FROM THE FIRST PHOTO ON PAPER TO THE DIGITAL REVOLUTION

THE CONCISE FOCAL ENCYCLOPEDIA OF PHOTOGRAPHY

The Concise Focal Encyclopedia of Photography

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From the First Photo on Paper to the Digital Revolution

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Mark Osterman is process historian for the Advanced Residency Program in Photograph Conservation at the George Eastman House International Museum of Photography and Film. Mark is a recognized expert in the technical evolution of photography and leads a series of demonstrations and workshops in his area of expertise worldwide. Osterman frequently demonstrates the pre-photographic techniques, the earliest photosensitive methods of Niépce and Daguerre through gelatin emulsion for papers and plates.

A graduate from the Kansas City Art Institute, Osterman has taught studio and darkroom photography for 20 years at the George School in Bucks County, Pennsylvania prior to coming to the George Eastman House.

With his wife France Scully Osterman, Scully and Osterman are widely recognized as the foremost experts in the collodion process in all its variants. Through their research, writings, workshops and exhibitions the Ostermans have been the single most important influence in the current revival of collodion in fine art photography.

Grant B. Romer is currently the Director of the Advanced Residency Program in Photograph Conservation at the George Eastman House International Museum of Photography and Film. He has been active as an educator and advocate for the conservation of photographs and a specialist in the history and practice of the nineteenth century photography, particularly the daguerreotype. He has lectured extensively world-wide as well as having held numerous fellowships and visiting professorships.

A graduate of the Pratt Institute and the Rochester Institute of Technology, Romer joined the staff of the International Museum of Photography and Film at George Eastman House in 1978 when he became its Conservator. He has also served as curator of numerous exhibitions, most notably the permanent historical survey gallery of the museum, and recently, "Young America—The Daguerreotypes of Southworth and Hawes."

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As an artist, she has addressed various social issues through her work. Her most recent published project, *DES Stories: Faces and Voices of People Exposed to Diethylstibestrol* (VSW Press, 2001) explores the impact of accidental chemical exposure on the lives of forty individuals. One portrait from the book was chosen for the John Kobal Portrait Award Exhibit at the National Portrait Gallery in London.

Nancy completed her Ph.D. at the State University of New York at Buffalo in the Graduate School of Education. She lives with her husband David and two children, Sarah and Stuart, in Chagrin Falls, Ohio.

J. Tomas Lopez is a Professor of Art and Art History as well as the Director of Photography/Digital Imaging at the University of Miami. Professor Lopez is nationally and internationally known for his large-scale digital prints ranging from underwater photography to politically charged flags. He has been showcased in over 100 group exhibitions and 25 solo exhibitions. His work is included in many permanent collections: The Smithsonian Institution, National Gallery of American Art, La Biblioteque Nation-ale de France (Paris), The International Museum of Photography, and many museums, public, and private collections. He has been with the University of Miami since 1994 where he lives and works with his wife Carol. Professor Lopez has been a recipient of the Florida Individual Artist Grants program, the Cintas Foundation Fellowship, and the NEA Award in the Visual Arts.

Acknowledgments

As I reach the conclusion of this project, I am reminded of the more than 1500 email files in my archive, the countless word and image files as well as the **GIGABYTES** of data that were required to produce the *Fourth Edition*. This book—a representative portion of the *Fourth Edition*—represents the work of a world wide photographic community and because of the method in which the original revision was undertaken, it has been suggested that the *Fourth Edition* wrote and illustrated itself.

From the beginning of this process, it was my objective to achieve the quality and successes of the first three editions, but to do so in a new and different way. This book is the work of many talented people and it includes the cumulative knowledge and experience of many dedicated professionals, many whom I do not know. Although I have never worked on a project this complicated, the journey was one of great discovery, adventure and challenges. My heart felt thanks to all the authors and photographers for sharing their expertise and in the end, creating the wonderful and diverse content for both the fourth and concise editions.

