Navigation – Hank Denolf

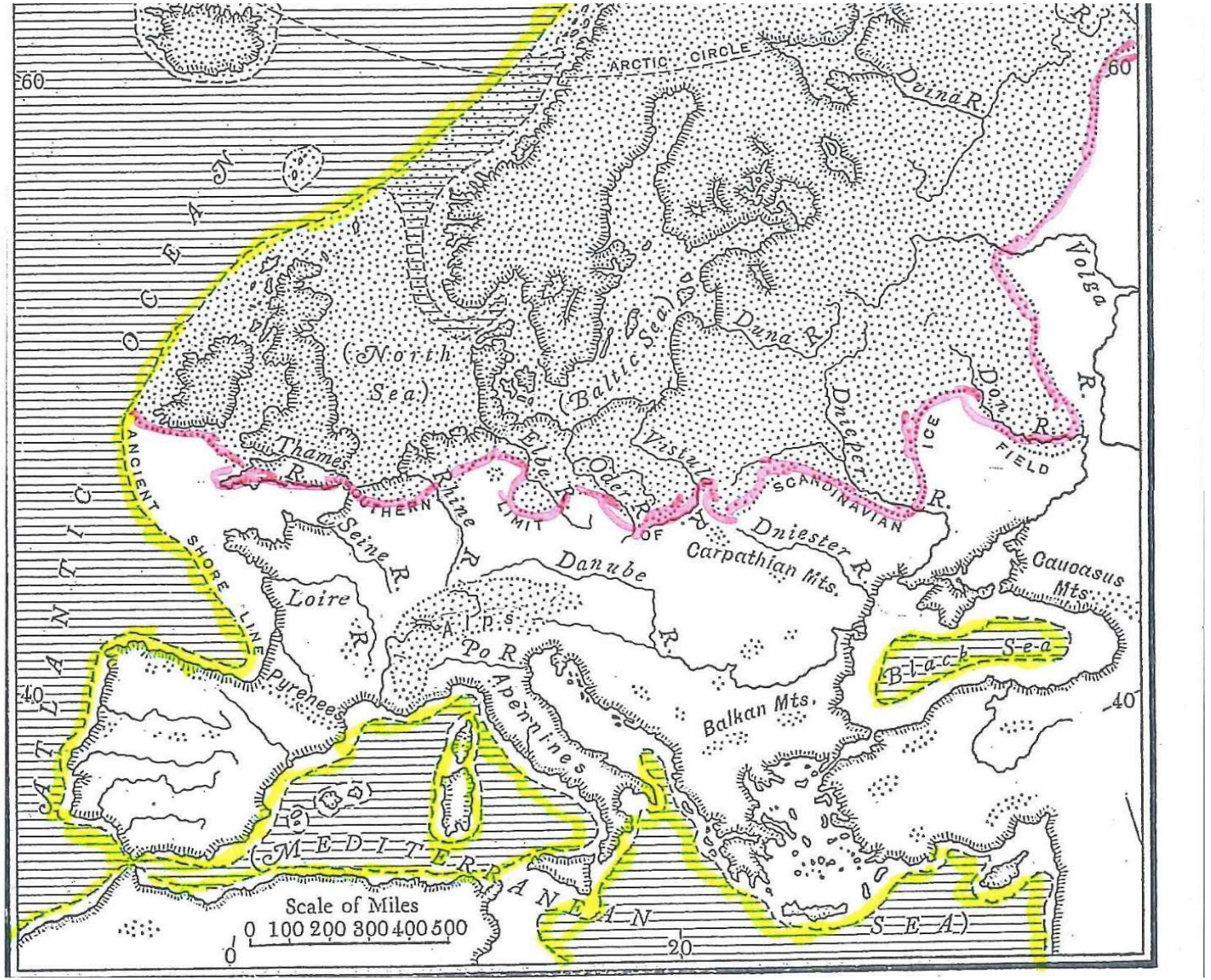
Graduate of Lawrence Technical University, retired electrical engineer.

Worked for Chrysler Missile Division and General Dynamics heavy arms (tanks). Included in his projects were the Red Stone Missile Program, working at Cape Canaveral, White Sands New Mexico and guided missile testing in Australia.

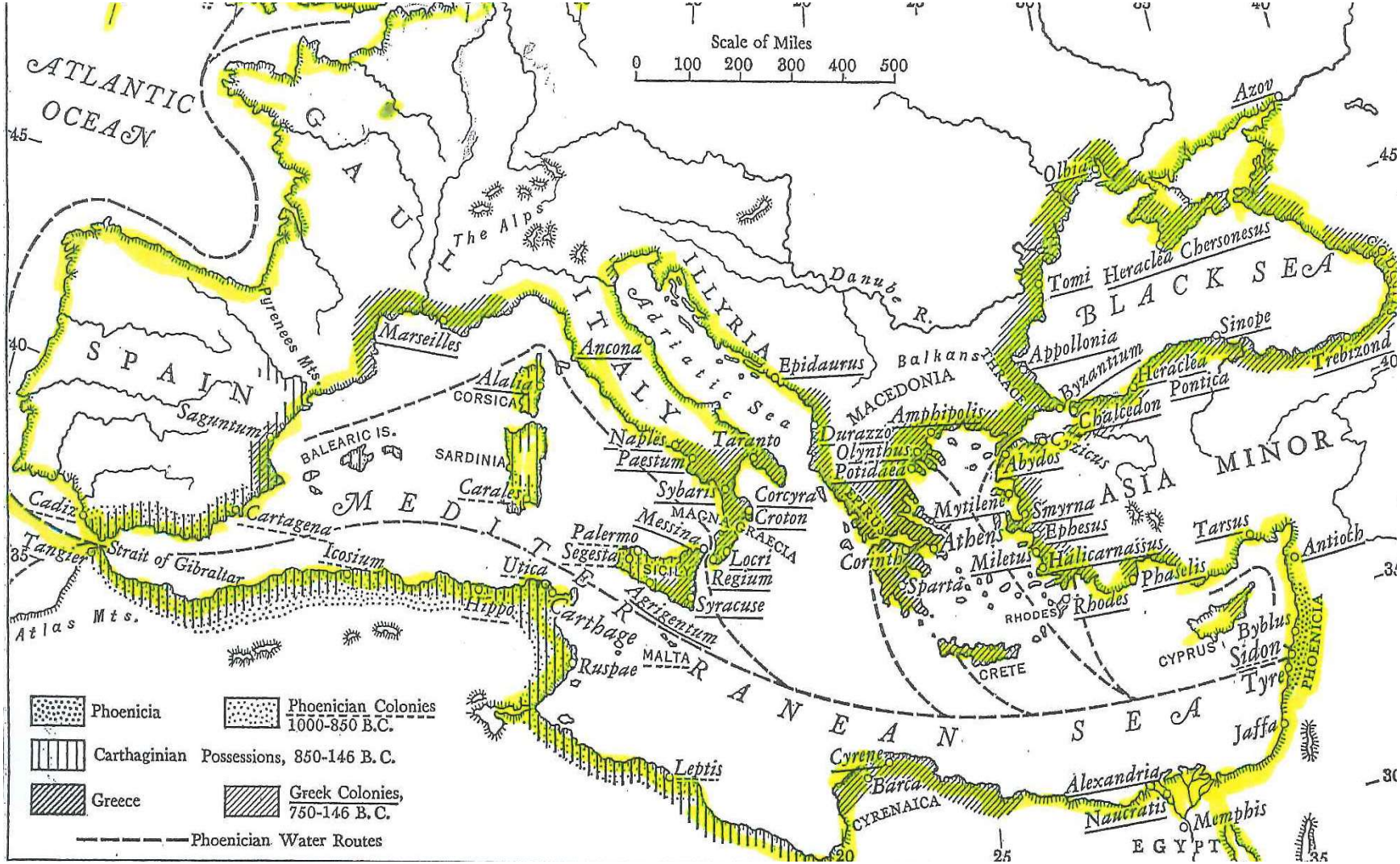
50 year member of Grosse Pointe Power Squadron having taught a gambit of courses, including advanced navigation and celestial navigation.

