CELESTIAL NAVIGATION

Captain Stephen Miller – Chapman School of Seamanship
A Brief Marine Navigation Primer

• Marine Navigation deals with going from one place to another by water.

• The Navigator first determines where his departure point and destination points are located.

• The next step is to determine the direction that must be traveled from departure point to destination point.
Our Estimated Position on 11 March 2011 For Our NOON Sight
A Brief Marine Navigation Primer

• The direction can be converted to a Course to be followed and drawn on a Mariner’s chart (ocean map)

• By using Time and Speed calculations the Navigator can indicate on his chart where he expects to be at any given time during the trip.

• This is the Deduced Reckoning Plan (DR)
Our Estimated Position on 11 March 2011
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• Once underway, the Navigator uses various methods for determining his location and compares that position with his plan.

• These methods include:
  – Two or three bearings to land based objects
  – RADAR bearings and distances – again to land based objects
  – GPS (Global Positioning System – Satellite based)
  – Depth soundings and bearings to land based objects
A Brief Marine Navigation Primer

• It should be obvious that once well out of sight of land that some of these methods are no longer an option.
• As one proceeds out to sea the depth of the water becomes too deep to measure.
• It is at this point that the only options are GPS and Celestial Navigation methods.
• The only drawback of GPS is that you are only sure it is working properly is when you arrive at your destination and relies on electricity.
• The only way to be sure of where you are far out to sea involves using Celestial Navigation.
YOUR initial questions about Celestial Navigation probably start out with
is Celestial Navigation?
WHAT

do we **USE**
to do
Celestial Navigation?
When do we DO Celestial?
How do we obtain a Position from Celestial Bodies?
Here are some brief answers to those questions
What is Celestial?
Celestial Navigation

is the

Art and Science of Navigating

out of the sight of land using

only the Celestial Bodies for

position determination
do we use to do Celestial Navigation?
The Celestial Bodies we use are:

SUN

Four PLANETS
VENUS, MARS, JUPITER, SATURN

and

MOON

57 STARS plus POLARIS
WE WILL USE THE SUN FOR OUR OBSERVATIONS

IN THIS SERIES OF LECTURES AND IF THERE IS TIME WE WILL LOOK AT USING THE NORTH STAR - POLARIS
Tools of the ‘Trade’

Sextant
Timekeeping Device or Watch
Nautical Almanac
Workform

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Step 1 Correct Hs to get Ho

1-1 Record Maximum Sextant Height (Hs = peak height of the sun at noon), and mark limb

1-2 Record Index Correction
(mark sign = if off, - if on)

1-3 Record eye height (HE) and Look up Dip
Correction on the right-hand side of Table A2,
front of the Almanac (7-8 in notes)

1-4 Sum the above three numbers to get
Apparent Height

1-5 Look up altitude correction or left-hand side of Table A2, front of the Almanac (7-8 in notes)
(correction depends on Ha, Limb, and month)
(mark sign = for lower limb, - for upper limb)

1-6 Sum the above two numbers to get
Observed Height

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Step 2 Determine the Zenith Distance

2-1 Record Ho from Step 1, above, and then subtract it from 90° to get the zenith distance.

2-2 Zenith distance

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Step 3 Use the Almanac to Find Sun’s Declination

3-1 Record the date and GMT of the sight
(the time the sun reached its peak height)

3-2 Turn to the daily page of the Almanac for the date of the sight, and find the sun’s declination (dec)
for the hour of the sight (line 3-1) and record it here.

3-3 Record the d-value from the bottom of the dec
column in the Almanac. Mark the signs of the
"d-value" and d-corr = + if the dec for the next hour
is larger, - if it is smaller.

3-4 Turn to the Increments and Corrections pages at
the back of the Almanac (7-9 to 12, in the notes)
and find the minutes table for the GMT minutes
(line 3-1). On the right-hand side of the double
deck in the table, find the d-corr corresponding to
the d-value of line 3-3

3-5 Apply the d-corr to the dec(hr) and record it
above.

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Step 4 Find Latitude

from Zenith Distance and Declination

Record DR Latitude to use as a guide, and then take the sum or difference of zenith distance and
declination to find your true Latitude at LAN.
IS CELESTIAL DONE?

- Stars, Planets, and/or Moon are observed **before Sunrise** – results in a FIX
- The SUN is observed **mid-morning** – results in a LOP only
- **NOON Sight** is done at ‘**NOON**’ – results in a LOP (our Latitude) and a Running FIX
- The SUN is observed **mid-afternoon** – results in a LOP only
- Stars, Planets, and/or Moon are observed **after Sunset** - results in a FIX
do we obtain a Celestial Position?
Our position from a Body can be measured in distance and a direction
NOW  Wait a Minute

we are approximately

93 million miles

away from the Sun and the SUN is up in the SKY so how could we possibly plot from that information?
WE are NOT getting THAT Distance!
WHEN using CELESTIAL

The object we are sighting

Is MOVING

Relative to us

BUT...
For our purposes the instant we observe the **BODY** We will FREEZE TIME So the **BODY** is essentially **STATIONARY**
From **THAT** instant of time we can determine from the **NAUTICAL ALMANAC** where on **EARTH** the BODY is Located
I DID SAY ON EARTH!
The location on EARTH is the point on the EARTH’s surface where a line from the Center of the Body (SUN) to the Center of the EARTH passes, it is called the Geographic Position, or GP.
When we OBSERVE A BODY with our Sextant we measure the ANGLE of the body above the Horizon.
The mathematical complement of this **Angle** is the **ANGULAR DISTANCE** we are from the **GP** of the **BODY**.

The Complement called **Zenith Distance** is **90° - Our Angle**
An IMPORTANT ANGLE - DISTANCE relationship from Chart Navigation IS

1° equals 60 nautical miles
Converting the Zenith Distance from an ANGLE to a DISTANCE is accomplished by applying THAT relationship.
ZENITH DISTANCE
**ZENITH DISTANCE**

In the example Zenith Distance is 60° of Arc (the complement of our 30° Angle)

One ° of Arc on a Great Circle is Sixty nm

Therefore:
Zenith Distance = 60° x 60 nm/° or 3600 nm

THIS is the **RADIUS** of a Circle of Position – with it’s center at the GP of SUN
CIRCLE OF POSITION

Diagram indicates an Afternoon Situation
The Noon Diagram

Meridian

DR

Latitude

Zenith Distance

Equator

SUN

Declination
We have determined our Zenith Distance from our Observation (Sight) From the Time of our Sight we can find the Declination of the Sun at that time from the Nautical Almanac With the Zenith Distance known and the Declination known We can find the difference between them and the RESULT IS OUR LATITUDE.
For Determining Latitude by a Noon Sight

THAT is HOW CELESTIAL NAVIGATION WORKS
There is Certainly MORE to CELESTIAL NAVIGATION than what you have just seen.
By studying Celestial Navigation
YOU will be able to
FIND OUT
WHERE
in the
WORLD
YOU ARE!