I had much help and support during the time it took to produce this and the *Fourth Edition*. Words alone cannot begin to express my appreciation to Diane Heppner, the book's acquisition editor who started this journey for me by supporting my application for the editor-in-chief position. I am grateful for that support but more importantly, I am sincerely grateful for her advice, which she shared freely during the various phases of creating, producing and publishing the *Fourth Edition*. The creation of the *Concise Edition*, which was built from content produced for the *Fourth Edition* was supervised by Valerie Geary and Brandy Lilly, who did a wonderful job given the short time this edition was provided. I am also grateful for the support of Dr. Zakia and Dr. Stroebel, the editors for the *Third Edition* who were supportive of my selection as editor-in-chief. I was also fortunate to have the unanimous support of Professors Andrew Davidhazy and Bill DuBois, the administrative chairs in the School of Photographic Arts & Sciences who endorsed my involvement in this project from the beginning. The School of Photographic Arts and Sciences is a very special place where my students and colleagues are a source of inspiration, knowledge and creativity, which is shared daily through their work and passion for photography.

The first step in revising the *Fourth Edition* was proposing a revision strategy and getting the proposal approved. With the approval in hand, identifying and persuading section editors to join the team was the next challenge I faced. Finding the right people was very slow and difficult, but once the editors were committed to the project, the results they produced were well worth the struggle. The expertise and networking accomplished by Professor Tom Lopez, Nancy Stuart Ph.D., and Mark Osterman and Grant Romer was truly remarkable. Their wealth of personal knowledge and their invitations to authors reached deep into communities that only experts in their fields could access. This book represents what is possible when a group of dedicated and brilliant editors, authors, and photographers who are passionately involved with photography commit to a project.

Early on during the conceptual phase of this revision, I reached out to Mr. Tony Bannon, the Director of the George Eastman House about a possible collaboration with the Museum and its collections. The idea to explore the collaboration was quickly embraced and became very important to me knowing this revision would include some of the world's important photographs that were held in the Museum's world-renown collections. Once supported, the Museum's associate curator, Sean Corcoran, as well as Todd Gustavson, the curator of the technology collection, selected and delivered excellent suggestions to illustrate so many of the essays.

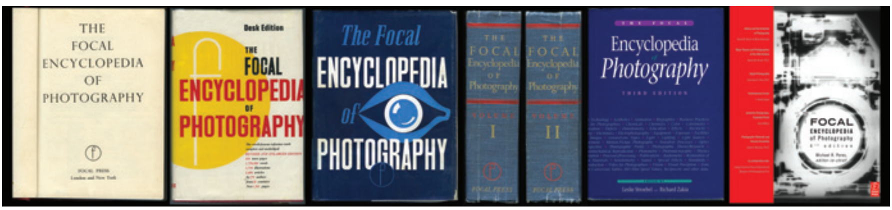
Many others offered help and encouragement throughout the various stages of this production. Becky Simmons, Kari Horowicz, and Amelia Hugill-Fontanel from the RIT Wallace Memorial Library provided many helpful insights when I was at various stages of producing this book and needed to do more research. The RIT Special Collections at the library also provided a number of important pictures taken during RIT's 100 year history of teaching photography.

There were countless others that offered encouragement during the adventure along the way including my parents, who more than 25 years ago supported my pursuit of a second degree in photography. I wish I had enough pages to list all of my collaborators that helped prepare me for this challenge. In the end though, the love and support of my wife Laurie and my children Jonathan and Leah, made this work possible. Their support and understanding of my passion for new adventures gave me the confidence to take on this challenge for which I am forever grateful. Their love was never more evident when I was in the final stages of finishing on-time when there did not seem to be enough time.

Michael Peres
June 2007

Introduction

The first edition of *The Focal Encyclopedia of Photography* was published in 1956 at a time when innovations in silver halide technology, photographic tools, and practices were growing exponentially. Reading the Introduction to the *First Edition* published by Hungarian author Andor Kraszna-Krausz, the first chairman of the editorial board, provided an interesting chance to compare how much imaging technology has changed since that time while the applications have changed more slowly. In fact some things have actually stayed the same. I might also add that it is an achievement for this, or any, book to be available 50 years after its initial printing.



Various covers and title pages from 50 years of editions.

