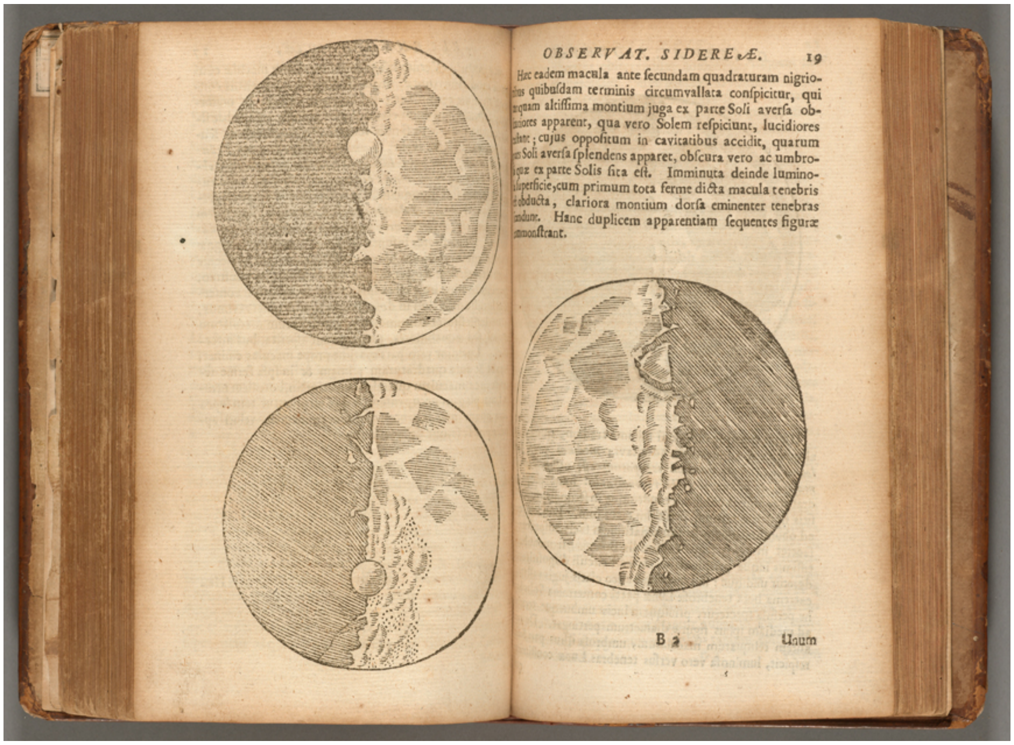
IV Constructing Scale

Constructing Scale

Scale is an omnipresent concern in early modern scientific illustration. In its absence an island on a map can be confused for a continent, or a grain of sand for a stone; a diminutive body through a spyglass can be misread as a behemoth. With the introduction of instruments like the microscope and telescope, capable of augmenting the range of vision and opening up new worlds, a plethora of hitherto unseen phenomena demanded novel techniques for indicating scale. Robert Hooke's *Micrographia* (1664) employs a number of visual innovations, such as the use of a scale bar beneath a specimen depicted in scope-eye view. Meanwhile, in other fields, the technique persisted of printing directly from natural specimens, guaranteeing a one-to-one ratio and enabling the naturalist to avoid the distortions of scale that arise in illustrations. The nature print is the degree zero of scale. However, in it a fundamental tension between precision and distortion persists, as a more complex and more verisimilar representation is sacrificed in favor of exact physical fidelity. By exaggerating the size of the central crater of the moon in *Sidereus Nuncius* (1610), Galileo rendered believable the novel idea that the moon, with its "mountains and valleys," is a body comparable with the earth and not of an entirely different nature, thereby lending support to the Copernican model of the world.

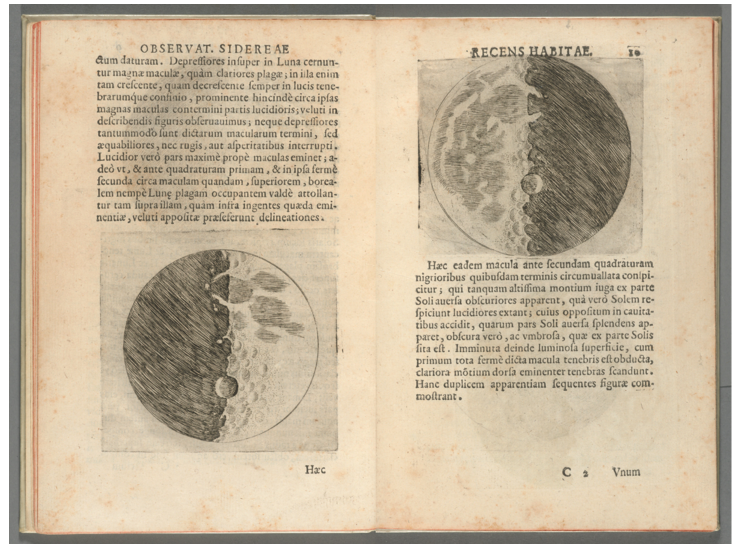


18
Unknown artist
After Galileo Galilei
Italian, 1564-1642
Images of the moon
Woodcut
In Galileo Galilei, *Sidereus nuncius* [Starry Messenger], London: Jacob Flesher, 1653; reproduced after the 1610 Frankfurt edition and bound together with Pierre Gassendi, *Institutio astronomica*, 1675.
Houghton Library, Harvard College Library, Gift of Robert Wheeler Wilson, 1927 (*FC6 G2157 647ie)

The *Sidereus Nuncius* presents the results of Galileo's observations of the heavens made with the telescope. The format of the book resembles that of a news pamphlet more than an astronomical treatise. Its title – sidereal messenger or message – echoes contemporary popular-cultural sensibilities. The narrative is compact and its content accessible, with little technical detail. The book starts with Galileo's narration of the circumstances in which he first learned of the telescope and how he came to build one (catalogue no. 19). He then briefly and vaguely describes the functionality of the instrument and presents a sketch meant to illustrate the relationship between its parts. The narrative then shifts to the presentation of his observations of the lunar surface illustrated with the images shown here. The book continues by relating his observations of the Milky Way and the constellations and ends with the presentation of the satellites of the planet Jupiter, which he called the "Medicean stars."

