Analog Devices

A brief discussion of continuous state computational devices spanning the centuries

James Tam

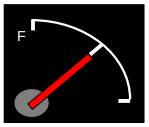
Digital Vs. Analog

- In this context (from Williams)
  - Digital devices are classified with discrete devices (finite number of states).


off


on

  - This is in contrast with analog devices (a continuum of possible states)



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Images: James Tam

Astrolabe

- An old computing device used to solve problems related to time and navigation.
- It's a projection of the map of the sky (a dome) on a 2D surface.
- It was clearly used in the Arab empire (~600 AD) but earlier uses are unclear (Williams) up to ~1600 AD.


https://commons.wikimedia.org

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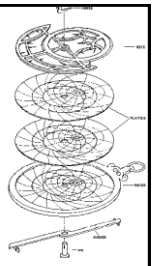
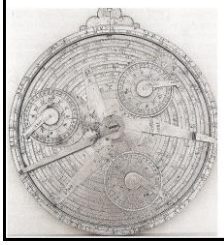
Astrolabe: Parts

Images: copyright unknown

- Outer backing: mater/"mother"
- Metal: plates/ "climate" or "tympanum"
- Cut-away disk: rete/"net/network?"





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Astrolabe: Some Common Uses

www.astrolabes.org

- Time keeping (given the sun's position when at the following latitude it is the XYZ time of day).
- Determining the current latitude (navigation)

For more specific details of the astrolabe (based on positions of stars) see the references

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Astrolabe: Video

- Ted talk: Tom Wujec
- http://www.ted.com/talks/tom_wujec_demos_the_13th_century_astrolabe.html

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Astrolabe: Today

- The development of more accurate mechanical clocks (such as Galileo's conceived pendulum clock ~1600's) reduced the need for the astrolabe.
- Mostly it's viewed as a historical curiosity but souvenir versions can still be purchased cheaply.

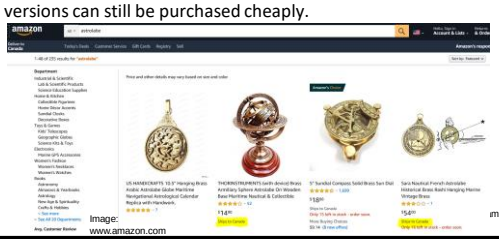

Image: www.amazon.com

The Antikythera Device: Discovery

- Discovered in 1900 by Greek sponge fisherman who found a shipwreck near the island of Antikythira.

Generated with: www.bing.com

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The Antikythera Device: Discovery (2)

- They took shelter from a storm and divers were sent after it blew over.
- Instead of finding sponges a shipwreak was found.
- It contained Greek statues and artifacts from the time of Christ.
- Included in those artifacts was a lump of encrusted bronze.

http://historicmysteries.com

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The Antikythera Device: Uses

- Due to the deteriorated condition (years in salt water) the exact use is unknown.
- It's speculated to be the device reported by the Roman philosopher Cicero (~1st century BC) and used to reproduce the positions of the sun, the moon and some of the planets. (Williams)

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The Antikythera Device: Videos

- History and background
  - https://www.youtube.com/watch?v=4eUibFQKJqI
- Working model: built out of everyday material (Lego)!
  - https://www.youtube.com/watch?v=RLPVCJjTNgk

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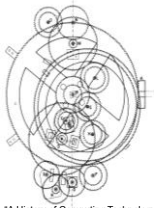
Antikythera Device: Significance

- The Antikythera device originated from Roman times yet contained gearing mechanism that did not reappear in Europe until much later in ~1500 years. (Similar to an automobile: Williams).



"A History of Computing Technology" by Williams

Encyclopedia Wikipedia

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Differential Analyzer

- Manually determining the area under a curve is cumbersome and inaccurate ("Using cutouts": Williams).
  - This has many applications:
  - http://www.intmath.com/applications-integration/applications-integrals-intro.php
- Early attempts to devise mechanical mechanisms (e.g., Lord Kelvin) for solving these problems were hindered by the limited ability to obtain accurately machined parts.
- Vannevar Bush (MIT) was the first to actually produce a working machine (Late 1920s, early 1930s: publication 1931).

Differential Analyzer: Videos

- http://web.mit.edu/klund/www/analyzer/

Differential Analyzer: Programming

- Because it relied heavily on mechanical movement to generate results, 'programming' and debugging the computational device was challenging.

"A History of Computing Technology" by Williams

Other Differential Analyzers

- The mechanical method of solving differential equations was so successful that at least 5 copies were made.
- Example: Manchester university

Hartree and Porter; From http://www.marshall.edu

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Differential Analyzer: A Military Application

- Ballistics research (artillery and rocket trajectories)
- World War II Norway: Shortly after the successful German invasion
  - Oslo University

Colourbox.com

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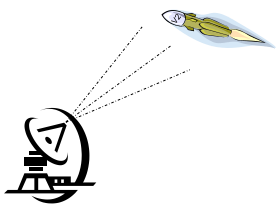
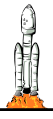
Differential Analyzer: A Military Application (2)

- World War II MIT:
  - Differential Analyzer was used to solve ballistic trajectories
  - (Yet the range of the 'shell' by far exceeded any artillery piece at the time).





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After This Section You Should Now Know

- The time period during which the astrolabe was used
- Some of the common uses of the astrolabe
- The general appearance and major parts of the astrolabe
- The date and circumstances under which the Antikythera device was found
- The appearance and general condition of the Antikythera device
- The date of creation and the significance of the Antikythera device
- The approximate creation date and use of the Differential Analyzer

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After This Section You Should Know (2)

- Some of the key people and events behind the original difference engine and it's copies
  - MIT
  - Manchester
  - Oslo

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References

- "A history of computing technology", Williams M.R., IEEE Computer Society.
- "Time and the astrolabe in the Canterbury tales", Osborn M., OU Press.
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  - http://www.astrolabes.org
- MIT: Differential analyzer
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