This *Concise Edition* was produced using selected content which was created for the complete revision of the *Fourth Edition*. The content in the *Fourth Edition* was undertaken at a time when great changes are being experienced in all technologies associated with photography. The book's format was created to provide a concise and comprehensive resource sharing the breadth of photography at the time when both film and digital practices co-mingled and users were firmly entrenched in both technologies. The content was written in a narrative style to allow subjects to be explored from both the theoretical and the applications perspectives. It was decided that subjects would be grouped thematically rather than alphabetically. The decision to allow subjects to be explored this way is less traditional for modern encyclopedias, and it was my hope that this would lead to a photographic resource that is uniquely different in this era of electronic resources. The exploratory writing style was selected to enable users to see how a subject is widely defined and then be able to use the ever-increasing resources found on the web in a complementary manner. Additionally, the use of photographs in this edition has created a completeness that prior editions were unable to achieve.

Images were supplied by authors, photographers, organizations, and from the Technology and Image Collections at the George Eastman House International Museum of Photography and Film. The response to the *Fourth Edition* has been excellent thus far and so the *Concise Edition* has been produced to share selected content to a group of readers who might not require the completeness of the *Fourth Edition.*

While photography can be defined as both a subject and a practice, it is also unique in that it uses the same technology when practiced as art or science. No event in the developed world occurs without cameras being present. Cameras are found virtually everywhere in medicine, at birthday parties, in art museums, in cellular telephones and at natural disasters. The power of the image and the consequences photography brings to bear are often overlooked at the time of the picture making during daily events, yet the capturing of such routine events sometimes can be compelling evidence of events long gone. In 1888 when Kodak and George Eastman branded the expression "you push the button and we do the rest" for the Kodak marketing campaign of the time, little could the world have imagined the penetration photography would have into everyday life world-wide in the 21st century.

Producing *The Focal Encyclopedia of Photography* at this moment in history has created many new questions as a consequence of the pace of all the changes the industry and users wrestle with. When I use the digital tools that are re-defining photography today I often wonder, will the majority of my digital pictures made in this era be readable tomorrow by my children or colleagues? Will the images of this era survive the journey of time, when the equipment required to make and see them is changing at rates never before experienced in this medium? Although the complex technical problems surrounding this issue are explored in several essays in the contemporary section of this book, the future is still an unsettled place for photographers who are anxious about these changes and evolution. Therese Mulligan, Ph.D. suggests "that we might consider for a minute that this era in photography must have practical and cultural circumstances that were similar to the era when photography was first practiced in the 1830's. The new is often met with trepidation and this is the nature of change. However, how do digital technologies present opportunities and new possibilities for interpretation, communication and art? Do they co-exist with photography and deepen its significance or is the converse the future?" I am sure you will find this book to be a real treasure and full of surprises.

Michael Peres
Editor-in-Chief
June 2007

HISTORY AND EVOLUTION OF PHOTOGRAPHY

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Contemporary Thoughts on the History of Photography

GRANT B. ROMER

George Eastman House and International Museum of Photography and Film

All photographers work today with historical perspective. They know that the technology they use has an origin in the distant past. They know photography has progressed and transformed over time, and they believe the current system of photography must be superior to that of the past. They are sure they will witness further progress in photography. These are the lessons of history understood by all, and none need inquire any further in order to photograph.

Yet photography has a very rich and complex history, which has hidden within it the answers to the fundamentally difficult questions: "What is photography?" and "What is a photograph?" All true photographers should be able to answer these questions for themselves and for others. To do so, they must make deep inquiry into the history of photography.

Recognition of the importance of history to the understanding of photography is evidenced in the title and content of the very first manual of photography published in 1839, *The History and Description of the Process of the Daguerreotype and Diorama.* Most of the early inventors of photographic processes gave account of the origin of their discoveries not just to establish priority but also to assist comprehension of the value and applications of the technology. When the entire world was childlike in understanding the full potential of photography, this was a necessity.

Many histories of photography have since been written for many different reasons. Each historian, according to his or her interest and national bias, placed certain details large in the foreground, diminished others, and represented most by a few slight touches. By 1939, the hundredth anniversary of photography, a much-simplified chronological story had been told, more or less fixed and repeated ever since. In essence it goes as follows: Photography emerged in the first quarter of the 19th century in Western Europe out of the exploration of the properties and effects of light, the progress of optics and chemistry, and the desire to make accurate and reproducible pictorial records of visual experience.