As recent scholarship has shown, the book was the centerpiece of a complex social and epistemic strategy. In an attempt to refashion himself, Galileo used it as an instrument to challenge the boundaries of existing disciplinary structures. He was initially a mathematician at the University of Padua. This was deemed an inferior position as mathematics was a propedeutic discipline, inferior to philosophy and theology. By dedicating the *Sidereus* to the Medici, he attempted to attract their patronage in order to allow him to transcend the limitations of his status and become a court philosopher, a position from which he could speak with increased authority.[1]

In addition, Galileo sought to establish priority and obtain international visibility. The discoveries the book presents challenged long held philosophical



OBSERVAT. SIDEREAE

ctum daturam. Depreſſiores inſuper in Luna cernuntur magnæ maculæ, quàm clariores plagæ; in illa enim tam creſcente, quam decreſcente ſemper in lucis tenebrarumque confinio, prominente hincindè circa ipſas magnas maculas contermini partis lucidioris; veluti in deſcribendis figuris obſeruauimus; neque depreſſiores tantummodò ſunt dictarum macularum termini, ſed æquabiliores, nec rugis, aut aſperitatibus interrupti. Lucidior verò pars maximè propè maculas eminet; adeò vt, & ante quadraturam primam, & in ipſa fermè ſecunda circa maculam quandam, ſuperiorem, borealem nempè Lunę plagam occupantem valdè attollantur tam ſupra illam, quàm infra ingentes quæda eminentiæ, veluti appoſitæ præſeferunt delineationes.

Hæc

RECENS HABITAE. 10

Hæc eadem macula ante ſecundam quadraturam nigrioribus quibuſdam terminis circumuallata conſpicitur; qui tanquam altiſſima montium iuga ex parte Soli auerſa obſcuriores apparent, quà verò Solem reſpiciunt lucidiores extant; cuius oppoſitum in cauitatibus accidit, quarum pars Soli auerſa ſplendens apparet, obſcura verò, ac vmbroſa, quæ ex parte Solis ſita eſt. Imminuta deinde luminoſa ſuperficie, cum primum tota fermè dicta macula tenebris eſt obducta, clariora mõtium dorſa eminenter tenebras ſcandunt. Hanc duplicem apparentiam ſequentes figuræ commoſtrant.

C 2 Vnum

Unknown artist in the workshop of Tommaso Baglioni after Galileo Galilei, *Images of the Moon,* engraving, in Galileo Galilei*, Sidereus nuncius* [Starry Messenger], Venice: Apud Thomam Baglionum, 1610, Houghton Library, Harvard College Library, Gift of T.M Harris, 1826 (IC6.G1333.610s)

beliefs. The image of the moon is perhaps the best example. The moon was thought to be the boundary separating our world of constant change and transformation from the world of the stars, made of the fifth essence (in contrast to the four earthly elements), immutable and eternal, always in perfect circular motion. The lunar surface was believed to be shiny and spotless, of a nature more akin to the other celestial bodies than the earth. Any evidence to the contrary was accounted to be a distortion caused by earth's atmosphere. To overturn this idea, Galileo had to prove not only that the moon was spotted, a phenomenon easily dismissed as an artifact, but also that its surface was rugged.

The image of the moon is configured in such a way as to not only fit, but also perform Galileo's argument. The way it does this is also relevant for the idea of scale that informs this section of the exhibition. Scale reveals important aspects about the nature of images. Fundamentally, there is a highly problematic relationship between an image and the object it represents. Consider size: not counting the nature prints which are attempts at realizing a perfect translation (catalogue no. 24), a visual representation is almost always bigger or smaller that the object it refers to. How, then, can one know the size of the referent, if the only thing available is the reference? Constructing scale is a solution to this problem of knowledge. This can be done quantitatively by disclosing the degree of magnification, thus allowing the conversion of the relationships between the objects of the representation and the objects which are represented (catalogue no. 23). It can also be suggested qualitatively, simply by setting up the representation in such a way that the viewer can

Fig. 1. Photograph of the moon in the fourth quarter compared with an image from the *Sidereus Nuncius*. Both images are in the public domain. A similar comparison is made by Owen Gingrich in the work cited here

deduce the size of one element by making comparisons with other elements.

This way of constructing scale is used here by Galileo to perform his argument. In order to demonstrate the ruggedness of moon's surface, he tried to make it understandable in terms of earth's geography. The moon, he insists, has "mountains and valleys" like the earth. To accentuate this idea, the central crater is increased in size. We should think of it argues Galileo, pushing the geographic analogy, as if it were the kingdom of Bohemia, surrounded by mountains on all sides. The result of these discursive and pictorial distortions is an image of the moon much different from what has been observed later or by using today's photographic representations.[2]

The *Sidereus Nuncius* was a tremendous success, selling out in a few days. A second pirated edition was printed in 1610 in Frankfurt. In the effort to make a fast and cheap product, the pirates chose not to reproduce the engravings, but to print the images using woodcuts instead. The difference in quality between the two technologies is quite compelling. On top of that the representations of the lunar surface are out of order and printed upside down. In spite of this, the pirated edition and not Galileo's first edition became the preferred model for later reprints. In fact, it can be said that the majority of readers who came to know the book close to the time it was published read one of the subsequent editions modeled on the pirated one and not the original. The 1653 English edition printed in London, from which the second image on display is taken, is testament to this.[3] Moreover, the pirated edition set an alternative standard for how stars are supposed to be represented – white on black, while the first edition of Galileo's book depicts them black on white.

