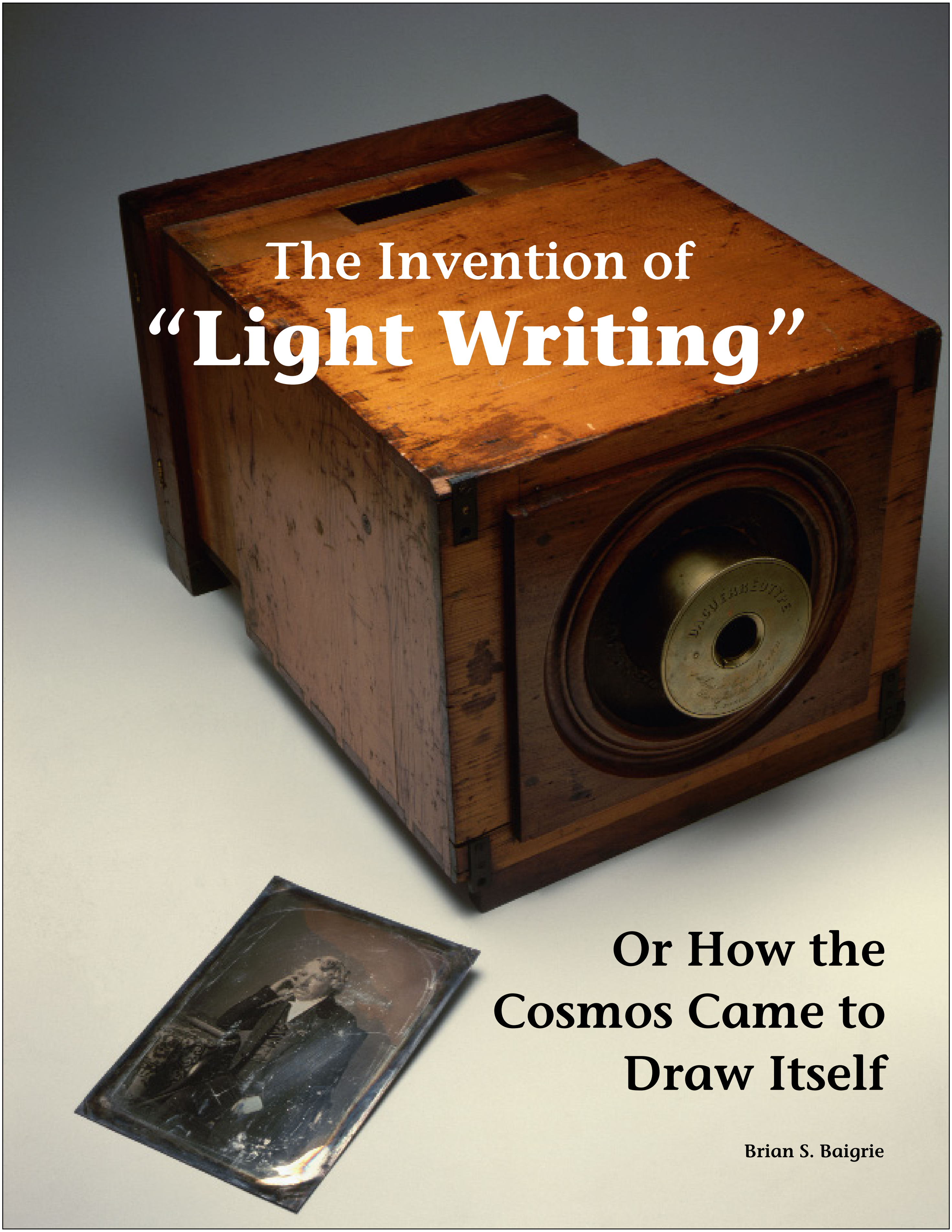

The Invention of "Light Writing"

Or How the Cosmos Came to Draw Itself

Brian S. Baigrie

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In the nineteenth century, scientists began to explore ways of "fixing" the image thrown by a glass lens. The daguerreotype appeared in the first half of the century, followed by less expensive techniques, including the tintype. Astronomers were among the first to employ the new imaging techniques: the photoheliograph, a device for taking telescopic photographs of the sun, was unveiled in 1854.

Thanks to improvements in imaging technology, nineteenth century scientists were able to learn about the world in ever-greater detail, a fact which placed scientific illustrators under increased pressure to produce more accurate images. At the same time, perhaps as a result of the growing sense that the demand for more accurate images was beginning to exceed the capability of the illustrator's hand, scientists began to explore ways of "fixing" the image projected by a glass lens, so that nature could, in effect, draw itself.