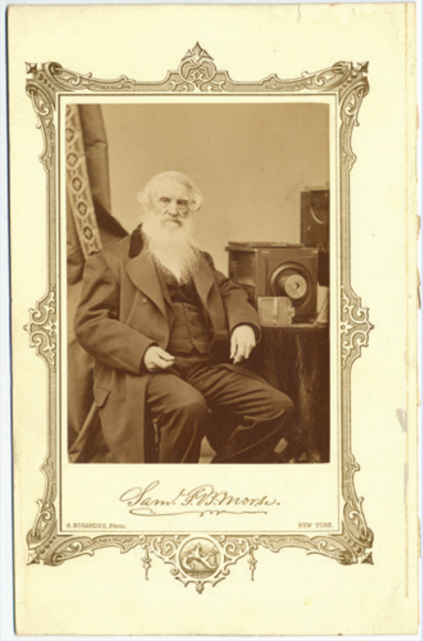

FIG. 1 A representative period portrait of inventor Samuel F. B. Morse, ca. 1890, by Abraham Bogardus. Albumen print. Courtesy of the George Eastman House Collection, Rochester, New York.

The first processes were relatively limited and were rapidly improved by the efforts of many through better lenses, camera design, and chemical innovation. One process yielded commercial dominance to an easier and better one until gelatin emulsion technology brought a new era of photography in the 1880s, which was to continue into the

21st century. The photography industry subsequently grew. More people became enabled to make more photographs. Cameras were freed from the tripod. Color and motion picture photography became possible. The applications of photography steadily multiplied and increasingly benefited society. "Masters" of the medium, in every era, created photographs that transformed how we see and what we know.

The developments of the last decade now make it necessary to deconstruct and reassemble that history of photography to include the origins, progress, and transformation of electronic imaging as well as that of other recording, reproduction, and information technologies. For instance, Becquerel's observation of the photovoltaic effect in 1839 must be placed along with Daguerre and Talbot's discovery of principle of the latent image as a primal moment in the history of photography. Every purchase of a digital camera adds to the historical importance of the discovery of the conversion of light into electricity.

With the convergence of imaging and information technology, it is now quite legitimate to trace the history of photography within many contexts other than that of the progress of optics and chemistry. Photography is now seen as a part, not the all, of imaging technology. The very definitions of *photography* and *photograph* are in transition along with the technology and industry of photography. Thus the history of photography must also change as silver is replaced by silicon. A new generation of photographers will soon know nothing directly of the thrill and mystery of the development of the latent image, which has long been the initiatory experience and bond among serious photographers. The digital revolution, like all revolutions, is in the process of disrupting and destroying an old order. The history of the chemical era of photography may become less interesting if it is not properly linked to the electronic era by a new inquiry.

History teaches that photography is a mutable and ever-changing technology. How it changes is not as interesting as why it changes. By what criteria is any method of photography judged superior to another at any given time, and who are the significant judges? Who decides what form of photography serves in the present? The future historians of photography would do well to address these questions. Perhaps the most interesting and important question for all is, "What do we want photography to be?"

Part page photograph: Photograph of John Taylor made by W. and F. Langenheim, ca. 1846. Transparency, albumen on glass (Hyalotype). Image courtesy of the George Eastman House Collection, Rochester, New York.

The Technical Evolution of Photography in the 19th Century

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Concept and First Attempts

Whereas the observation of numerous light-sensitive substances and the formative evolution of the camera obscura predate 1800, the invention of photography, as we know it, was essentially a 19th-century phenomenon. Who actually invented photography has been disputed from the very beginning, though the task would have been easier had there been a universally accepted definition of *photograph*.

Taken literally, the Greek words *photos* and *graphos* together mean "light drawing." Even today the term *photography* is being manipulated to fit digital imaging, but in its most elegant form, a photograph may best be described as a reasonably stable image made by the effect of light on a chemical substance. Light is energy in the form of the visible spectrum. If light or some other invisible wavelength of energy is not used to make the final picture by chemical means, it cannot, by this definition, be a photograph.

The stability of an image made by light is also important. Without stability, the term *photograph* could apply to the most fragile and fugitive examples of images such as frost shadows of buildings on a sunny November morning. The word *photography* was not the product of just one man. Its introduction was a logical choice by those with knowledge of Greek who contemplated the concept. The term may have been first used by Antoine Hercules Romuald Florence in 1833. Florence was living in Brazil, working in relative isolation, and had no apparent influence on the European scientific community. Sir John Herschel (Figure 7), in England, also used the terms *photography* and *photograph* in 1839, but his contacts were many. Because of this Herschel has traditionally been credited with the use of the terms by those seeking words to describe both the process and product.