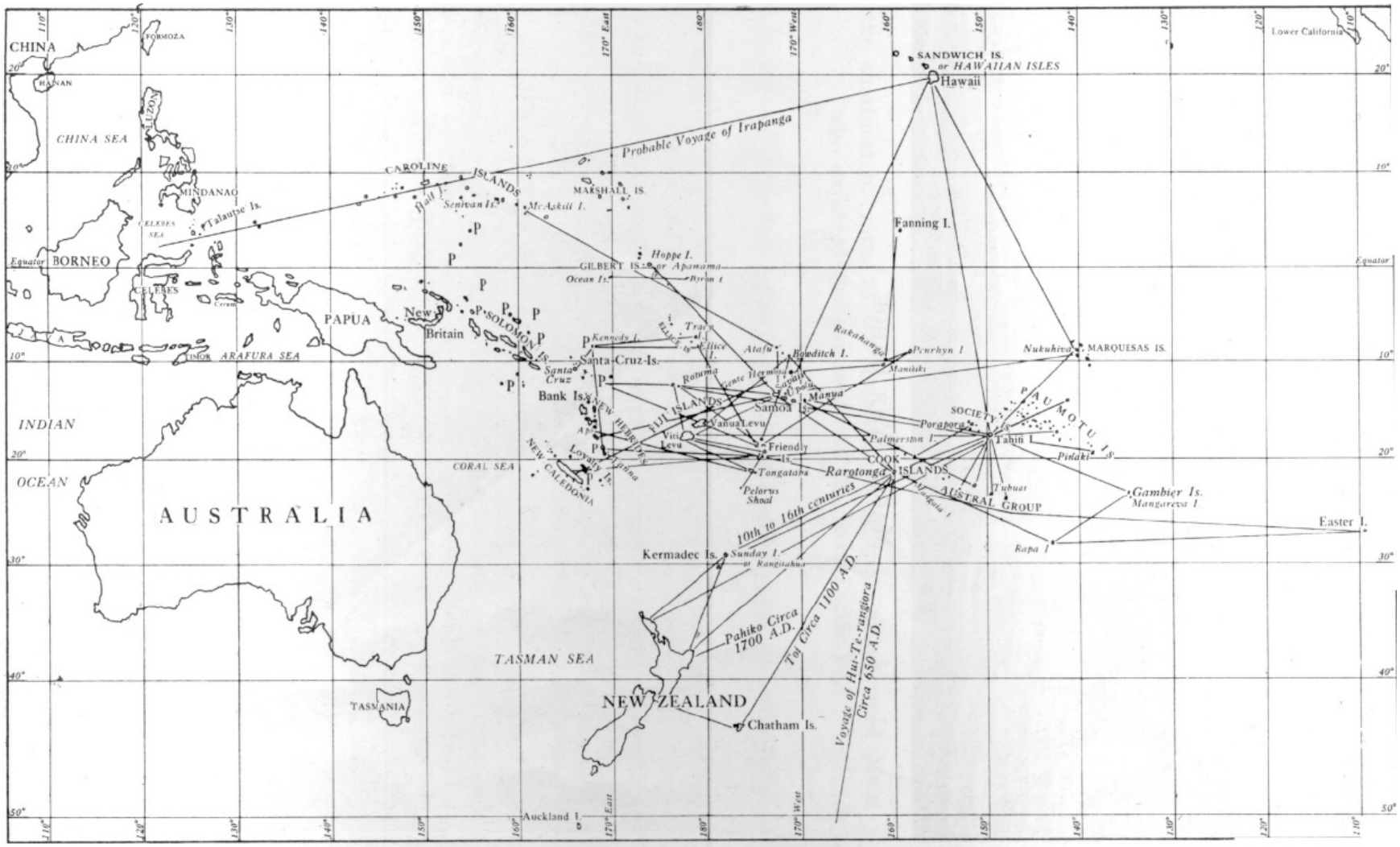
This will be an overview of old style navigation techniques progressing to perfection of celestial navigation using a sextant and modern time and data records.

