The Prehistory and Cryptozoology of the Telescope

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Far Seeing about Seeing Far

- Assyrian lenses
- Egyptian lenses
- Roman lenses
- 100 Ptolemy's *Optics*
- Viking lenses
- 1000 Ibn al-Haytham's *Kitab al-Manazir*
- Eyeglasses from 1280s
Early Lenses and Magnifying Views

- Oldest lens found is the Nimrud lens, 2700 years old, from Assyria.
Early Lenses and Magnifying Views

• 150 Nero's Monocle
  • Roman Emperor Nero is recorded to have improved his poor vision by viewing events through a "stone".
  • Most historians think this was a cut gem.
  • Was it cut to correct his vision or to magnify?

• 850 The Lothar lens, from a German monastery
Early Lenses and Magnifying Views

- 1000 Viking lens
Single-Lens Viewing

• 1200s Roger Bacon writes that a magnifying lens makes new stars appear where the sky appears empty to the naked eye.
• 1400s Leonardo daVinci writes that a lens makes features on the Moon appear larger.
• Both probably using a convex magnifying lens.
• You can find this today in high school science experiments.
  • But you need young eyes to focus this image.
The Camera Obscura

- An Ancestor of the Telescope.
- Pinhole or lens projects image onto opposite wall of a room.
- First built by al-Haytham ~ 1000.
- Widely adopted by artists in the Renaissance.
  - Assisted drawing in the new perspective style.
Cryptozoology: Mystery Beasts that Never Were (or were they?)

- Giant Mirrors
- The Perspective Trunk
- The 16" reflector
- Prototelescopes
The Harbor Mirror of Alexandria

- Pharos Lighthouse at Alexandria.
- Romans added a mirror to reflect sunlight by day and fire by night.
- One of the 7 Wonders of the Ancient World.
The Myth of the Mirror

• Claims by European writers in the Middle Ages that a giant magnifying mirror enabled an inspector to stand before the mirror and examine ships as they approached port.

• There are claims that other harbors had these devices.

• The people who built the mirror at Alexandria never claimed it had these superpowers.
The Mythical Monster Mirror

- A concave mirror only magnifies an object closer than its center of curvature.
- To put the center of curvature at the distance of a ship would require a mirror many meters tall.
- In this period mirror makers were producing accurate curves on the order of centimeters, not meters.
Leonard Digges and his Amazing Perspective Trunk

• Digges was a prominent architect, surveyor, and landed gentleman of the reign of Henry VIII.

• The Perspective Trunk was a portable camera obscura for surveying use.

• Projected the image onto a parchment screen to observe from outside the trunk.

Illustration is of a 19th century descendant
Leonard Digges and his Amazing Perspective Trunk

- 1571 Leonard's son Thomas Digges writes that he could magnify that image and read a broadside posted 2 miles away.
  - He said he was writing a paper on this.
- Thomas Digges became England's first modern astronomer, the first to promote the Copernican model in England, and tried to develop a telescope.
Thomas Digges' Telescope and the Spanish Armada

- 1570s Digges sends to his patron Baron Burghley a design for a telescope using an objective lens and a mirror focuser.
- Burghley sends it to Royal Navy cannon inventor William Bourne.
- Bourne proposes swapping the elements: a primary mirror and a lens to magnify and focus.
- 1580 Bourne proposes a new design with 2 lenses.
Did the English Navy have a Digges Telescope?

- After defeating the Spanish Armada, Queen Elizabeth rewards Digges with land and money for unspecified services to the Crown.
- But Digges' design could not be built with state of the art Elizabethan technology.
  - Researchers have built it using modern technology.
- Digges probably demonstrated the Perspective Trunk at a Navy lookout post.
- Part of a larger program of secret weapons.
  - E.g., the backstaff (predecessor of the sextant).
Why Couldn't Digges Build His Telescope?

- Digges designed his telescope from the math and theory available at the time.
- Working From Bacon's *Optics,*
  - Limited restatement of Ptolemy, no refraction.
  - Just one chapter in Bacon's *Opus Magnus.*
- Digges computed that he needed a 12" to 16" lens and mirror.
  - The largest usable lens at this time was 2".
- Meanwhile, the lensmakers experimented till they converged on a small lens that worked.
Why Did Newton Succeed Where Digges Failed?