This history of Galileo's *Sidereus Nuncius* is relevant for the idea of 'printing knowledge,' the overall theme of this exhibition. It illuminates, first of all, the social significance of the two printing techniques – engraving and woodcuts featured in the section of technique (catalogue nos. 1 and 2). Secondly, it shows the circulation between knowledge-making and print-making: knowledge is made available through prints, which themselves, as prints, make new knowledge.

Florin-Stefan Morar

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[1] Mario Biagioli, *Galileo, Courtier* (Chicago: University of Chicago Press, 1993), 103-57.
[2] Owen Gingerich and Albert van Helden, "From Occhiale to the printed page: the making of Galileo's Sidereus Nuncius," Journal for the History of Astronomy 34 (2003): 251–267.
[3] Adrian Johns, *The Nature of the Book: Print and Knowledge in the Making* (Chicago: University of Chicago Press, 1998), 25f.

19.
Leonardo Semitecolo
Italian, early 18th c.
Telescope
Private Collection

Although we have no precise information about the Venetian instrument maker Leonardo Semitecolo, many objects by him survive, including a large number of telescopes. Semitecolo spyglasses are also quite common, appearing more often than any other in European flea markets and antique fairs. They appear to have been manufactured over a long period of time beginning in the third quarter of the eighteenth century. This particular telescope is made in the seventeenth-century style of pasteboard tubes covered in vellum and stamped leather, and also has the optical design of the earlier period.

This instrument dates from a time when the telescope was already recognized as an emblematic scientific instrument. Owning one carried a certain prestige. The fact that this telescope cites the style of an earlier period by the way it is manufactured only increases its aura. It is thus probable that it was not built to be used in a scientific setting but to decorate a cabinet or study of a gentleman. This reveals a point in the longue durée history of the telescope: with Semitecolo's instrument we are in the era of its mass production and reproduction.

Telescopes appeared in the Netherlands at the beginning of the seventeenth century in an artisanal setting. Three artisans have been traditionally credited with invented it: Jacob Metius of Alkmaar, Hans Lipperhey, and Sacharias Janssen. In a classic study, Albert van Helden established that the earliest undeniable mention of a telescope is in a letter written by Lipperhey on September 25, 1608, and that he was the first to request a patent on the telescope.[1] Although it was treated as a secret in the Netherlands because of its easily replicable nature it quickly spread across Europe. The instrument was sold in European cities like Paris in spectacle maker shops. Its importance for warfare and navigation was emphasized in this context, but it soon attracted the attention of natural philosophers. Having seen the telescope in Paris, Jacques Badoer sent news of it that reached Galileo Galilei in July of 1609. Galileo used this to claim that he re-invented the telescope all by himself having as basis only a vague rumor.

Mario Biagioli has recently emphasized the importance of a letter of Paolo Sarpi to an Italian-born Huguenot, Francesco Castrino, which was first published in 1833 but was excluded from Antonio Favaro's edition of Galileo's *Opere.* This letter discloses the fact that a telescope was brought to Venice by an artisan who attempted to sell it to the Venetian Senate for the price of one thousand *zecchini* as early as the eighth of July 1609. The bid of the artisan was unsuccessful, but because of this it is plausible that Galileo might have seen the telescope before attempting to build one himself or at least received important technical details from his friend Sarpi, who witnessed the event. Taking this into account Biagioli has proposed a new chronology for Galileo's invention of the telescope, according to which Galileo was given a detailed technical account by Sarpi or saw the instrument himself on the nineteenth or twentieth of July. Returning to Padua the next day he uncovered the secret of its construction and built a prototype. He took a 9x power instrument to Venice on July twenty-seventh and showed it to his friends.[2]

The occurrence of this technology transfer helps us to reevaluate Galileo's account of his discovery. It is nevertheless undeniable that Galileo improved the technology of the telescope, building 9x, 20x and 30x power instruments by better processes like grinding and polishing lenses. These more powerful telescopes allowed him to make the observations of the heavens he described in the *Sidereus Nuncius* (see catalogue no. 18) and subsequent publications. Galileo carefully guarded his technical knowledge of the telescope. In the *Sidereus nuncius* only basic information about how the instrument is supposed to function is revealed. He did not include any discussion of techniques used to build the instrument or of the importance of grinding lenses or the diaphragm he used to enhance the resolution of the objective lens. Moreover, he was very selective of the persons to whom he sent instruments and spare parts, and to whom he disclosed technical information. He preferred princes and noblemen to natural philosophers who could use what Galileo sent them to make discoveries for themselves. Likewise, the narrative in the *Sidereus Nuncius* was designed to maximize the credit he could expect from his readers while minimizing competition.[3]

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[1] Albert van Helden, *The Invention of the Telescope*. Transactions of the American Philosophical Society, 67 (4) 1977

[2] Mario Biagioli, "Venetian Tech-Transfer: How Galileo Copied the Telescope," Forthcoming in Albert van Helden, Sven Dupre', Rob van Ghent, and Huib Zuidervaar, eds., *The Origins of the Telescope* (Edita Publishing, 2010).

[3] Mario Biagioli, *Galileo's Instruments of Credit* (Chicago: University of Chicago Press, 2006).

20.
John Bleuler
British, 1757-1829
Pantograph [and wood case], London, c. 1790
Ebony and ivory
Collection of Historical Scientific Instruments, Department of the History of Science (DW0454)

Pantographs are instruments designed to copy and re-scale two-dimensional drawings and maps by conveying motion through a mechanical connection. Users first select the desired ratio of reproduction by adjusting the placement of the smaller brass arms on the larger ones and by placing the writing implement holder at the appropriate increment. They then trace the original two-dimensional image with the brass stylus, transferring motion through the pivot points of the parallelogram such that the drawing implement produces the re-scaled image on the surface below.