Europe during Ice Age



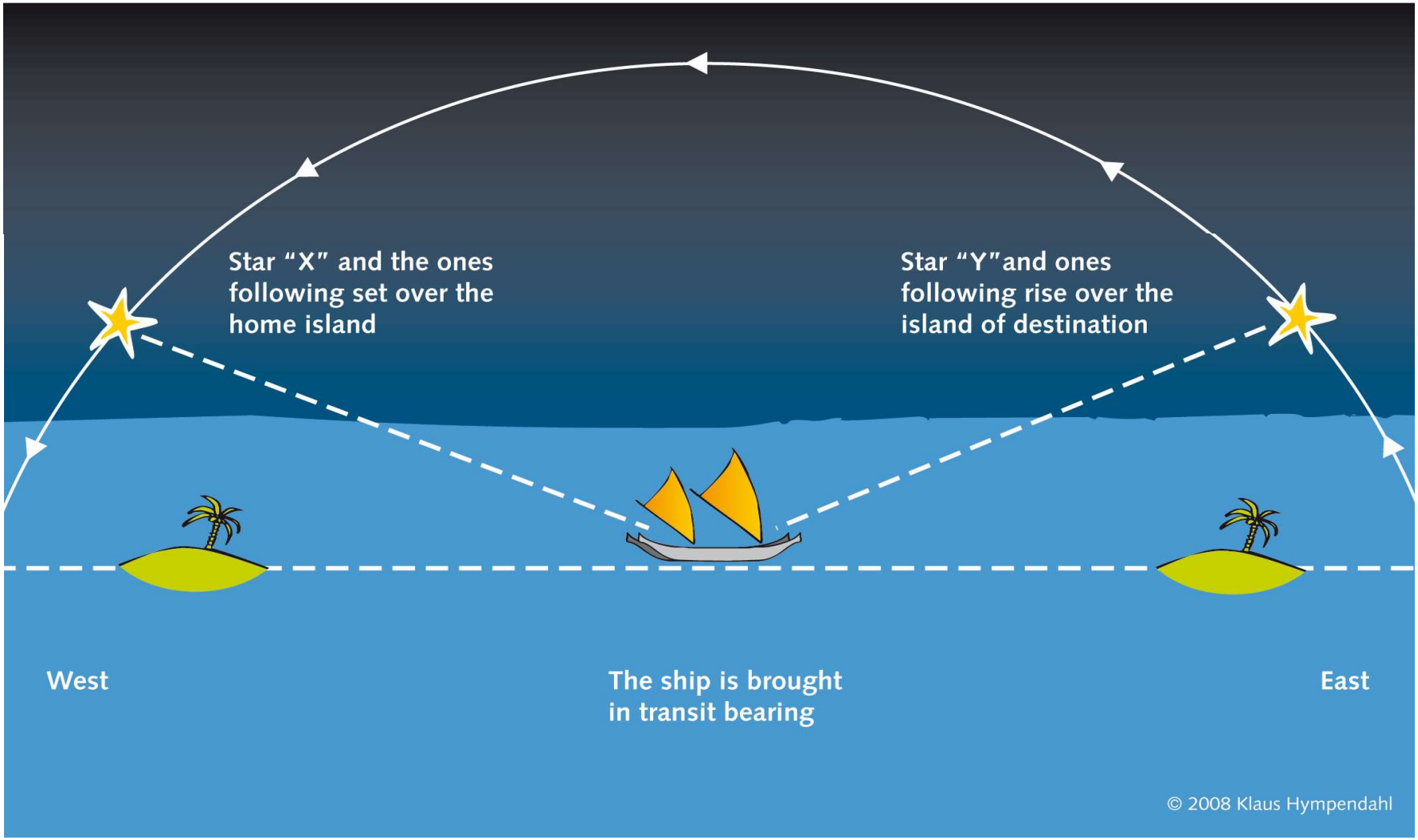
Colonization of the Mediterranean - Phoenicians





