

## A Computational Perspective on Navigation

## Where are we?

- On earth
- In California
- La Jolla
- Pepper Canyon Hall 109 at UCSD
- Between the parking office and Vis Arts

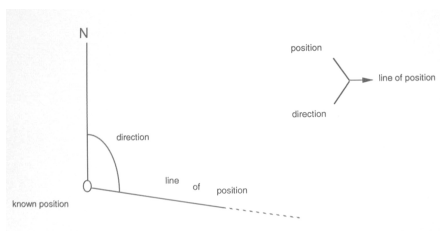
## Marr's three descriptions for every intelligent system

- Computational
- Representational/algorithmic
- Implementational

## Constraints

- A constraint excludes some possibilities in a range of possibilities.
- A particular constraint may leave many possibilities in play.
- Constraints can be combined to restrict the range of possibilities in play.
- Sometimes it is possible to combine constraints in a way that leaves only a single possibility.

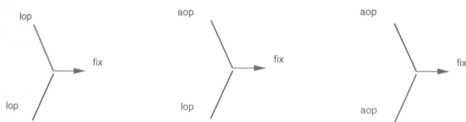
## Line of Position



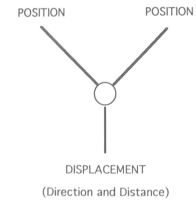
## Arc of Position



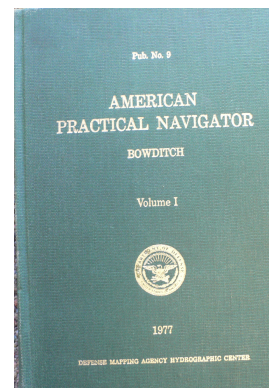
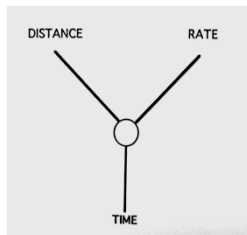
## Combining one-dimensional Constraints



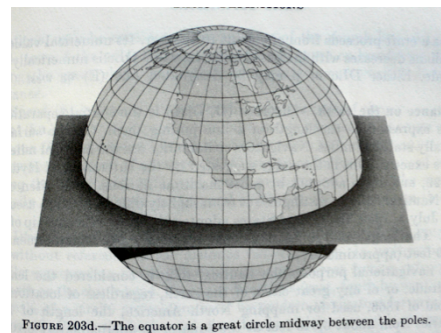
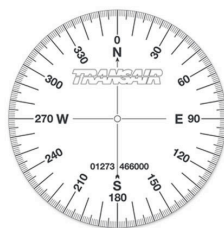
## Position/Displacement Constraint

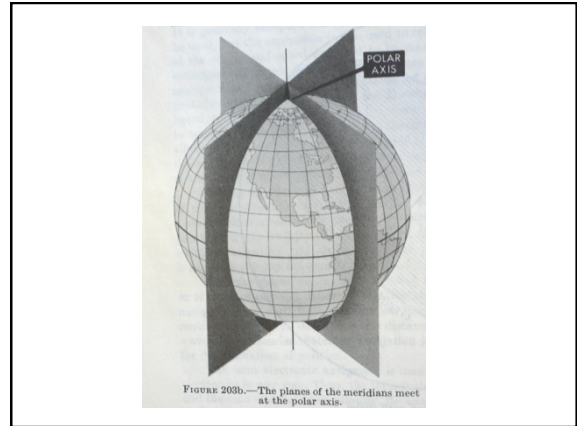
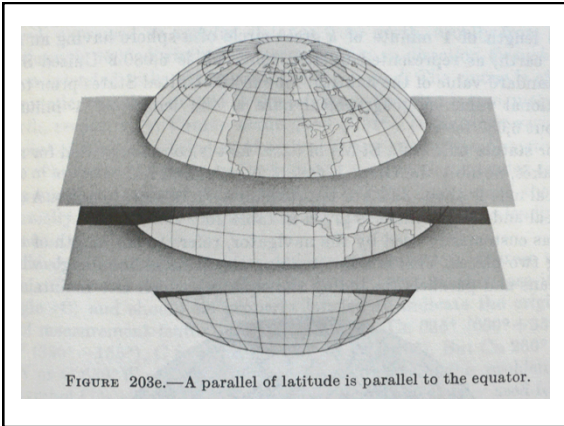