This exploration involved two distinct problems. The first was to prepare a medium that was so sensitive to light that it would allow an image to be impressed upon it. The second was to render the same medium insensitive to further exposure, so that the resulting image could be viewed in light without the second exposure causing it any harm.

(Facing page) Photograph of a daguerreotype camera. A portrait of Louis Jacque Mande Daguerre, taken by Charles Meade in 1841, lies beside the camera. (*Above*) Photograph of William Henry Fox Talbot (circa 1865).

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1839
The French government compensates Daguerre for inventing the daguerreotype, enabling world-wide use of the technique.

Myers, Library of Congress

Daguerreotype portrait of a peddler (1840-1860).

1839-1840
John W. Draper photographs the moon in first application of daguerreotypes to astronomy.

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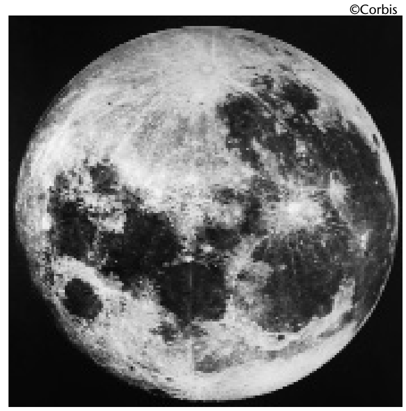

Daguerreotype of the moon (1840).

1841
William Henry Fox Talbot patents new process involving creation of paper negatives.

1840s
Optical means used to reduce daguerreotype exposure times to 3-5 min.

The daguerreotype

During the first quarter of the nineteenth century, the problem of light writing (as it came to be known) was taken on by many scientists and amateur inventors, who experimented with papers or plates prepared with light-sensitive chemicals. During the 1830s, two different solutions were placed before the public.

The first was developed by the French commercial artist Louis Jacque Mande Daguerre (1787-1851). The daguerreotype was made on a sheet of silver-plated copper, which could be inked and then printed to produce accurate reproductions of original works or scenes. The surface of the copper was polished to a mirrorlike brilliance, then rendered light sensitive by treatment with iodine fumes. The copper plate was then exposed to an image sharply focused by the camera's well-ground, optically correct lens. The plate was removed from the camera and treated with mercury vapors to develop the latent image. Finally, the image was fixed by removal of the remaining photosensitive salts in a bath of hyposulfite (sodium thiosulfate) and toned with gold chloride to improve contrast and durability. Color, made of powdered pigment, was applied directly to the metal surface with a finely pointed brush.

Daguerre's attempt to sell his process (the daguerreotype) through licensing was not successful, but he found an enthusiastic supporter in François Arago, an eminent member of the Académie des Sciences in France. Arago recommended that the French government compensate Daguerre for his considerable efforts, so that the daguerreotype process could be placed at the service of the entire world. The French government complied, and the process was widely publicized on August 19, 1839, as a gift to the world from France.

The daguerreotype enjoyed an immense following, especially in the United States, where fascination with the silvered plate endured for nearly 20 years. The charm of the daguerreotype lay both in its extraordinary beauty and in the fact that it was not hobbled by patent or license. The formula was free except in England, where Daguerre had quietly secured a patent, with at least the tacit knowledge of the French government.

The daguerreotype was not without its drawbacks. The first cameras required a lengthy exposure lasting many minutes. By the 1840s, however, various optical means had reduced the exposure time to three or at most five minutes, and by the end of the decade to a matter of seconds. Still, the image was fixed on highly polished metal that was heavy and its highly reflective surface made viewing difficult. Another complication was that the metal surface was extremely delicate, requiring a protective cover glass and a frame or case that made it heavier still. The image itself was limited. The most common size was approximately 2.75 in. x 3.25 in. (7 cm x 8.2 cm), and it could only be made larger with great difficulty. Finally, the most serious drawback was that the image itself was unique—there was no negative from which multiple prints could be made.

By the late 1850s, inexpensive tintypes, which produced an image on a thin metal plate, had eroded the dominance of the daguerreotype. In the first half of the 1860s, soldiers in the American Civil War documented their experience on tintypes, new light, durable paper prints. People began to miss the quality of the fragile, bulky daguerreotype, but in the face of dozens of paper portraits costing the price of only one daguerreotype, the daguerreotype as a commercial process rapidly disappeared.