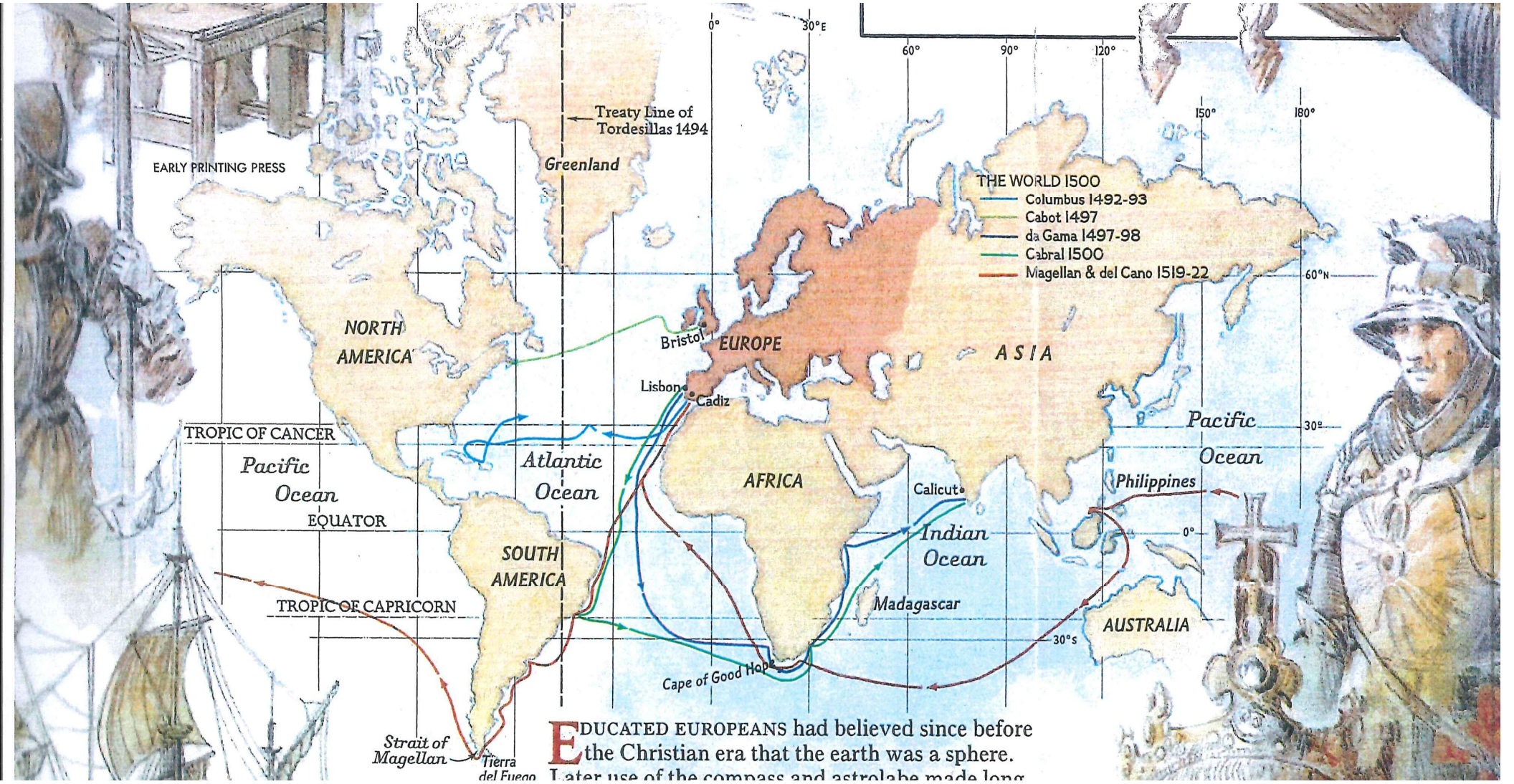
MAP SHOWING SOME RECORDED VOYAGES OF THE POLYNESIANS

STARPATH NAVIGATION



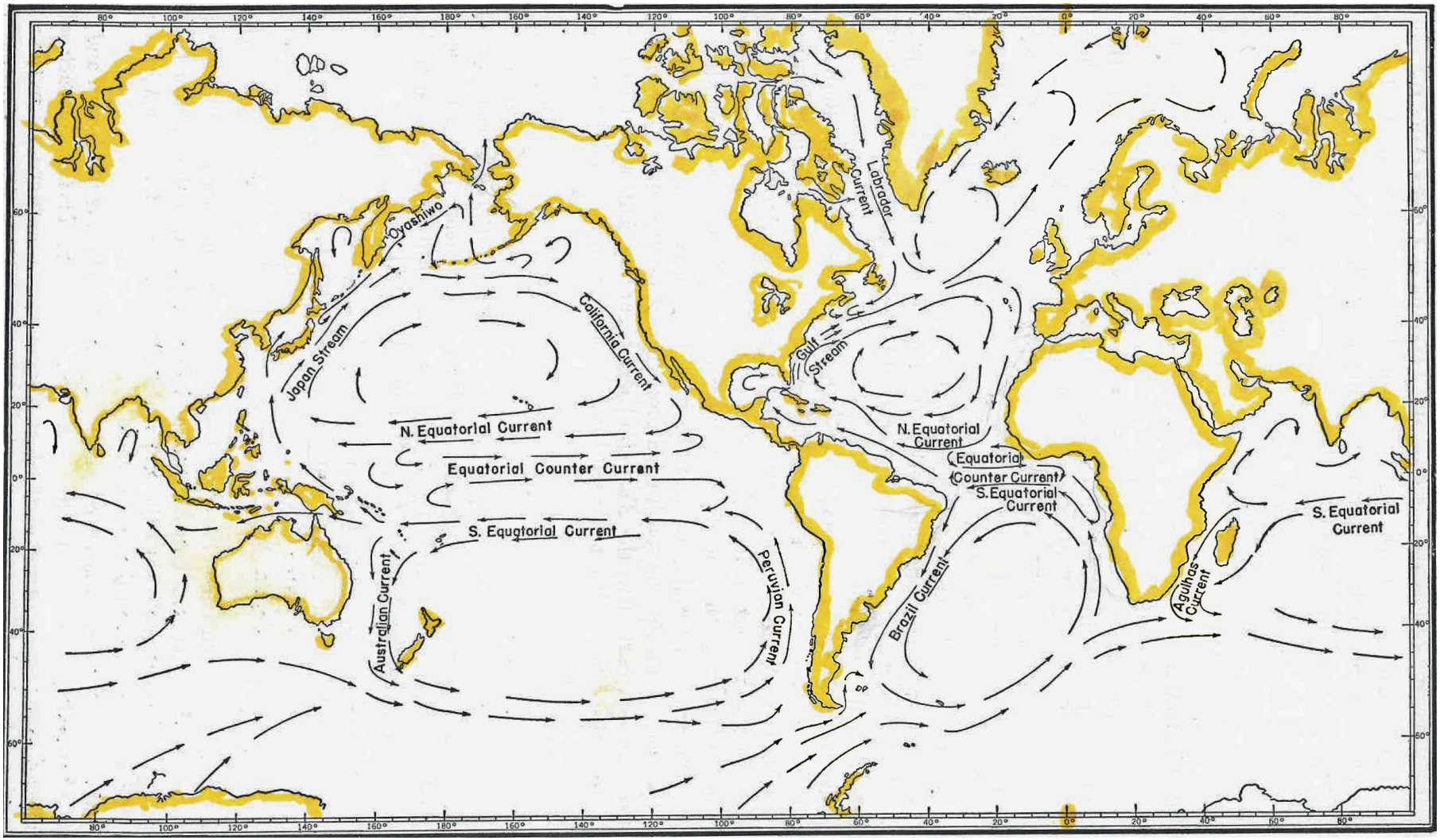
Watching the direction of seabirds traveling for food was used.
Studying an understanding wave patterns, and using direction of a guiding star.

