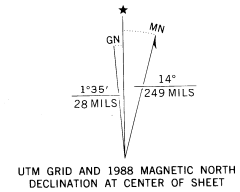
Geography 12: Maps and Mapping

Lecture 12:
Navigation: Route Selection

Review: Position Finding

- Environmental
- Compass (declination)
- Gyrocompass
- Digital compass
- GPS

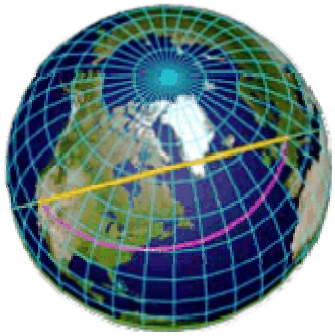


UTM GRID AND 1988 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET



Directions on Maps

- Orthodrome: line of true azimuth, Great Circle
- Loxodrome (Aka Rhumb line): Constant azimuth; directional line that crosses each successive meridian at a constant angle



Projection matters!

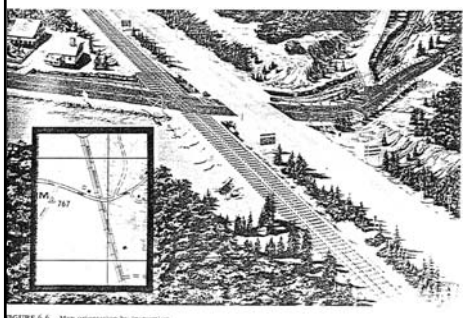
Navigating along a great circle

- Need to convert compass bearing to true north
- Declination can be East or West
- Conversion diagram: Figure 7.5
- East is least, West is best
- Azimuth = bearing
- Course vs. bearing

Map orientation

- Use all possible position clues to physically rotate map to align with landscape
- Many in-vehicle systems rotate to direction-of-motion
- Simplest navigation: pick target or intermediate target and align

Map inspection and resection



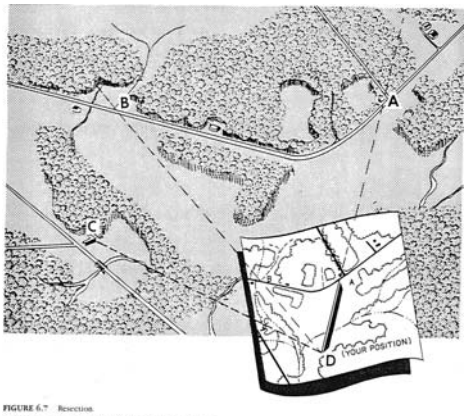
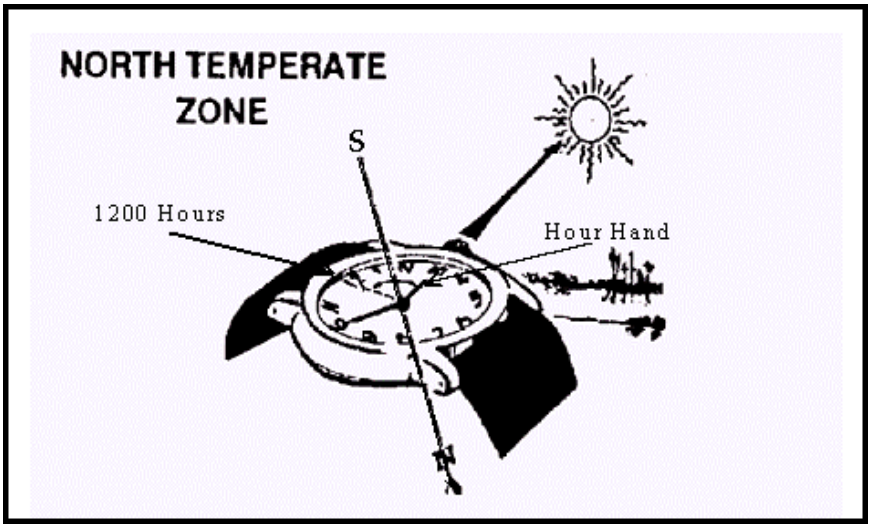


FIGURE 6.7 Resection.

Direction from your watch



Select visible target along azimuth



Route Selection

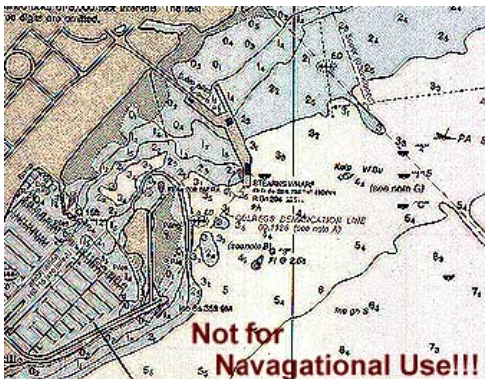
Objective: get from A to B BUT…..