- 1668 Newton builds his reflecting telescope.
  - Newton was trying to solve the problem of chromatic aberration (which he explained for refractors).
- Newton had an additional century of development of theory and technology.
  - Not least, his own contributions to optics.
- As President of the Royal Society, Newton had the older papers about Digges' attempt.
The Difficult Labor and Fuzzy Claims to the First Telescope

- From the *Optics* of Bacon and, after 1604, Kepler, many scientists recognized the telescope was possible.
- Galileo: "Everybody knew it should work, it was only a question of discovering what arrangement of lenses was needed."
- Patent application for first Dutch telescope was denied because "Everybody is building these. We can't enforce the patent monopoly."
- All through the 1500s people in many countries tried to build one.
The Many Pretenders to the Throne of First Telescope

- 1538 Fracastoro in Italy writes about using 2 lenses to make objects appear larger and closer.
- 1570 John Dee in England writes about military uses for the perspective glass.
- 1580 Digges' and Bourne's designs in England.
- 1598 Della Porta in Italy places a mirror + lens in a Camera Obscura to enlarge the image.
- 1604 Kepler's *Optics*. Still no refraction.
  - Galileo: "Kepler's *Optics* is so complicated nobody understands it, not even Kepler."
The Many Pretenders to the Throne of First Telescope

- 1608 Hans Lipperhey in Holland demonstrates a telescope and applies for a patent on it.
- 1608 a telescope for sale at Frankfurt Book Fair.
- 1609 telescopes for sale on the streets of Paris.
- August 2 1609 Thomas Harriott in England observed the Moon through a Dutch telescope.
  - Publishes sketches of the Moon before Galileo.
  - Develops the first theory of refraction.
The Many Pretenders to the Throne of First Telescope

- July-August 1609 Galileo copies a Dutch telescope.
  - But quickly improves the design.
  - March 1610 publishes his first observations.

- 1609 Juan Roget (Spaniard working in Genoa) claims to have invented the telescope.

- 1611 The word "telescope" invented by a poet honoring Galileo.

- 1610s Dutch sources claim other inventors.
Galileo's Job Search
Or, how he inflated his account of his first telescope to impress his patrons

- Galileo: "It is too bad that I had heard a telescope already existed. Otherwise you would be even more impressed at how I arrived at the design by pure reason."
Did Galileo Reason His Way Past Digges' Mistakes?

<table>
<thead>
<tr>
<th>Digges</th>
<th>Galileo</th>
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</thead>
<tbody>
<tr>
<td>Using Bacon's <em>Optics</em></td>
<td>Using Kepler's <em>Optics</em></td>
</tr>
<tr>
<td>Had no theory of refraction</td>
<td>Still had no theory of refraction</td>
</tr>
<tr>
<td>So computed mathematically a reflecting design</td>
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</tr>
<tr>
<td>Concluded he needed a mirror larger than any that could be made with good optical qualities</td>
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</tr>
<tr>
<td>Canvassed England for someone who could make a 14“ mirror</td>
<td>Commissioned a shop to try to make a 6“ mirror</td>
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</tbody>
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- Galileo made all the same mistakes Digges did.
- He said "it was only a question of discovering what arrangement of lenses was needed" after he saw the Dutch telescopes that used lenses rather than mirrors.
### How Did Galileo Invent His Telescope?

<table>
<thead>
<tr>
<th>Galileo's Account</th>
<th>What Historical Documents Support</th>
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<tbody>
<tr>
<td>Galileo visits Venice to discuss reports of the Dutch telescopes</td>
<td>Agree with Galileo's account ...</td>
</tr>
<tr>
<td>A foreigner comes to Padua with a telescope</td>
<td>Galileo was probably in Venice for part of the 2 weeks Sarpi took for his evaluation</td>
</tr>
<tr>
<td>Galileo rushes home to Padua to see it</td>
<td>Galileo may have had the foreign telescope on the table in front of him when he built his</td>
</tr>
<tr>
<td>But misses the foreigner, who is now in Venice and tries to sell it to the city</td>
<td></td>
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Galileo on the Shoulders of Giants

- Taught himself lensmaking.
- Soon was producing the largest, best quality lenses known in early telescopes.
- Developed better telescopes specifically for planetary observations.
  - During his career his telescopes advanced from 10mm (stopped) aperture, 3x to 60mm aperture, 33x.
- Recognized that his observations were experimental evidence supporting the Copernican model.
Summary: How Did We Get the Telescope?

It was a magical time...

Real Ancestors of the Telescope

Imaginary Ancestors of the Telescope

It was a magical time...

Not just one, but many telescopes

- Lots of people were doing lots of work.
- "Genius is 1% inspiration and 99% perspiration" – Edison
- "The telescope itself fails to be invented" – Van Helden
Bibliography and References


- The Digges Telescope. http://www.chocky.demon.co.uk/oas/diggeshistory.html


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