Beginning of Navigation to New World



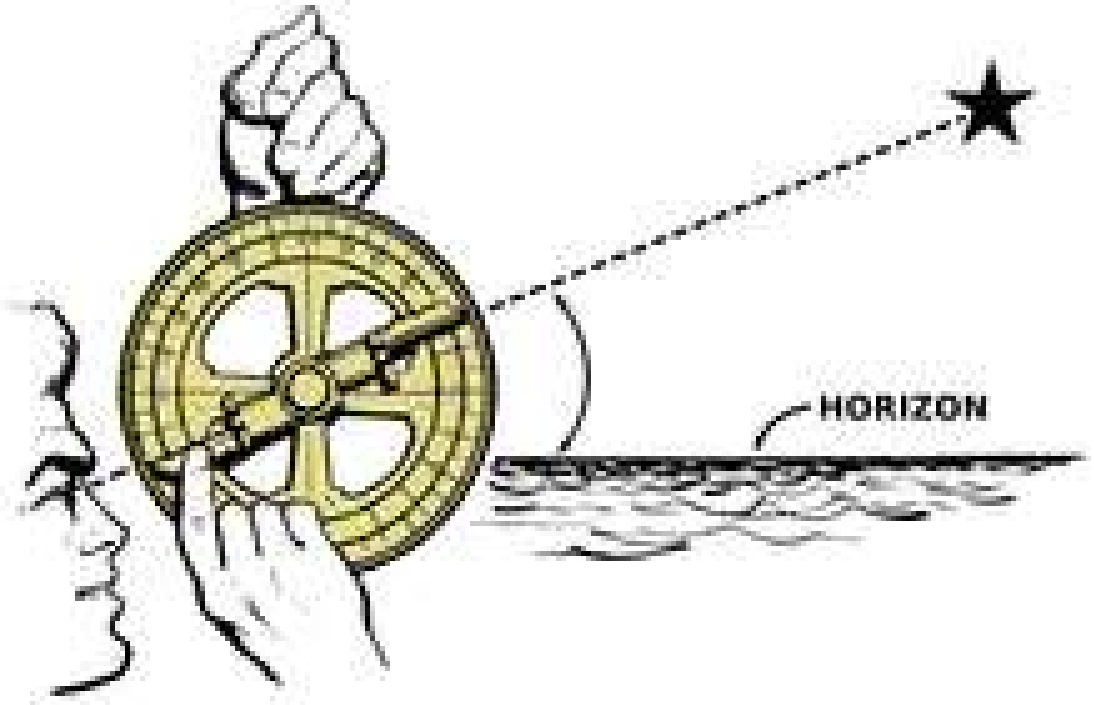
EDUCATED EUROPEANS had believed since before the Christian era that the earth was a sphere. Later use of the compass and astrolabe made long

World currents discovered and charted

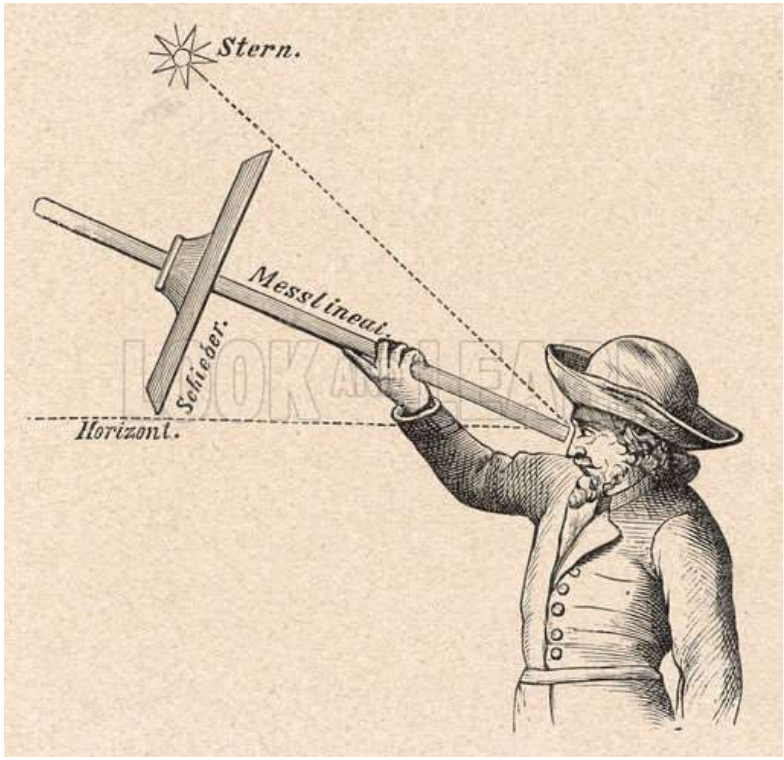


Marine Astrolabe based upon Greek astronomer and mathematician, Hipparchus.
Difficult to hold steady on rolling ship causing large errors.

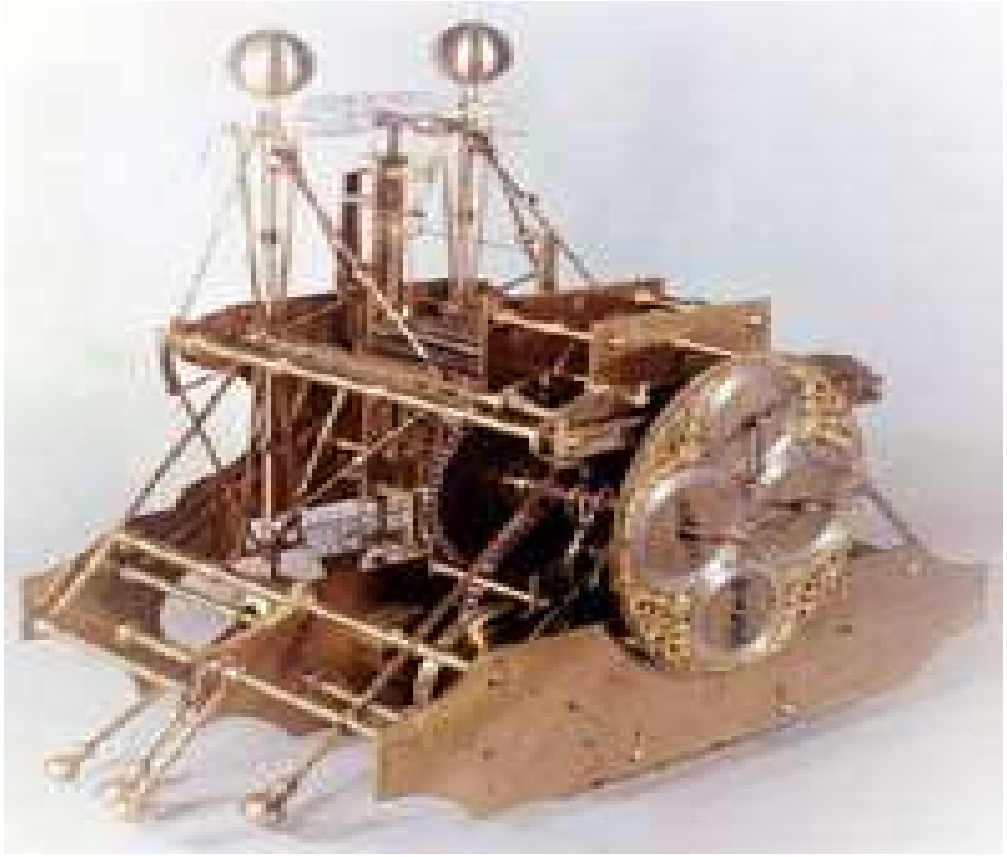
Astrolabe from shipwreck, made of Silver, showing value placed on instrument.