- Positive
  - Minimize time, distance, gradient
  - Maximize safety, scenery
  - Visit N locations, include points
- Negative
  - Eliminate obstacles
  - Avoid locations, areas, risks

Route selection at sea

NOS Charts

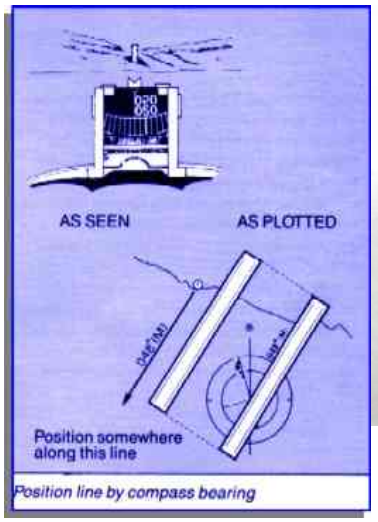
- Harbor Charts
- Coast charts
- General charts
- Sailing charts



Ocean Charts

- Show azimuths and conversions
- Show many features, aids, and “hazards to navigation”
- “Notice to Mariners” and revisions
- Nautical mile: length of a minute of arc (1852m, 6076.12ft., 1.151 statute miles)
- Distance by dividers, bearing by straight edge
- Includes soundings, sea level & tides important!

Distance and bearing

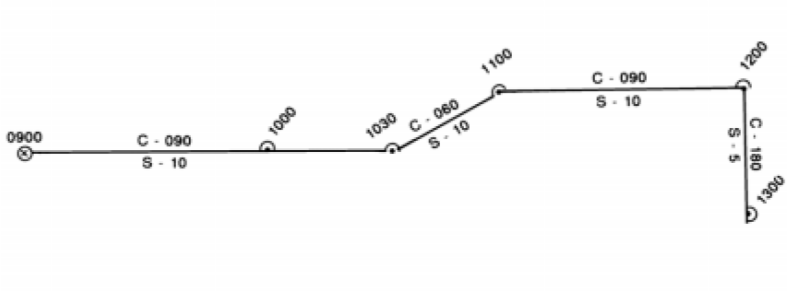




Dead reckoning

- Oldest way of navigating (and position finding) at sea (and on land)
- Divide trip into legs
- Legs are distance and bearing only
- Errors are additive and multiplicative!
- Errors common in d, but measurement of b also poor

Typical Dead Reckoning Plot



Navigation Aids at Sea

RADAR

- Radio detection and ranging
- Beam of radio signals from known points
- Measures return (reflection from object)
- Beam sweeps to get 360 degrees
- Interpretation a skilled art!





Navigation Aids



RDF

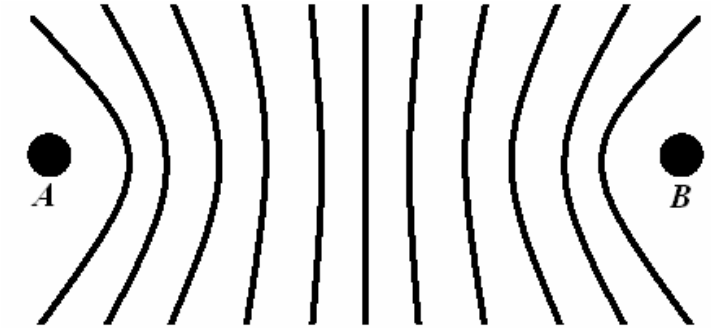
- Radio signals transmit form multiple known locations
- Receiver computes range and solves for position
- Works in all weather
- Common in aircraft