The wet negative

The second solution to the problem of light writing was worked out by the English amateur scientist William Henry Fox Talbot. Talbot started conducting experiments on paper covered with silver nitrate and other photosensitive chemicals in 1834. He corresponded extensively with John Herschel during the course of these experiments. The process that Talbot invented on his own was flawed because his negatives and prints faded after a short time. Although he had carefully concealed from Herschel his original method of fixing paper to render it insensitive to further exposure to light, it was Herschel who provided the literal and figurative fix that Talbot needed. In 1819, Herschel had discovered that sodium thiosulfate (also referred to as hyposulfite) dissolved

1850s
Ambrotypes, easy to tint and cheaper to make and sell, gradually eclipse the daguerreotype.

1860
Solar prominences photographed by Warren de la Rue using his new photoheliograph.

Washington County Historical Society, Minnesota

A dismantled ambrotype photograph (1860).

1860s
American Civil War documented with tintypes, a new technology based on thin metal plates and paper.

1879
Improvements to photographic plates allow exposure times as short as 1/125 of a second.

Washington County Historical Society

Tintype photograph (1860-1880).

silver salts. Herschel suggested that Talbot try replacing his brine wash and potassium bromide with hyposulfite of soda, which washed off the light-sensitive silver-nitrate salts that were responsible for the fading images of Talbot's original process. Although Talbot was slow to accept the new process, he eventually did and added it to his patent application in 1841.

Unlike Daguerre's crisp images on metal plates, Talbot's process (sometimes called the Calotype or Talbotype) produced paper negatives from which rather soft, painterly paper prints were made in a separate step. The transparent image, or negative, could be used repeatedly to produce prints on paper. His discovery and the process of photogenic drawing were announced in 1839 to the Royal Society. The primary difference between the two processes was that Daguerre's process was considerably quicker and the images on metal were more detailed than were Talbot's. Although Talbot had invented photographic paper that was superior to any other product in existence, the fibers of the paper eliminated the minute details that Daguerre's process revealed with stark clarity.

Acceptance of the Talbotype was also hobbled by the fact that the process was patented; commercial licenses were difficult to sell in the face of the essentially free and established daguerreotype. So although Fox Talbot's prints-from-negatives approach attracted a talented following and would eventually become the standard method in photography, in the early days it was no match for the daguerreotype in the eyes of portrait-making entrepreneurs and the portrait-buying public. It took two decades of evolution and new inventions to finally bring about the full acceptance of negative–positive photography.

Photographing the skies

Astronomers were among the first to embrace the new photographic technology, contributing greatly to its improvement during the nineteenth century. This in itself was not surprising. At times, the image of a telescope is not fleeting and remains visible long enough for an illustrator to catch its outlines. If extremes of heat and cold do not mitigate against the use of a pencil, the image can readily be captured by an illustration. These occasions are exceedingly rare, however. As often as not, the briefness of an astronomical phenomenon fatally compromises the prospect of an illustration. In contrast, the rapidity of response of a photographic plate makes it possible to capture even the briefest astronomical event in an image. Another considerable advantage of photography is that light much too feeble to excite vision, if it is given enough time, can impress an image on a sensitive photographic plate. By use of the most powerful telescope, the camera has the capacity to grasp what is invisible and bring into view a deeper universe heretofore unseen by the most acute observer. A ray of light from a star, however feeble, continues to impress the pellicle of a plate, minute after minute, hour after hour, night after night, until at last the star, too faint to be detected by a telescope, imprints its image on the plate. Mechanical precision is a prerequisite for this sort of work. Twenty-five hours of exposure over the course of ten nights to obtain an image is not unusual.

During the winter of 1839-1840, John W. Draper, professor of chemistry at New York University, was the first to apply Daguerre's process to astronomy when he succeeded in taking a good picture of the moon. Five years later, William Cranch Bond (1789-1859), director of the Harvard Observatory, took a series of lunar photographs. With the assistance of a professional photographer, Bond took the first daguerreotypes of stars in 1850. On April 2, 1845, Armand Hippolyte Fizeau (1819-1896) and Jean Bernard Léon Foucault (1819-1868), who published a number of papers that helped to improve the daguerreotype, took clear images of the sun, which was photographed with increased success because it was one of the objects best suited to the slow speed of photographic material available at that time. The stars also presented photographers with images that were stable during the many minutes and even hours of exposure, but the sun had the added advantage of high luminosity.