Some of the first images to be recorded with light-sensitive materials were made by Thomas Wedgwood, son of Josiah Wedgwood, the well-known potter. His associate, the scientist Sir Humphrey Davy, published the results and observations in the *Journal of the Royal Institution* in 1802. Wedgwood and Davy made images on paper and white leather coated with silver nitrate. They laid leaves and paintings on glass upon the sensitive materials and exposed them to sunlight, which darkened the silver. In an attempt to keep the image, they washed the exposed materials without success. They found that combining the silver solution with sodium chloride produced the more sensitive whitish paste of silver chloride. Even with this improvement, Wedgwood felt the process was too slow to make images in a camera, and though they did make the first photographic enlargements of microscopic specimens by projecting the images using a solar microscope, they had no way to preserve the image once it was formed.

Many of the observations of Wedgwood and Davy were actually ideas already covered years earlier by Johann Heinrich Schulze (1725), Carl Wilhelm Scheele (1777), and Jean Senebier (1782), though without the same sense of purpose. Schulze discovered the sensitivity of silver nitrate to light rather than to heat. Scheele, in addition, observed and published that ammonia would dissolve unexposed silver chloride, the means to permanently fix silver chloride images. It is still difficult to understand why Scheele's published observation escaped Davy. The experiments of Wedgwood and Davy are important because their work combined photochemical technology with the sole intent to make images with light. Few doubt that success would have come to Wedgwood had he applied ammonia to his images, but he died a few years after publishing his findings. Davy did not continue the research.

Joseph Nicephore Niépce

Several years later Joseph Nicephore Niépce (Figure 15), living in the village of Saint-Loup-de-Varennes near the town Chalon-sur-Saône in France, began his own experiments using paper sensitized with silver chloride. Some time around 1816, Niépce made printed-out negative images on paper by using a camera obscura and partially fixed them with nitric acid. Not satisfied with the process, he moved on to another light-sensitive material, asphaltum.

Niépce had been involved with etching and lithography and was looking for a means to make etched plates without having to depend on skilled handwork. It is probable that he and others would have noticed that the asphalt etching ground was harder to remove with solvents when printing plates were exposed to the sun. He coated lithographic stones and plates of copper, pewter, zinc, and glass with asphaltum dissolved in oil of lavender. When the asphalt dried, the plates were covered with an object and exposed to light. The unexposed areas were then dissolved with a solvent such as Dippel's oil, lavender oil, or turpentine while the hardened exposed areas remained intact, creating a negative image. Why Niépce did not use his asphalt images on glass as negatives to make positive prints on silver chloride paper remains a mystery to photographic historians and scholars.

Niépce eventually placed waxed engravings in contact with these sensitive plates. After the unexposed areas were removed with a solvent, the plate negative image of the engraving was visible. The plate was then etched with acid and subsequently used as a conventional etching plate for printing in a press. Niépce called these plates heliographs, from the Greek words *helios* and *graphos*, meaning "sun drawing." The process eventually became the conceptual cornerstone of the photo-engraving industry.

Of all the heliographic plates made by Niépce, the only known surviving example made in a camera has become an icon of photographic history. In 1826 Niépce prepared a heliograph with a thinner asphalt coating upon polished pewter. This plate was exposed in a camera facing out the window of his estate, known as Le Gras (Figures 15–17). The "View from the Window at Le Gras," now in the Gernsheim collection at the Harry Ransom Center in Austin, Texas, probably took two days of exposure to record the outline of the horizon and the most primitive architectural elements of several buildings outside and below the window. Niépce's image is both negative and positive depending on how it is illuminated, and it is permanent.

Louis Jacques Mandé Daguerre

It was 1826 when Louis Jacques Mandé Daguerre contacted Niépce though the firm of Vincent and Charles Chevalier (Figure 3), opticians in Paris from whom they were both purchasing lenses for their experiments. Daguerre, inventor of the popular Diorama in Paris, was also seeking a means to secure images by light in a camera. At the time of their meeting, Niépce was discouraged because of an unsuccessful trip to London where he had tried to generate interest in his heliograph process. Daguerre had nothing more to offer than some experiments with phosphorescent powder and a technique called *dessin fumee*—drawings made with smoke (Figure 18). Nevertheless, Niépce entered into partnership with Daguerre in 1829 for the purpose of working toward a common goal. It is assumed that he felt that Daguerre's energy and popular success would be of some benefit.