We have little information about this pantograph's maker, whose name, Bleuler, appears on the engraved emblem on the inner upper cover of the instrument's case. He advertised himself as an optician and kept a shop at 27 Ludgate Street in London. The directory of scientific instrument makers[1] reveals that Bleuler was a member of the spectacle makers' guild, from which he was freed in 1779, and that he apprenticed to a master named Shuttleworth. There are several instruments by Bleuler still in existence.

This particular instrument consists of four arms made of ebony with four pivoting connections. The two longest arms are attached at one end and the two smaller arms at the opposite end. The other end of each smaller arm is attached to one of the longer arms. The longer of the smaller arms has a screw made of brass attached to it at both ends. Users can take out this arm and re-position it in one of the holes bored in the adjoining longer arm to increase or decrease the size of the area between the four arms. The resulting shape of the Pantograph is a single parallelogram with two extended sides.

Each of the four pivot intersections sits atop a small screw made of brass and framed in ivory. There are three holes bored in each of the instrument's two longest arms and in the longer of its small arms. These are provided with a bushing made of brass. Depending on the desires of its user, the pantograph can be fixed by either of the two longer arms. A pencil is attached on the opposite end of the fixed point. The tracer stylus, also made of brass, is attached to the middle bushing.

The Pantograph is stored in a long, thin, triangular box made of wood. The lid and the bottom are attached with hinges along one of the long sides. There are two latch hooks along the opposite long side of the bottom of the box. These fit into loops attached to the top of the box to keep it closed.

Florin-Stefan Morar

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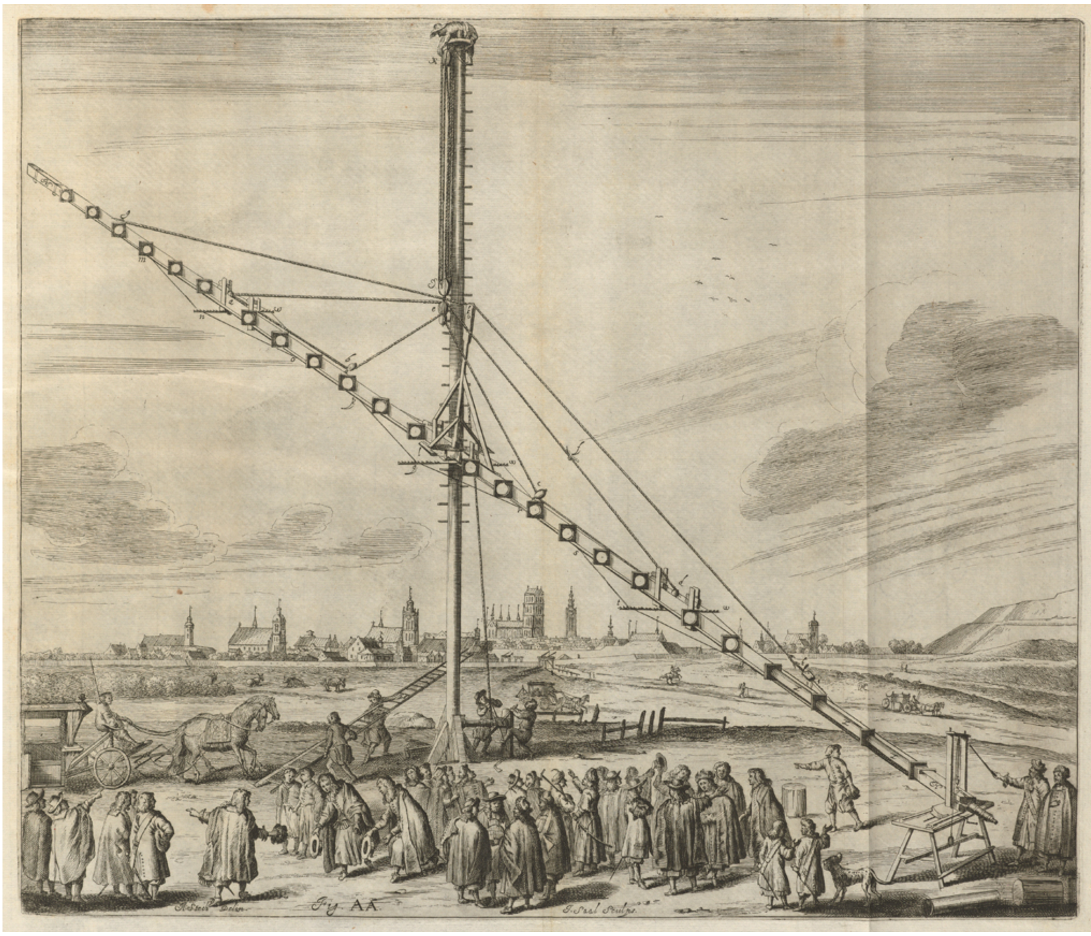
[1]See Gloria Clifton, *Directory of British scientific instrument makers, 1550-1851* (London : Zwemmer in association with the National Maritime Museum, 1995).



