottom left corner), example 11.5°.
  2. Place compass edge on edge of map North/South line with front of compass facing top of map.
  3. The map is oriented to MN.

**Orienting the Map with the Landscape (True North – Black Index Line)**

- **TECHNIQUE # 4**
  1. Identify several landmarks on the map and on the terrain.
  2. Visually orient the map landmarks with the terrain landmarks.
  3. The map is oriented to True North.

**Map Information – Distance**

- **Orienting the Map with the Landscape**
  1. Lay the compass on the MN line on the map.
  2. Rotate the compass to align the protractor to GRID.
  3. You see that the azimuth is 295°.
  4. Convert this to MN azimuth and put this on your compass.
  5. You are in thick woods and cannot see any landmarks. But you decide to go for a hill (A) on the map.
  6. Lay the compass on the MN line on the map.
  7. Align the compass edge through the HILL on the map.
  8. With compass & map:
     - **TECHNIQUE # 1** (True North)
     - **TECHNIQUE # 2** (Magnetic North)
     - **TECHNIQUE # 3** (Magnetic Declination)
     - **TECHNIQUE # 4** (Black Index Line)

- **Map Scale**
  - The relationship between map and ground distance is the function of the map scale.
  - The bar scale looks like a small ruler and usually has 3 to 4 bar scales; feet, inches, meters, and kilometers.
  - The ability to determine distance on a map, as well as on the earth’s surface, is an important factor in planning and executing safe, practical routes.
  - The map scale of 1:xx,xxx means that one unit of measure on the map is equal to xx,xxx units of the same measure on the ground.
    - Example: A map scale of 1:25,000 means that one unit of measure on the map is equal to 25,000 units of the same measure on the ground.
      - On map 1 cm = 25,000 cm (250 meters, 0.25 kilometers) on the ground.
      - On map 1 in = 25,000 inches (6566.7 feet, 2002 meters) on the ground.
      - Example below shows the navigator using centimeters (cm) as a measurement, therefore the map 10cm x 25,000 = 250,000cm (2.5 kilometers) on the ground.
  - The map scale of 1:100,000 means that one unit of measure on the map is equal to 100,000 units of the same measure on the ground.
    - Example below shows the navigator using centimeters (cm) as a measurement, therefore the map 10cm x 100,000 = 1,000,000cm (10 kilometers) on the ground.
  - The map scale of 1:250,000 means that one unit of measure on the map is equal to 250,000 units of the same measure on the ground.
    - Example below shows the navigator using centimeters (cm) as a measurement, therefore the map 10cm x 250,000 = 2,500,000cm (25 kilometers) on the ground.
  - On map 1 cm = 250,000 cm (2500 meters, 2.5 kilometers) on the ground.
  - On map 1 in = 250,000 inches (50833 feet, 1500 meters) on the ground.
  - On map 1 cm = 100,000 cm (1000 meters, 1 kilometer) on the ground.
  - On map 1 in = 100,000 inches (2666.7 feet, 300 meters) on the ground.

- **Conversion of Directions**
  - A map scale of 1:100,000 means that one unit of measure on the map is equal to 25,000 units of the same measure on the ground.
    - On map 1 cm = 25,000 cm (250 meters, 0.25 kilometers) on the ground.
    - On map 1 in = 25,000 inches (666.67 feet, 202.78 meters) on the ground.
    - On map 1 cm = 100,000 cm (1000 meters, 1 kilometer) on the ground.
    - On map 1 in = 100,000 inches (2666.67 feet, 300 meters) on the ground.
Map Information - Position

- Finding one's position on a map in the usual sense, such as at the intersection of two compass bearings, is more a matter of compass technique than of map reading skills. BUT...
- It is possible to locate your POSITION on a map without a compass, by land feature and map association.
- It is IMPOSSIBLE TO BE TOTALLY LOST. Finding your location is a process of narrowing down the options until you can determine a point on a map.
- By determining the lay of the land and finding prominent features, then relating them to your map, the narrowing-down process will not take long.
- Landmarks can be anything that you recognize as being on the map. Classically these are hill tops, but you can use the intersection of two roads, a building such as a power grid sub-station, the abrupt edge of a ridge, the edge of an island, the bend in a trail, anything that you can recognize as being on the map and that you can see.

Map Information - Identification

- The identification of significant features, both natural and man-mades, is partly a matter of knowing the language of maps.
- One category of map language is lines. In addition to showing contour relief, lines are used to portray roads, trails, railroads, power lines, and drainage features.
- Another category of map language is composed of various picture symbols.
- A third part of map language is color.
- Part of identification is in knowing the language of maps; the rest is a problem of interpretation. What is the relationship among contour lines, symbols, and color?

Navigation is not about finding yourself after you are lost (although that's what happens sometimes); navigation is about keeping track of your POSITION as you move away from a known point. As you move you have to remain cognizant of the terrain you are leaving, of the terrain you are passing, and of the terrain that is coming up.
Map Information – Identification

What a Topo map and actual Land features show

Compare the next five slides with this map, to get view point perspective of what you see on this map and what you see on the landscape in front of you.

View 1

View 2

Map Information – Identification

What a Topo map and actual Land features show

Note: here the map is turned upside down so you can get a better perspective.

View 1

View 2
Map Folding and Map Care

- Maps should be correctly folded.
  - Maps should be folded to make them small enough to be carried and still be available for use without having to unfold them entirely.
  - After a map has been folded it should be placed in a folder for protection. This will prevent the corners and edges of the map from wearing out and tearing easily when opened.

- It is hard to navigate accurately with a dirty, grimey, wet or damaged map. Take care of your map and it will take care of you.
  - Most maps are printed on paper and require protection from water, mud, weather, and tearing.
  - Whenever possible, a map should be carried in a waterproof packet to prolong its life.

- Marking a map.
  - If it is necessary to mark a map, use light lines so that they may be erased without smearing or smudging. If the margins of the map must be marked care must be taken that additional information which may be needed, such as grid data or magnetic declination data, be marked on the back of the map.

- Special care should be taken of a map that is being used in any situation, especially in a small group; the mission may depend on that map.

All members of the group should know the map’s location at all times.

THE END OF LAND NAVIGATION
PRESENTATION
PART 1