By the early 1830s, both Daguerre and Niépce observed that light would darken polished silver that had been previously exposed to iodine fumes. Niépce used that same technique to darken the exposed portions of heliographs made on polished silver plates. Niépce and Daguerre had also developed the physautotype, a variant of the heliograph that used rosin instead of asphalt on silver plates. The process was equally slow, but the images were superior to the heliograph, looking more like the daguerreotype that was soon to be invented. It is assumed that around this time Daguerre came upon the process that would make him famous. His experiments began by exposing silver plates fumed with iodine in the back of a camera obscura. Given sufficient exposure, a fully formed violet-colored negative image against a yellow ground was made on the plate within the camera. These images were beautiful, capable of infinite detail, but not permanent.

Daguerreotype

In 1833 Niépce died, leaving his heliograph process unpublished and his son Isadore to assume partnership with Daguerre. Two years after Niépce's death, Daguerre discovered that the silver iodide plate required only a fraction of the exposure time and that an invisible, or latent, image that could be revealed by exposing the plate to mercury fumes. Instead of requiring an exposure of hours, the new process required only minutes, and the image could be stabilized by treating it in a bath of sodium chloride.

The resulting image, called a daguerreotype, was both positive and negative depending on the lighting and angle in which it was viewed. The image was established by a delicate, frosty white color in the highlights and black in the polished silver shadows, provided the plate was tilted toward a darkened room. By the time he demonstrated the daguerreotype process to Francois Arago, the director of the Paris Observatory, Daguerre had a completely practical photographic system that included fixing the image permanently with sodium thiosulfate, a process that was discovered by Sir John Herschel in 1819. Sodium thiosulfate was known at this time as hyposulfite of soda or as hypo. In 1839 the French government awarded Daguerre and Isidore Niépce a pension for the technology of the daguerreotype and offered the discovery to the world.

Every daguerreotype was unique. The final image was the very same plate that was in the camera during exposure. The latent image and use of silver combined with iodine (silver iodide) that were introduced by Daguerre became the basis of every major camera process of the 19th century until the introduction of gelatin bromide emulsions used in the manufacture of dry plates and developing-out papers.

Photography on Paper

William Henry Fox Talbot (Figure 13), an English scholar in the area of hieroglyphics, began his own experiments with silver chloride in 1834. Talbot, however, came to understand how the percentages of silver nitrate to sodium chloride affected sensitivity. Nevertheless, images made in the camera could take hours. Why he did not use hypo to fix his images remains a mystery since he was in communication with Herschel. Hypo was an expensive chemical, and it is possible that Talbot sought another compound for the sake of economy.

His observations, however, led him to discover a way of making the unexposed areas of his images less sensitive. Talbot treated his images in a strong solution of sodium chloride and a dilute potassium iodide or potassium bromide, which resulted in the colors brown, orange, yellow, red, green, and lilac, depending on the chemical and degree of exposure. This process did not actually remove the unexposed silver chloride, so these images were simply considered "stabilized." Provided the image was not exposed to strong light, it could be preserved for years or even used to make a positive image by contact printing in the sun on a second piece of sensitized paper.

The process for both the stabilized negative and the subsequent positive print was called photogenic drawing. Like all silver chloride papers, the exposures required for a fully formed print were minutes for a contact image of a leaf printed in the sun and up to several hours for a negative made within a camera, depending on the size of the negative. Typically the procedure of using the original negative to make a positive print often darkened the former so much that it was useless for printing a second time. By 1839 Talbot's positive photogenic drawings were colorful, soft in focus, and still relatively sensitive. Compared to the speed, permanence, and infinitesimal resolution attainable by the daguerreotype, the photogenic drawing was very primitive, very slow, and impossible to exhibit in daylight without a visible change. Sir John Herschel is said to have remarked to Arago after seeing a daguerreotype in May of 1839, "This is a miracle. Talbot's [photogenic] drawings are childish compared with these."