21.
Isaak Saal
German?, Danzig, dates unknown
After Andreas Stech
German, 1635–1697
Fig AA: The 140 ft telescope
Engraving
In Johannes Hevelius [Jan Heweliusz], *Machina coelestis,* Gdansk: Simon Reiniger, 1673-1679
Houghton Library, Gift of Robert Wheeler Wilson, 1927 (Typ 620 73 451 F)

Johannes Hevelius (1611-1687) was councilor of the hanseatic city of Danzig (Gdańsk), then part of the Polish-Lithuanian Commonwealth, today in Poland. Hevelius was son of a prosperous brewer. He studied in Leiden, a university famous in the early modern period for its faculty of medicine and endorsement of the experimental method. In his youth he traveled to London and Paris, among other places. He contacted and conducted correspondences with several of the most prominent natural philosophers of his time like Henry Oldenburg, Pierre Gassendi, Giovanni Domenico Cassini, and Athanasius Kircher. In 1664, he was elected fellow of the Royal Society, following the publication of his *Selenographia* (1647), which included the most detailed maps of the moon up to that time. Hevelius owned one of the largest astronomical observatories in the early modern period, overlooking the Vistula. He was also a skilled maker of quadrants, telescopes and other scientific instruments and owned a printing press where he published his works.[1] His wife Catherina Elisabetha Koopman was active in running the observatory. She is represented in several engravings in Hevelius's *Machina coelestis* as involved in making observations. After her husband's death she edited several of his unpublished works.[2]

The *Machina Coelestis* [The machine of the heavens] is modeled after Tycho Brahe's *Astronomiae Instauratae Mechanica* [Instruments for the restoration of astronomy] (1598) and presents a series of engraved images depicting instruments. Hevelius, his wife Elisabetha, artisans working in his workshop and people from Danzig, noblemen and commoners are also represented on several plates. As in Tycho's case, the book was produced in Hevelius's own printing press. The drawings were made by the German artist Andreas Stech, known for his paintings of the Polish king Jan Sobieski III. Stech had a long history of collaboration with Hevelius but also collaborated with other natural philosophers. He also made drawings for Jakob's Breyne's botanical treatise, *Exoticarum aliarumque minus cognitarum plantarum centuria prima: cum figuris æneis summo studio elaborates* [The first group of exotic and other less known plants: with engraved figures made with greatest care] (1678). The plates for the book were engraved by another artisan, Isaak Saal. In this manner, the *Machina Coelestis* reflects the collaboration between artists, artisans and natural philosophers in the early modern period, highlighting an essential aspect for the topic of this exhibition – printing knowledge.

The Figure AA on display in this exhibit depicts Hevelius's largest telescope, which is supposed to have measured 140-150 feet. In the text accompanying the image, Hevelius goes into great detail how the instrument was built. The first step was erecting the pole, which should go deep enough in the ground to ensure stability. Then the beam containing the lenses is raised using a winch system. Hevelius advocates leaving the instrument open. The serial interposition of the lenses creates the same effect as if the instrument were closed. The main limitation of the instrument arises from the fact that it can be used only in perfect weather conditions. Because of this it must be raised and lowered every time at great cost. Hevelius mentions that a special storage space was erected in the proximity.

Figure W depicts a "helioscope", an instrument used to make observations of the solar surface. The idea of this instrument comes close to that of photography. The light is projected on a screen and the solar spots and irregularities are traced on paper. The instrument is also useful for recording the phases of a solar eclipse. A similar instrument was used by Hevelius to map the surface of the moon in greater detail than before, in his *Selenographia*. Mapping the surface of the sun or a solar eclipse is just like "measuring sand," writes Hevelius. The instrument must be moved all the time to follow the movements of the sun as it quickly changes place on the sky. Because of this he recommends that it be operated by someone "quick fingered" and well versed in the use of instruments.

Both of these images, as representations of astronomical instruments meant to magnify and thus size down an unreachable experience, function in different ways with respect to the idea of scale. The helioscope represents in this sense an interesting addition relative to the telescope: it is an instrument meant to capture stable instances of moving objects. In addition, the images themselves use the techniques of constructing scale to convey

Isaak Saal after Andreas Stech, *Fig W: A helioscopic instrument*, engraving in Johannes Hevelius [Jan Heweliusz], *Machina coelestis*, Gdansk: Simon Reiniger, 1673-1679, Houghton Library, Gift of Robert Wheeler Wilson, 1927 (Typ 620 73 451 F) their subject matter. This is particularly true of the first image. If this 140 ft. telescope had been represented by itself without the landscape in the background, the on-lookers at its base and the man on its summit, it would have been an object with size, since the text tells us that it is supposed to be 140 feet long, but at the same time one without scale. The image would have failed to convey the colossal stature of the instrument, which the artist clearly intended to convey.

The context in which these images appeared can help to further elucidate their nature. Hevelius was caught in one of the most vociferous controversies of the epoch. It started with an arbitration of the Royal Society in the case of a debate between Hevelius and the French astronomer Auzout about cometary observations. The society ruled in favor of Auzout and disregarded Hevelius's data as incorrect. Robert Hooke intervened in the debate arguing that Hevelius erred because he did not use telescopic sights on his instruments, thus raising doubts about the quality of all of Hevelius's observations. Like Tycho Brahe, Hevelius used sextants and quadrants with open sights. He simply lined up the star he wanted to situate in the eyepiece to measure its angle in the heavens. Instead, Hooke proposed using telescopic sights, by adding a lens and an adjustable cross-hair micrometer to judge the position. Hevelius rejected this technique, contending that his observations with open sights were precise enough. As Janet Vertesi has recently argued, the publication of the *Machina coelestis* was part of Hevelius's reply to Hooke.[3] He tried to establish himself as an authoritative astronomer by presenting in great detail the instruments he was able to build and thus assert the trustworthiness of his observations.