Cross Staff & Back Staff – Early versions of Sextant
First crude style invented by English Captain John Davis - 1594



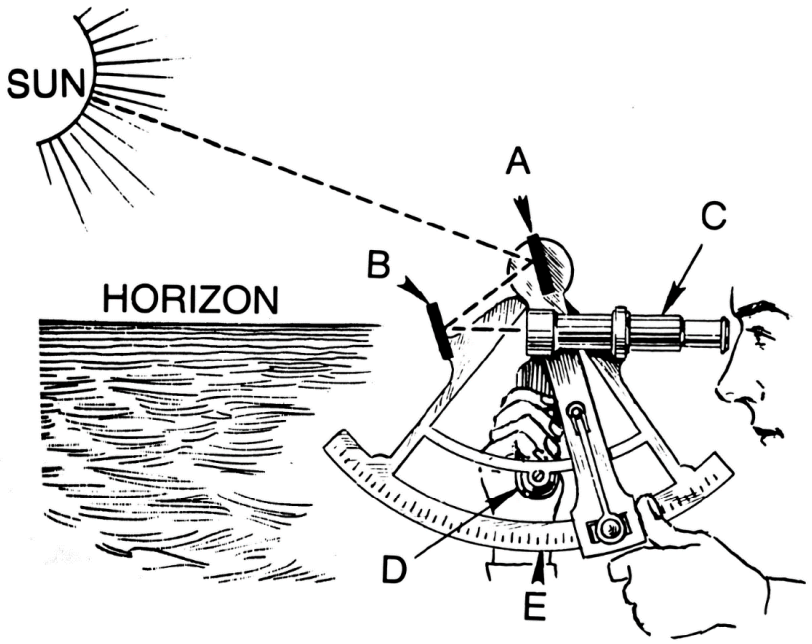
1st Marine Chronometer – John Harrison, British- 1730
weight – 65 pounds
allowed calculation of longitude at sea