## Distance, Rate, and Time Constraint



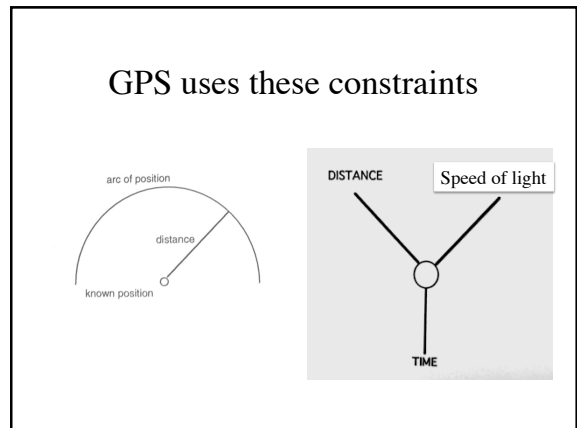
## Circle of 360 degrees





**Where are we?**

- Pepper Canyon Hall 106 at UCSD.
  - Latitude 32° 52' 39.56" N
  - Longitude 117° 14' 13.79" W



**Marr's three descriptions for every intelligent system**

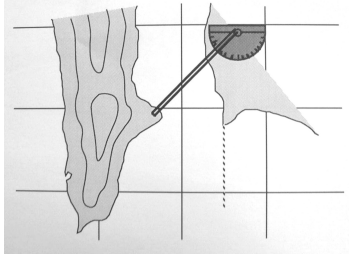
• Computational	• Determine your position, or plan travel
• Representational/algorithmic	• Latitude, Longitude, time in seconds, distance in nautical miles
• Implementational	• Computer programs running in your GPS system

**Computation via the propagation of representational state.**

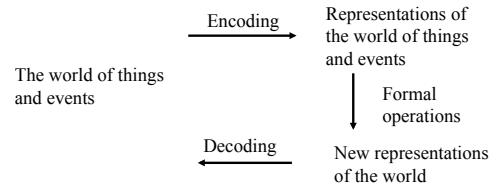
- Ship position plotting
- What information...
  - Goes where?
  - When?
  - In what form?



## Hoey in Coordination with the Chart



## The Secret of Our Success



## Units in the Western System

- Geographical position: latitude, longitude
- Nautical Mile
- Time
- Charts, properties of projections

## Navigation Chart

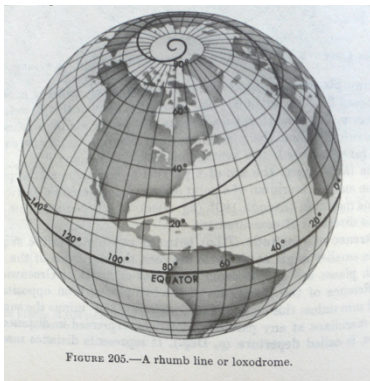
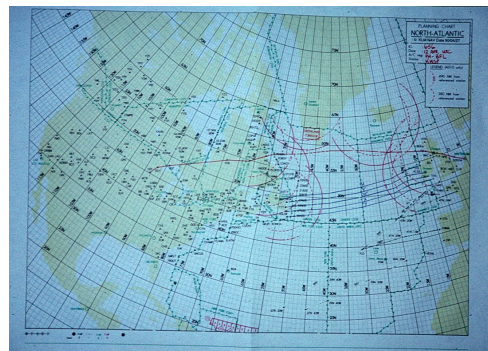


FIGURE 205.—A rhumb line or loxodrome.