Florin-Stefan Morar

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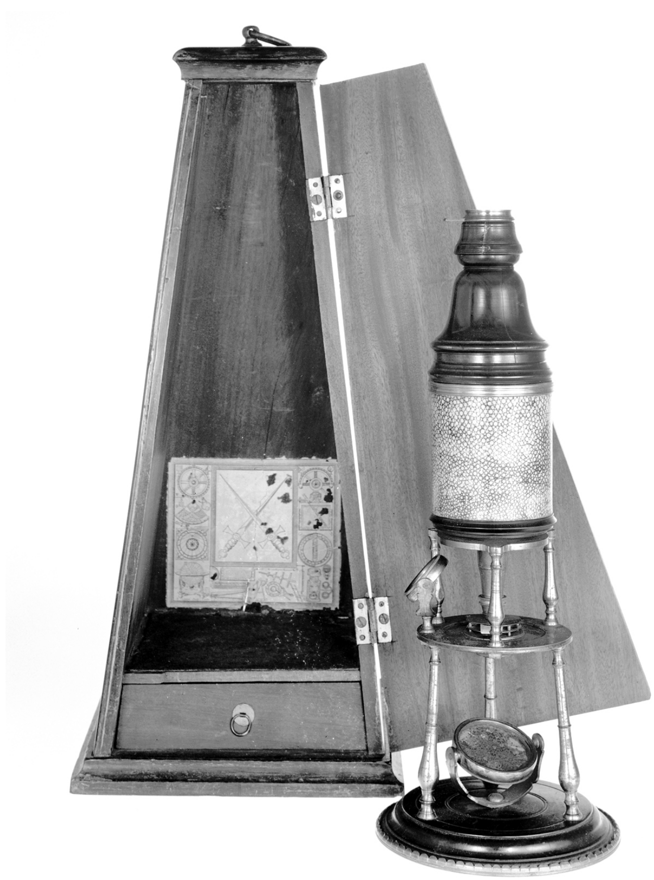
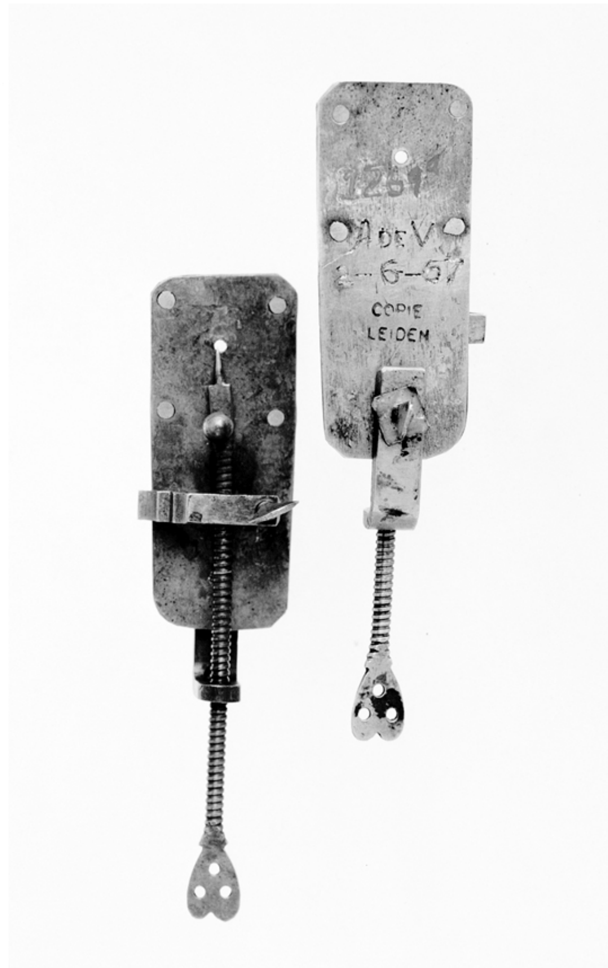
[1] Gillispie, Charles, *Complete Dictionary of Scientific Biography*, Vol. 6 (Detroit: Charles Scribner's Sons, 2008), 360-364.

[2] J. J. O'Connor and E. F. Robertson, "Biography of Catherina Elisabetha Koopman Hevelius," (2008) can be read under: http://www-history.mcs.st-and.ac.uk/Biographies/Hevelius_Koopman.html (accessed 04/10/2010)

[3] Vertesi, Janet (2010), "Instrumental images: the visual rhetoric of self-presentation in Hevelius's Machina Coelestis," British Journal for the History of Science, Published online by Cambridge University Press, 22 March 2010, doi:10.1017/S0007087410000440.



22.a
Edmund Culpeper
English, c. 1660-1737
Culpeper-type compound microscope, London, c. 1730
Accessories: frog (fish) plate; 3 bone slides; 4 objectives; diverse glasses; ivory box with mica covers and wire rings; dark plate
Brass, glass, ivory, lignum vitae, oak, shagreen, and vellum
Collection of Historical and Scientific Instruments, Department of the History of Science (1048)



22.b
Arie de Vink
Dutch, act. 1960s
Simple Microscope, Leiden, 1967
Brass and glass
Collection of Historical and Scientific Instruments, Department of the History of Science (1269b)

The Edmund Culpeper compound microscope is similar in style to the instrument used by Robert Hooke to make the observations and illustrations found in *Micrographia*. One of the interesting features of the biography of Edmund Culpeper in the context of this exhibition is that he was apprenticed to the engraver and mathematical instrument maker Walter Hayes. Like his teacher, Culpeper employed both these skills throughout his career as is evidenced by the trade card, pasted in the back of the microscope's storage, which was printed from a plate engraved by Culpeper himself.[1]

Sometime around 1725 Culpeper began making the tripod style instrument that is now commonly referred to as the "Culpeper style" microscope. The optical tube of this particular instrument is made of wood covered with vellum and shark or ray skin.

Inside the optical tube would have been two convex lenses. The signature feature of the design, the tripod legs, are brass and mounted on a lignum vitae base.