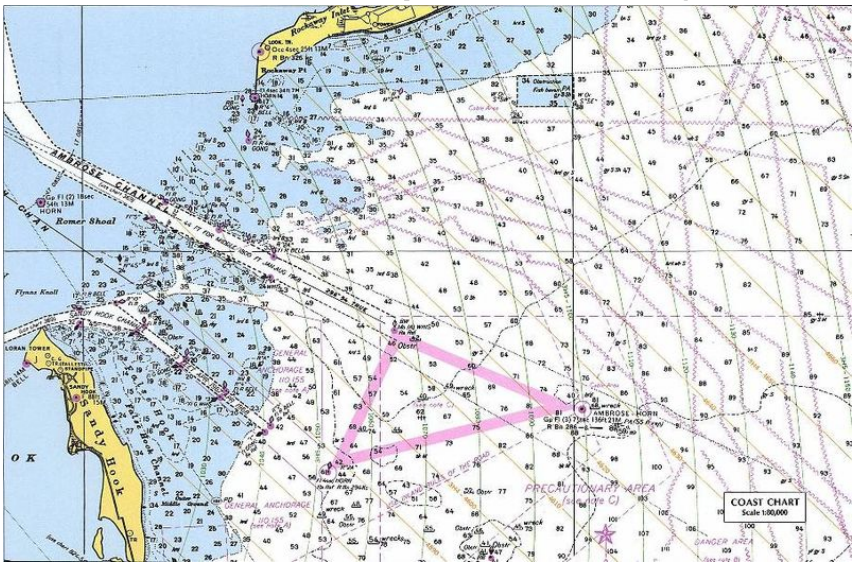
LORAN

- Master and slave synchronized radio transmitters
- User measure time between receiving two signals
- At all equidistant points, signals arrive together
- Time delays are printed on LORAN charts
- Some atmospheric issues, and PDOP
- World-wide system of transmitters & charts
- Similar Decca system outside N. Pac, N. Atl and Med.

LORAN: How it works

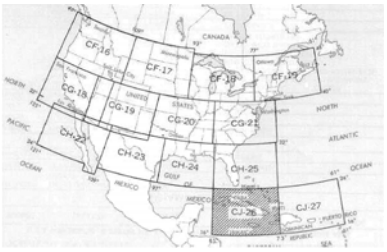


LORAN map with delays



Air Navigation

- Various maps and charts at scales from 1:12K to 1:2M
- Global coverage at 1:1M WAC; DoD 1:250K JOG
- Lambert conformal conic: Shows land only
- Corrected by Notice to Airmen (NOTAM)
- Overseen by FAA
- Includes graticule/restrictions/radio navigation by RDF



JOG: San Diego



WAC legend

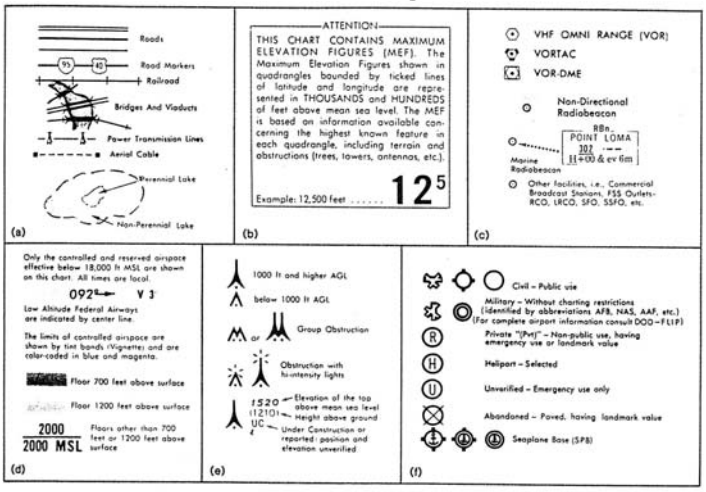
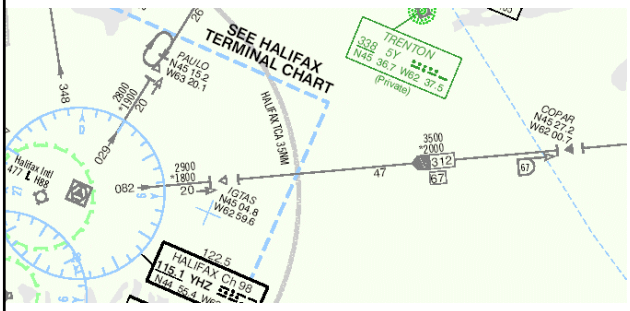


FIGURE 6.20 Examples of the symbols used on WAC and sectional charts. (*a*) Topography. (*b*) Elevation markings. (*c*) Radio aids to navigation and communication. (*d*) Airport traffic service and airspace information. (*e*) Major obstructions. (*f*) Information about airports.