## N. Atlantic Air Routes



## Pre-modern Western Navigation

- Sidereal Compass
- Linear constellations
- Units
  - Day's Sail
  - Kenning (= etak of sighting)
- Birds
- Latitude Sailing

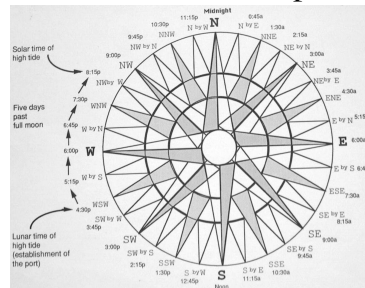
## The divergence of traditions

- Crystallization of knowledge and practice in physical artifacts
- Measurement and analog/digital conversions
- Digital computation
- Chart as the model of the world

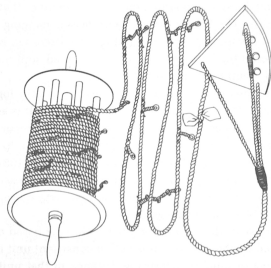
### Astrolabe



### Medieval Tide Computer

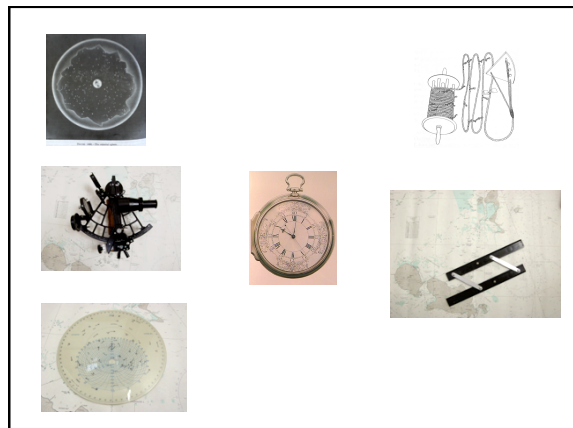
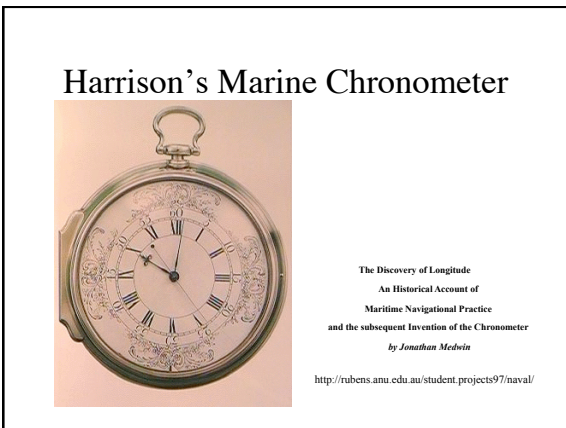
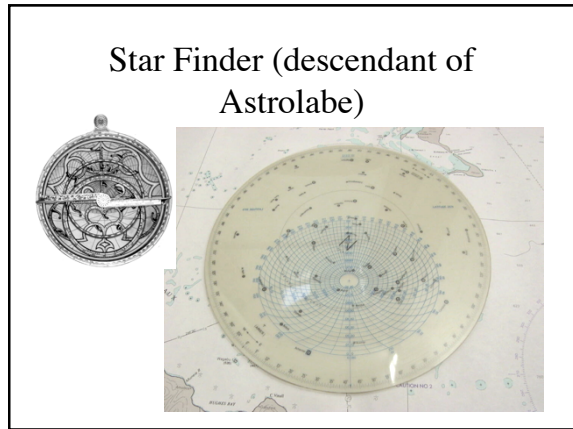
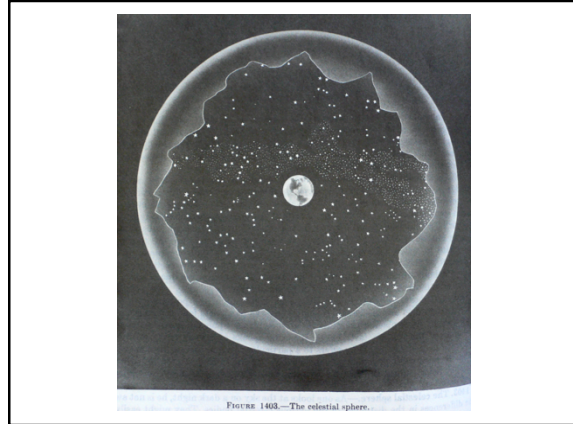


### Chip Log



### Parallel Ruler





## Concepts

- Every cognitive ecosystem has a history
- Every history is contingent
- Change – adaptation through constraint satisfaction
- Relations are not found in the properties of the elements, but in the roles the elements play in an activity.

## Ecosystem Relations

- Dependence
- Synergy – symbiosis
- Competition – arms race
- Predator – prey