In addition to the dual training of some instrument makers as engravers, there is another interesting connection between microscopes from this period and print culture. Beginning in 1660 it was typical for the optical tube of the microscope to have gold-tooling, the same style of embossed ornamentation used by bookbinders. In part this may have had to do with the increasing specialization of trades after 1700. As opposed to an instrument maker producing every part of an instrument, it was common for bookbinders to pick up side jobs like producing optical tubes (notably without the optics) accounting for the gold-tooling decoration on the instruments that is also found on leather book bindings. By the mid-eighteenth century, however, instruments were increasingly made entirely of brass, putting an end to this decorative style.[2]

The simple microscope, although only about two inches long, holds an equally important place in the history of microscopy – it was the type of instrument used by Hooke's Dutch contemporary Antoni van Leeuwenhoek (1632-1723). Stripped down to its essentials, the simple microscope is basically a bead of glass mounted between two brass plates with an adjustable specimen pin for focusing. Despite being dwarfed in size by the compound microscope commonly used in England, Leeuwenhoek's simple microscope could achieve over 250 X magnification (compared to the roughly 30 X of the compound microscope) and was used to make some of the first observations of microorganisms, bacteria, blood cells and spermatozoa.[3] This particular instrument on display is a replica of one of Leeuwenhoek's own made by modern Dutch instrument maker Arie de Vink.

Jeremy Blatter

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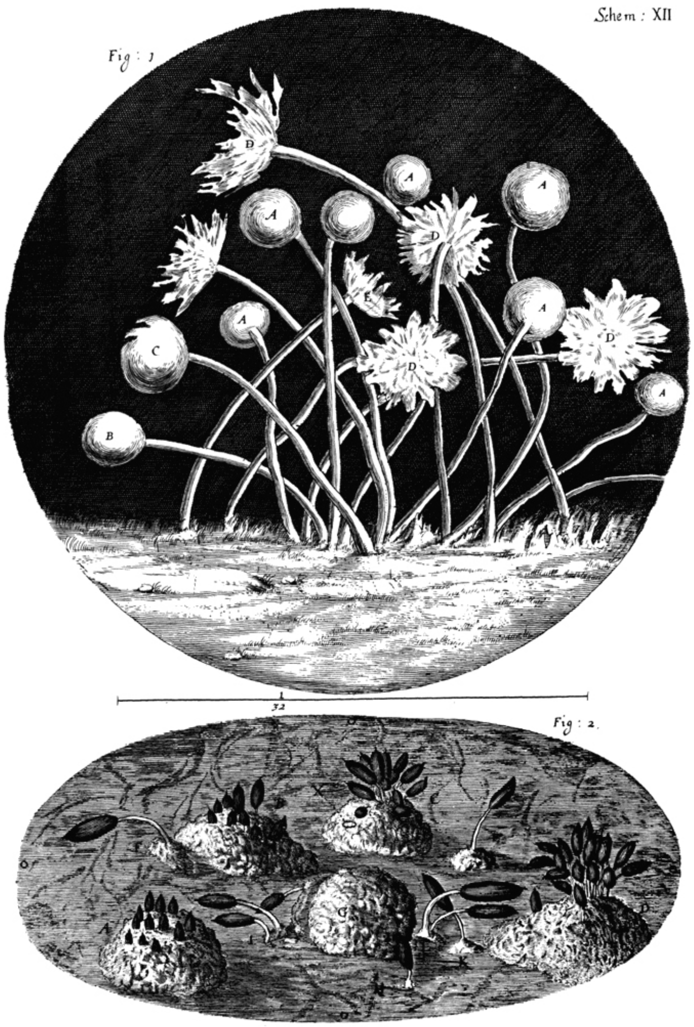
[1] G. L'E. Turner, *Essays on the History of the Microscope*, (Oxford: Senecio Publishing Company Ltd., 1980), 9-12.
[2] Ibid., 79-108.
[3] Brian Bracegirdle, *A History of Microtechnique*, (Lincolnwood: Science Heritage Ltd., 1986), 8-10.



23.
Unknown artist
After Robert Hooke
English, 1635-1702
Scheme XII "*Of* blue Mould, *and of the first Principles of Vegetation arising from* Putrefaction"
Engraving
In Robert Hooke, *Micrographia: or Some Physiological Descriptions of Minute Bodies Made by Magnifying Glasses with Observations and Inquiries thereupon*, London: John Martyn and James Allestry, 1664
Economic Botany Library of Oakes Ames (Rare Book 22F)

In one of his best-known books *Conversations on the Plurality of Worlds* (1686), French writer Bernard de Fontenelle makes a brief detour from the subject of heliocentrism and telescopic observations to meditate on the imperceptibility of the microscopic world. "We see from the elephant down to the mite," he writes, "but beyond the mite an infinite multitude of animals begins for which the mite is an elephant, and which can't be perceived with ordinary eyesight."[1] Such an assertion that there existed a supersensible world beyond the threshold of unaided human vision was not just philosophical or theological speculation; with the emergence of microscopy in the seventeenth century it became an actual site of experimental science.

Twenty years before Fontenelle's *Conversations*, Robert Hooke wrote in almost identical terms about the opening of this microworld to the senses: "*By the means of* Telescopes, *there is nothing so* far distant *but may be represented to our view; and by the help of* Microscopes, *there is nothing so* small, *as to escape our inquiry; hence there is a new visible World discovered to the understanding.*" These lines from the preface of Hooke's *Micrographia* (1664) capture something of the marvel experienced by those early explorers of the subsensible realm, an experience in many ways akin to the discovery of the New World. And like the plethora of exotica early explorers encountered in the Americas, microscopists unearthing the microworld struggled to convincingly describe their remarkable findings with visual and verbal means. There was, however, a crucial difference. Whereas exotic flora and fauna often had an Old World analogue by which one could make sense of them, even familiar things like houseflies, when observed under the microscope, took on an otherworldly appearance. In its extraterrestrial ambiance, Hooke's engraving of blue mould epitomizes this alien quality of life observed under the microscope.