1839—The Race for Acknowledgment

Talbot was caught off guard when Daguerre's work was announced by Arago to the Academy of Sciences in Paris on January 7, 1839. Aware but not knowing the details of Daguerre's technique, Talbot rushed to publish his own photogenic drawing process in a report titled, "Some Account of the Art of Photogenic Drawing." The report was read to the Royal Society on January 31 and subsequently published in the English journal *The Athenaeum* on February 9. Talbot's account made a strong point of the utility of his process but contained no specific formulas or details of the actual technique of making photogenic drawings.

Daguerre and Isidore Niépce had accepted a government pension in exchange for the details of both the daguerreotype and heliograph processes. On August 19, 1839, Arago explained the daguerreotype process in detail to a joint meeting of the Academy of Science and the Academy of Fine Arts at the Palace of the Institute in Paris. A daguerreotype camera and complete set of processing equipment was manufactured by Giroux, Daguerre's brother-in-law, and offered for sale at this time. Daguerre also produced a manual, which was the first of its kind and remains one of the most comprehensive photographic treatises ever written. Within its pages are historical accounts, complete formulas, descriptions of Niépce's heliograph process with variations, and Daguerre's latent image process, and line illustrations of all the equipment needed to make a daguerreotype.

Bayard, Ponton, and Herschel

Hippolyte Bayard, an official at the Ministry of Finance in Paris, invented a direct positive process on paper in 1839. His process was based on the light bleaching of exposed silver chloride paper with a solution of potassium iodide. The prints were then permanently fixed with hypo. Bayard sought the attention of the French government to claim the invention of photography. His direct positive process was permanent but very slow and was rejected in favor of Daguerre's. In 1840 Bayard submitted his process a second time and was rejected again. In response he produced a self-portrait as a drowned man and sent it to the Academy accompanied with prose expressing his disappointment. Had this image been of a leaf or piece of lace, like so many of Talbot's photogenic drawings, Bayard and his process would probably never have been remembered with such pathos. In comparison, Bayard's direct positive self-portrait was technically superior to what Talbot was making at the same time.

In 1839 Mungo Ponton, in Scotland, observed that paper soaked in a saturated solution of potassium bichromate was sensitive to light. The delicate printed-out image was washed in water and had reasonable permanence. The process was not strong enough for a positive print and not fast enough for camera images, but Ponton's work led Talbot to discover the hardening effects of gelatin treated with chromium compounds. This characteristic of dichromated colloids became the basis of both carbon and gum printing and several photomechanical printing processes.

In the same year, Sir John Herschel made hypo-fixed silver carbonate negatives on paper. He also produced the first silver halide image on glass by precipitating silver chloride onto the surface of a plate and printing out a visible image within a camera. The process was similar and as slow as the photogenic drawing, however in this case the image was permanently fixed with hypo. When this glass negative was backed with dark cloth, it could be seen as a positive image. Herschel, who could have invented photography, seems to have been satisfied with helping others to do so. He held back on publicizing his processes as a courtesy to Talbot.

Improvements to Daguerre's and Talbot's Processes

The improved daguerreotype

Daguerre's original process of 1839 was too slow to be used comfortably for portraiture. Exposures were typically no less than 20 minutes. Because of the slow lens and optics of the time, the early daguerreotype process was limited to still-life and landscape imagery. Two improvements that were to change all this were the introduction of bromine fumes in the sensitizing step of the process and the formulation of a faster lens.

In 1840 several experimenters working independently discovered that different combinations of chlorine, bromine, and iodine fumes could be used to produce daguerreotype plates that were many times more sensitive than plates that were simply iodized. Because of these experimenters' research, daguerreotypists eventually settled on fuming their plates with iodine, then bromine, and once again with iodine. The bromine fuming procedure eventually became standard practice throughout the daguerreotype era, allowing daguerreotypists to make exposures measured in seconds.

The design of a faster lens, formulated in 1840 by Max Petzval, also allowed for shorter exposures. In combination with the more sensitive plate, this faster lens ushered in the first practical application of the daguerreotype process for portraiture. The Petzval lens was designed specifically for portraiture and became the basis for all portrait and projection lenses for the next 70 years. By the early 1840s, commercial daguerreotype portraits were being made in studios under a skylight (Figure 22).

Another important improvement in 1840 was gold toning, introduced by Hippolyte Fizeau. A solution of *sel d'or*, made by adding gold chloride to hypo, was applied to the fixed plate. The process became known as gilding. Gilding extended the range of tones and made the fragile image highlight less susceptible to abrasion.