Great strides were made by Warren De la Rue (1815-1889), an amateur astronomer. By 1852 he had taken photographs of the moon that could be enlarged without blurring. Ten years later, he was producing photographs that showed as much as could be seen through any telescope. In 1854, he

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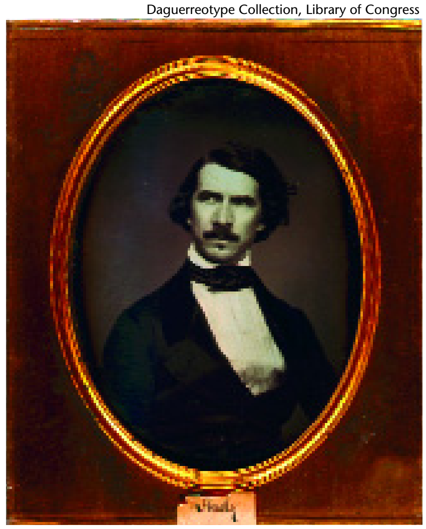
designed the photoheliograph, a device for taking telescopic photographs of the sun, which he used in 1860 to take dramatic photographs of solar prominences during the total eclipse, proving that they were indeed solar and not (as was supposed) lunar in origin.

Most nineteenth century photographs were made on glass-plate negatives, except for the Calotype, which used a paper negative, and the daguerreotype and tintype, neither of which required negatives. Since early glass-plate negatives used a process that required them to be coated just before use, they were known as wet-plate negatives. Dry-plate negatives, which did not require the photographer to make his own plates, were introduced in 1864, but they were so insensitive that they did not initially cut into the dominance of the glass-plate negative.

A new era of observation opened up in 1879 with improvements to the dry photographic plate, making it more sensitive—1/125 of a second for proper exposure. The higher speed of the new material and the fact that a relatively long period of time could elapse between preparation and use led to the rapid diffusion of photographic plates as a means of observation. Almost immediately, Henry Draper (1837-1882), the son of John Draper, abandoned the wet-plate process for the dry photographic plate. He photographed the nebula of Orion, the first nebula to be photographed, with a clock-driven telescope and a 140-min exposure. A year later he succeeded in taking a picture of its spectrum as well. By 1882, Draper had taken photographs with a prism lens of over one hundred stellar spectra. The application of this method proved to be extremely valuable in the compilation of the first general catalog of stellar spectrum types published in 1890 by Harvard University.

Daguerreotype Collection, Library of Congress



George Peter Alexander Healy, one of the most successful portrait painters of the mid-nineteenth century. Mathew Brady's studio, half plate daguerreotype, between 1844 and 1860.

Other astronomers soon began to photograph the spectra of the stars, and it became clear that the stars could be grouped according to the lines in their spectra. Pietro Angelo Secchi (1818-1878) proposed four spectral classes in 1867: class 1 with a strong hydrogen line; class 2 with numerous lines; class 3 with absorption bands rather than lines, which were sharp toward the red and fuzzy toward the violet; and class 4 with bands that were sharp toward the violet and fuzzy toward the red. Secchi's classes mark a fairly straightforward temperature sequence. Class 1 included blue and white stars; class 2, yellow stars; class 3, orange and red stars; and class 4, deep red stars alone. It was difficult to avoid the conclusion that the stars of each type differed physically from those of other types. If the sequence was one of decreasing temperature from blue and white stars of class 1 to deep red stars of class 4, the conclusion might be drawn that the sequence involved an evolution in the life of the stars from stage 1 to stage 4.

In 1887, the director of the Paris Observatory proposed an international project dedicated to producing the first photographic chart of the heavens. It involved outfitting many of the world's great observatories with new refractors customized for photographic purposes. This project had already been anticipated by Edward Pickering (1846-1919) and his co-workers at Harvard University who, between 1886 and 1889, made a complete spectrographic survey of the stars of the northern hemisphere.

The most significant result of the use of photography in astronomical work was that it led to the discovery of new celestial bodies that might otherwise have remained undiscovered. These discoveries were based on one fundamental fact about stellar photography, namely, since stars are virtually motionless, they register on a photographic plate as tiny round dots. Astronomers hypothesized that, if a photographic plate were exposed over a period of time in a camera and directed by clockwork to a particular point in the sky, many bodies having appreciable motion across the field of view (e.g., asteroids and comets) might register on the same plate as minute but nevertheless measurable streaks. It was just such a streak that, on August 13, 1898, disclosed the existence of Eros, an asteroid approximately 10 miles (16 km) in diameter that at the time was thought to approach earth more closely than any heavenly body except for the moon.

Nature at last had drawn itself, demonstrating in the most dramatic way possible the superiority of the new light writing over traditional methods of astronomical illustration. Observations of Eros enabled astronomers to compute more precise distances of the sun and the planets. In the same manner, the ninth satellite of Saturn was discovered by William Pickering (1858-1938).

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