In order to overcome the foreignness of the microscopic object and represent it to the reader as a convincing "matter of fact," an innovative technique had to be employed which Steven Shapin and Simon Schaffer have called "virtual witnessing," that is "the production in the reader's mind of such an image of an experimental scene as obviates the necessity for either direct witness or replication."[2] In *Micrographia* this effect is achieved through a number of literary devices and visual strategies. First, Hooke carefully walks his reader through a precise reenactment of the experimental procedure including at times almost irrelevant circumstantial details to give it an air of authenticity. The description introducing the plate on display provides an excellent example:

> …the first Figure of the XII. *Scheme*, which is nothing else but the appearance of a small white spot of hairy mould, multitudes of which I found to bespeck & whiten over the red covers of a small book, which, it seems, were of Sheeps-skin, that being more apt to gather mould, even in a dry and clean room, then other leathers. These spots appear'd, through a good *Microscope*, to be a very pretty shap'd Vegitative body, which, from almost the same part of the leather, shot out multitudes of small long cylindrical and transparent stalks, not exactly streight, but a little bended with the weight of a round and white knob that grew on the top of each of them; many of these knobs I observ'd to be very round, and of a smooth surface, such as A A…

In much the same way that the richness of the description enables the reader to imagine themselves seeing through Hooke's eyes, the accompanying copper plate engraving brilliantly caps off this effect. Its round format and scope-eye provide the reader with the virtual, or vicarious experience of looking through Hooke's microscope, an effect similarly achieved in filmmaking by the use of point of view shots. Furthermore, the addition of the scale bar between the two views of the mould not only indicates the degree of magnification, but in doing so anchors the reader's gaze in the microworld and augments the epistemological significance of the image.

Jeremy Blatter

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[1] Quoted in Catherine Wilson, *The Invisible World: Early Modern Philosophy and the Invention of the Microscope* (Princeton: Princeton University Press, 1995), 207-208.
[2] Simon Schaffer and Steven Shapin, *Leviathan and the Air-Pump* (Princeton: Princeton University Press, 1989), 69.

24.
Johann Hieronymous Kniphof (German 1704-1763).
Nature print with hand coloring
In *Botanica in originali, seu Herbarium vivum…* [Botany in the Original, or Living Herbarium]
Halle: Joannis Godofredi Trampe, 1758-1764.
Library of the Arnold Arboretum
(Fol. 5 K74)

Born in Erfurt in 1704, Johann Hieronymus Kniphof was a physican and botanist who enjoyed a long career as professor of medicine at the University of Erfurt. On display here is his most famous work, the *Botanica in originali,* one of the first botanical atlases to employ the Linnaean classificatory system.[1] The plant genus Kniphofia, which includes the flamboyant red-hot poker plant, is named for Kniphof.

Several different nature prints from the *Botanica* will be on display over the duration of the "Paper Worlds" exhibition. The first is the *Echinops sphaerocephalus*, or great globe thistle. Because a nature print is a physical imprint of an individual plant specimen in its full dimensions, this large thistle had to be cut into two parts in order to fit on the page. Another striking feature of the globe thistle print is the flattening of the spherical flower head into an almost abstract design. Whereas other modes of naturalistic imaging might reduce the scale of the specimen to fit the page and present the three-dimensional form of its flowering bud, the nature print notably sacrifices these features to the representation of undistorted scale. Also on display will be two prints of different parts of the *Angelica Archangelica*, or garden angelica plant, and a yellow lupin.

In a certain sense there can be no history of the nature print – the technique of creating an image of a plant by inking it on one side and stamping it onto paper – because a form of the nature print can occur naturally. Pick up a leaf pressed into the mud and you will discover it has left behind an impression of itself much like a footprint. Similarly nature prints have a family resemblance to fossils. At the same time, human intervention in, or transformation of this natural process of impression, and its development into a technique of imprinting onto paper, is an important achievement in the history of printmaking. Although it never achieved tremendous popularity the earliest examples reach back to the fifteenth and sixteenth centuries, and it has continued to enjoy a perennial interest ever since.

One artisanal technique that may warrant comparison to the nature print is lifecasting, or sculptures produced from molds made from actual animal or plant specimens. Nuremburg goldsmith Wenzel Jamnitzer (1508-1585) was well known in the sixteenth century for "casting from life," the products of which were eerily mimetic sculptures.[2] The common denominator of the nature print and lifecast is that they represent the degree zero of scale and share a unique indexical relation to their referent. In so far as the physical specimen plays a more significant part than the hand of the artist in the process of representation, one might conceive of nature prints as having a uniquely "objective" quality. In the context of his discussion of the ontology of photography André Bazin once wrote that while "all arts are based on the presence of man, only photography derives an advantage from his absence. Photography affects us like a phenomenon in nature, like a flower or a snowflake whose vegetable or earthly origins are an inseparable part of their beauty."[3] It might be instructive to think about the nature print in a similar way, for while it may initially seem more primitive than other forms of botanical illustration, there is an undeniable presence of the "real," a connection to a particular specimen long since decomposed, which emanates from the perfect impression of a leaf's veins and the peculiar pattern of root growth.

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[1] Gill Saunders, *Picturing Plants: An Analytical History of Botanical Illustration*, (Berkeley: University of California Press, 1995), 141-148.
[2] Pamela Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution*, (Chicago: University of Chicago Press, 2004).
[3] André Bazin, "The Ontology of the Photographic Image," in Leo Braudy and Marshall Cohen, eds., *Film Theory and Criticism* (New York: Oxford University Press, 1999), 198.

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