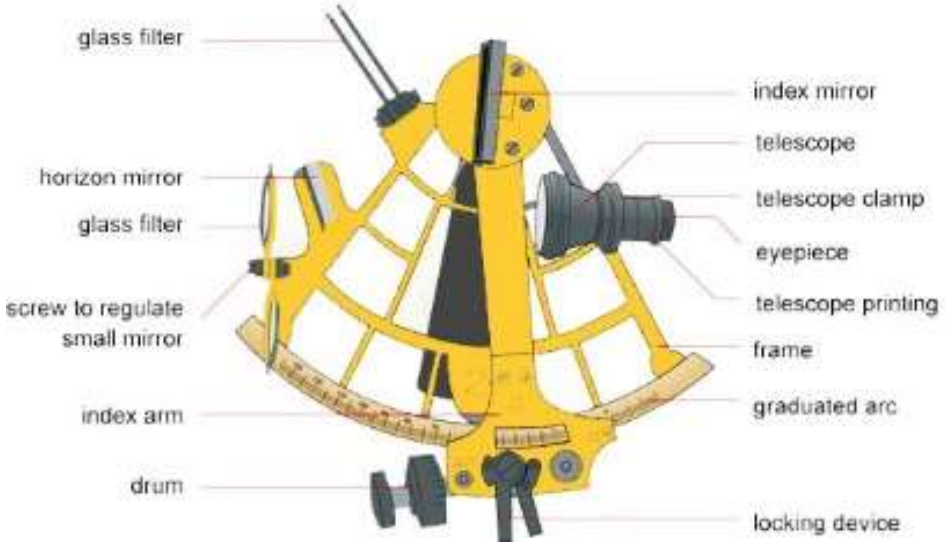


Modern Chronometer

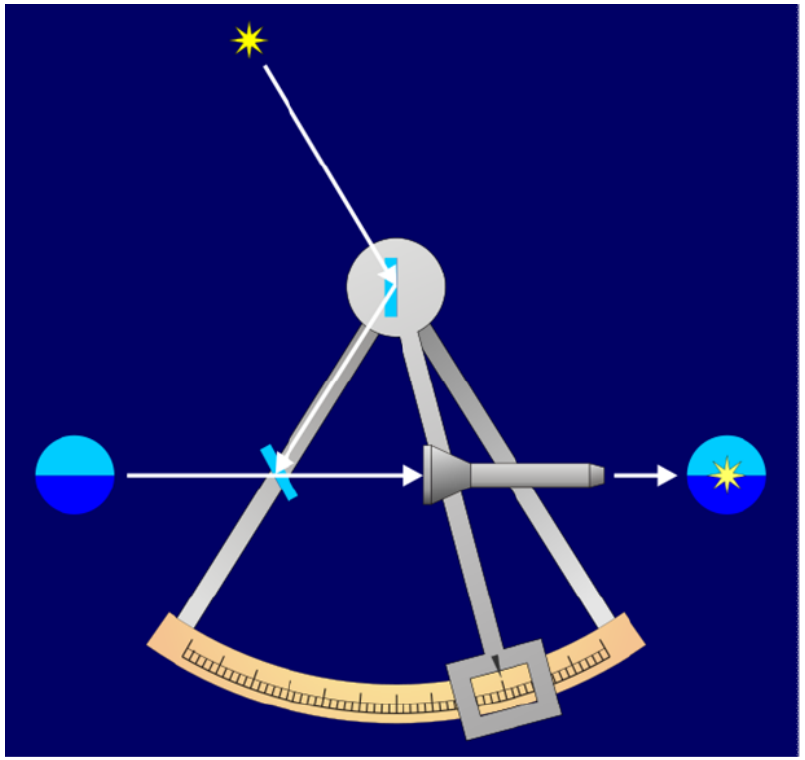
Atomic Clock

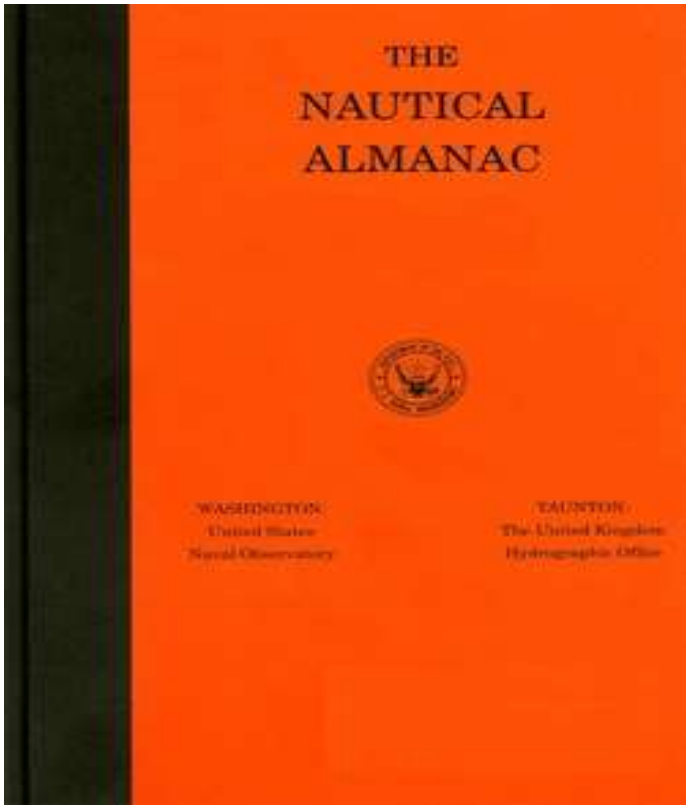
Modern Sextant – first implemented 1730
improved upon through today.





Sighting with a Star
Nautical Sighting Tables





U.S. Navy Sextant – 1944
U.S. Army Airforce Aircraft “averaging” Sextant - 1944

Sun and Moon sightings taken anchored near St. Clair Light.

UNITED STATES POWER SQUADRONS — NAME Henry V. Denolf

LINE OF POSITION – H.O. 211 & H.O. 214 — SQUADRON Grosse Pointe DIST. 9

Body Symbol: SUN L.L. ☉	Bearing 210°	DR AP Lat. 42°27.9'N. 42° N.	DR AP Long. 82°45.3'W. 82°31.5'W.
Sight No. 26	Ht. Eye 6.0 ft.	Dip Short ——— Bearing ———	Distance ———

Apply IC and Dip before taking out Main Correction.

			ALTITUDE CORRECTIONS				
				Sun LL / UL	Moon LL / UL	Star	Planet
Date 4 Oct. 1969	hs	38°27.0'					
WT 13-50-12 EST	IC +	0.5'					
WE S +33	corr'd hs	38°27.5'	Main Correction A 2	+15.0'			
ZT 13-50-45	Dip (If artificial hor. divide by 2)	2.4'	Additional	XX		XX	
ZD + 5	Ho	38°25.1'	Additional for UL only	XX	(–30.0')	XX	XX
GMT 18-50-45	Alt. Corr. +	15.0'	Additional Refraction				
Gr. Date 4 Oct 1969	Ho	38°40.1'	Total / Altitude Correction	+15.0' / +15.0'			

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	SHA • No.	GHA	Dec. (N/S) d	Note: Both diagrams on the back of this Form must be completed.
Day				
Day 4	18 h GHA ☉	92°50.0' (——)	4°29.0' (+1.0')	Advance (or Retard) L.O.P.
Yellow	50 m 45 s	12°41.3'		Minutes ———
Yellow	d corr. code	———	+0.8'	Speed ——— Kts.
GHA and Dec.		105°31.3'	4°29.8' (N/S)	Miles ———

INTERCEPT AND AZIMUTH BY H.O. 211

GHA	105°31.3'						
DR-Lo	82°45.3' W.						
LHA	22°46.0'						
t	22°46.0' W.	A	41231.				
dec.	4°29.8' S.	B(+)	134.1	A	110536.		
		A	41365.1	B(–)	3499.	B 3499.	A 41365.1
K	4°52.5' S.			A	107037.		
DR-L	42°27.9' N.						
K ∽ L	47°20.4'					B(+)	16901.
Hc	38°41.5'			A	20400.		B(–) 10761.
Ho	38°40.1'	Observed greater–toward / Computed greater–away					
a	1.4	mi. Toward / away	Zn 209.6°	Z N/S	150°22.5' E/W	← A	30604.1

INTERCEPT AND AZIMUTH BY HO 214 (USING Δd CORR.)

GHA	105°31.3'				
Asm Lo	82°31.3' E/W				
LHA	23°	(Alt) H_t	39°00.6'	Δd 0.93	(Az) Z N/S 149.9° E/W
(HA) t	23° E/W	d cor (+)	0.2'	←(x d. diff.)	
Asm L	42° N/S	H_c	39°00.8'		
Asm dec	4°30' N/S	H_o	38°40.1'		
d diff	0.2'	a toward / away	20.7 mi.		Z_n 210.1°

UNITED STATES POWER SQUADRONS — NAME Henry V. Denolf

LINE OF POSITION – H.O. 211 & H.O. 214 — SQUADRON Grosse Pointe DIST. 9

Body Symbol: MOON U/L ☾	Bearing 290°	DR AP Lat. 42°27.9'N. 42°N.	DR AP Long. 82°45.3'W. 82°48.4'W.
Sight No. 29	Ht. Eye 6.0 ft.	Dip Short ——— Bearing ———	Distance ———

Apply IC and Dip before taking out Main Correction.