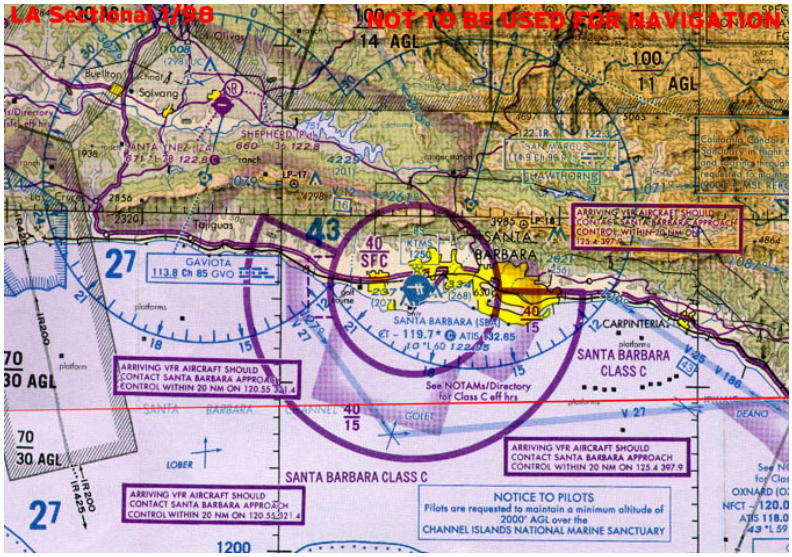
IFR/VFR

- Different charts for Visible vs. Instrument flight rules
- Both include maximum elevation in grid cells
- Concept of vectors, flight plans

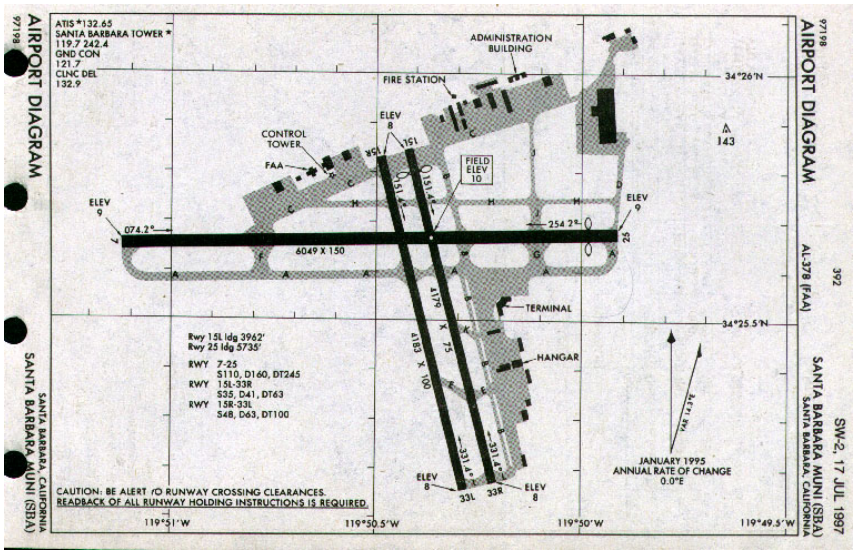




SBA: VFR



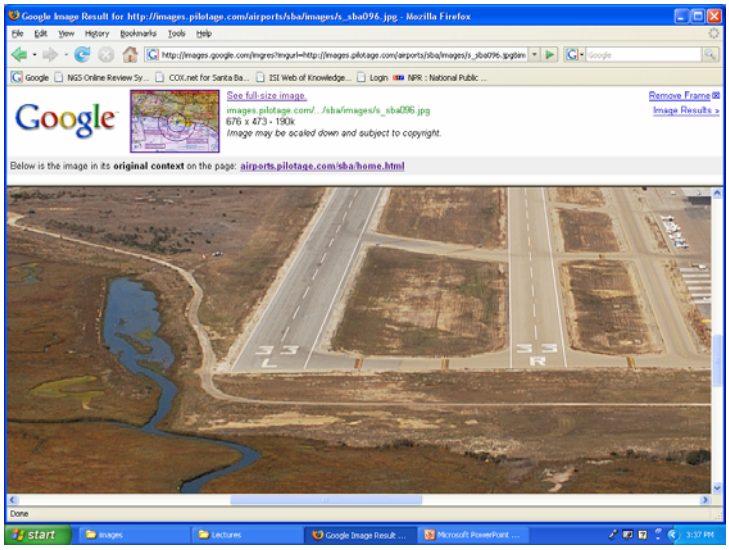
SBA: IFR



SBA Approach



Direction indicators!



Height in aircraft

- Altimeter: uses h = f(P)
- Must continuously correct, via radio



Summary

- Maps show information that allows direction finding
- Projection and declination are important
- Maps are often more useful when oriented
- Route selection depends on goals
- Simplest is dead reckoning
- Many different aids to navigation for air, land and sea
- Special purpose charts assist navigation