			ALTITUDE CORRECTIONS				
				Sun LL / UL	Moon LL / UL	Star	Planet
Date 4 Oct. 1969	hs	12°01.5'					
WT 13-56-17 EST	IC +	0.5'					
WE S +33	corr'd hs	12°02.0'	Main Correction XXXIV		+62.6'		
ZT 13-56-50	Dip (If artificial hor. divide by 2)	2.4'	Additional 54.2 H.P.	XX	+1.1'	XX	
ZD + 5	Ho	11°59.6'	Additional for UL only U/L	XX	(–30.0')	XX	XX
GMT 18-56-50	Alt. Corr. +	33.8'	Additional Refraction A4 TEMP. 65°F V PRESS. 30.21 UL inc. Total		+0.1'		
Gr. Date 4 Oct. 1969	Ho	12°33.4'	Altitude Correction		+33.8'		

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	SHA • No.	GHA	Dec. (N/S) d	Note: Both diagrams on the back of this Form must be completed.
Day				
Day 4	18 h GHA ☾	165°03.8' (11.6)	25°20.5' (7.2')	Advance (or Retard) L.O.P.
Yellow	56 m 50 s	13°33.7'		Minutes ———
Yellow	V and d corr. code	+ 10.9'	– 6.8'	Speed ——— Kts.
GHA and Dec.		178°48.4'	25°13.7' (N/S)	Miles ———

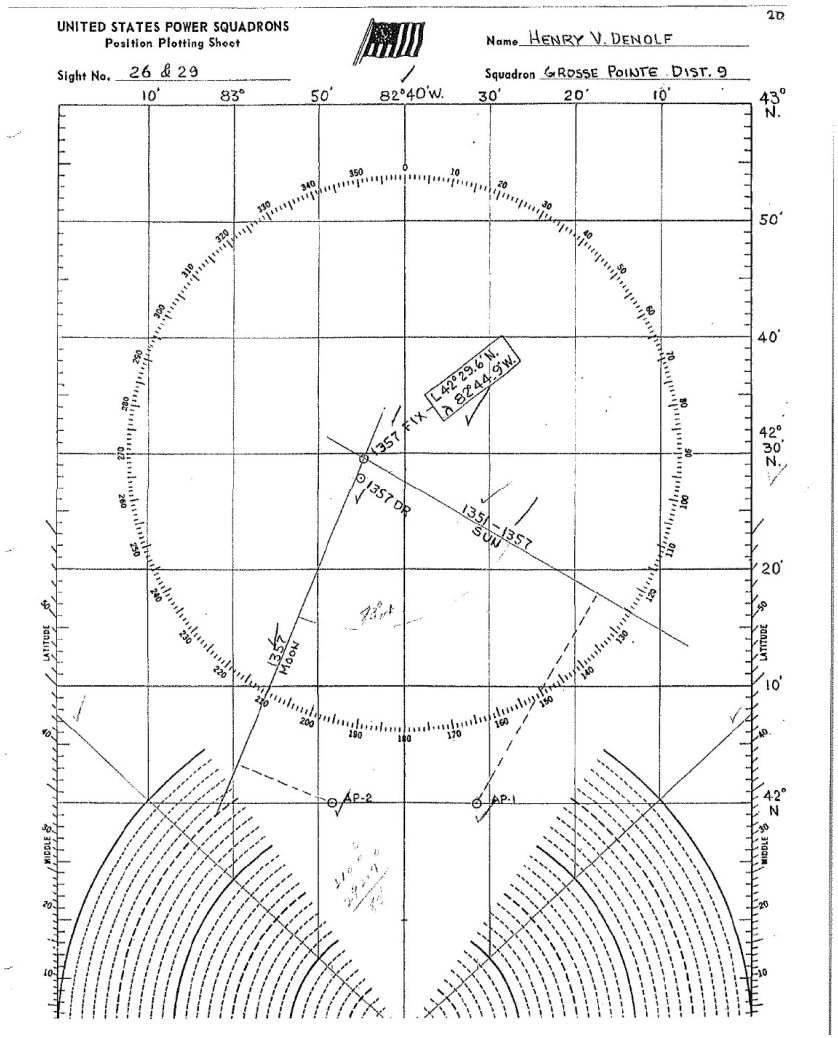
INTERCEPT AND AZIMUTH BY H.O. 211

GHA	178°48.4'						
DR-Lo	82°45.3' W.						
LHA	96°03.1'						
t	96°03.1' W.	A	243.				
dec.	25°13.7' N.	B(+)	4352.	A	37041.		
		A	4595.	B(–)	35985.	B 35985.	A 4595.
K	102°35.0' N.			A	1056.		
DR-L	42°27.9' N.						
K ∽ L	60°07.1'					B(+)	30256
Hc	12°34.0'			A	66241		B(–) 1053
Ho	12°33.4'	Observed greater–toward / Computed greater–away					
a	0.6	mi. Toward / away	Zn 292.8°	Z N/S	67°10.5' E/W	← A	3542.

INTERCEPT AND AZIMUTH BY HO 214 (USING Δd CORR.)

GHA	178°48.4'				
Asm Lo	82°48.4' E/W				
LHA	96°	(Alt) H_t	12°15.7'	Δd 0.65	(Az) Z N/S 67.3° E/W
(HA) t	96° E/W	d cor (+)	9.0'	←(x d. diff.)	
Asm L	42° N/S	H_c	12°24.7'		
Asm dec	25°00' N/S	H_o	12°33.4'		
d diff	13.7'	a toward / away	8.7 mi.		Z_n 292.7°

Position Plot from sightings



Naval Academy reinstates celestial navigation

By Tim Prudente, Associated Press | Posted Nov 1st, 2015 @ 6:10am

ANNAPOLIS, Md. (AP) — The same techniques guided ancient Polynesians in the open Pacific and led Sir Ernest Shackleton to remote Antarctica, then oriented astronauts when the Apollo 12 was disabled by lightning, the techniques of celestial navigation.

A glimmer of the old lore has returned to the Naval Academy.

Officials reinstated brief lessons in celestial navigation this year, nearly two decades after the full class was determined outdated and cut from the curriculum.

That decision, in the late 1990s, made national news and caused a stir among the old guard of navigators.

Maritime nostalgia, however, isn't behind the return.

Rather, it's the escalating threat of cyber attacks that has led the Navy to dust off its tools to measure the angles of stars. After all, you can't hack a sextant

You can't hack a sextant !