The calotype

Talbot's photogenic drawing process, as introduced, was also impractical for portraiture even when improved lenses became available. In 1841, however, Talbot changed his formula to use silver iodide, which was more sensitive than silver chloride. It was the very same silver halide as used by Daguerre, though applied to paper. The iodized paper was sensitized with a solution of silver nitrate, acetic acid, and a small amount of gallic acid.

This new paper was exposed damp and required only a fraction of the time needed to print a visible image with the photogenic drawing process. It bore either a feeble or no visible image when removed from the camera. The latent image was developed to its final form in a solution of gallic acid and then stabilized in potassium bromide or permanently fixed in sodium thiosulfate. The new process was called the calotype, from the Greek *kalos*, meaning "beautiful." Despite the use of silver iodide, the calotype process usually required at least a minute of exposure in full sunlight using a portrait lens.

Calotype negatives could be retouched with graphite or inks to prevent transmission of light or could be made translucent locally with wax or oil. Talbot made positive prints from these as he did with photogenic drawings, by printing them in the sun onto plain silver chloride paper. Even after Talbot adopted the use of hypo for fixing his negatives, he occasionally stabilized these prints in salt or iodide solutions, presumably because he preferred the final image colors. Eventually Talbot and other calotypists chose to permanently fix their positive images in hypo, resulting in an image of colors ranging from deep orange to cool brown. These were called salt (or salted) paper prints (Figures 28 and 29). Another improvement was made by not adding the gallic acid in the sensitizing step of the process.

Those wishing to use the patented calotype process were required to pay Talbot for the privilege. This license was expensive, and the commercial potential of the calotype process was not particularly attractive to the average working person. The calotype seemed to appeal to the educated upper classes that had an appreciation for the arts, scientific curiosity, and plenty of leisure time. Variants of preparing calotype paper began to emerge as more people used the process. An early improvement to the process omitted the gallic acid in the sensitizer, allowing the paper to be used hours after preparation without browning spontaneously.

In 1844 Talbot published the first installment of a book titled *Pencil of Nature,* which was illustrated with salt prints from calotype negatives. The publication was sold by subscription, and subsequent issues were sent to the subscriber as they were produced. Because of technical difficulties, *Part II* was not sent until seven months after the first. *Part VI* was not available until 1846. The venture was not successful, but it offered a vision of what might be possible in the future. If there was ever a commercial use for the calotype, it was to be for the illustration of written material and particularly for documentation of architecture. Although not technically conducive to portraiture, particularly in a studio, the calotype process was used on occasion for this purpose.

The most ambitious and celebrated uses of the calotype process for portraits were made by the team of David Octavius Hill and Robert Adamson (Figure 27) as reference images for a painting that Hill was planning of the General Assembly of the Free Church of Scotland. The portraits for this project give a fair idea of the quantity of light required for an exposure. In many examples the subjects face sunlight as if it were a strong wind. Hill and Adamson produced several bodies of work from 1843 to 1847, including genre portraits and architectural views. Their work stands alone as the most comprehensive use of calotypy for portraiture.

Although the calotype process was licensed by Talbot to Frederick and William Langenheim of Philadelphia, the calotype would never become popular in the United States. Shortly after the process was perfected by the Langenheims, the daguerreotype was well established and not to be toppled until the invention of collodion photography in 1851.

Calotypes were made by a small number of photographers in the 1840s and early 1850s (Figures 35 and 37), the most famous examples being documentary images of architecture by French and English photographers. In 1851 Maxime du Camp produced major albums of views from Egypt, Palestine, and Syria, which were documented by the calotype process in 1849 (Figure 39). Documentary work by Edouard Baldus and Henri le Secq (Figure 36) were also made with an improved variant of the calotype called the waxed-paper process, introduced by Gustave Le Gray in 1851.

The waxed-paper process evolved because French papers were not ideally suited for calotype as they were sized with starch rather than gelatin. Le Gray saturated the paper with hot beeswax prior to treating with iodine and sensitizing with silver. The development was identical to the calotype. Waxing the paper prior to iodizing resulted in better resolution, and the process could be done with the paper completely dry, making it perfect for the traveler.

The Business of Photography

By the late 1840s, the daguerreotype process was being used commercially in every industrialized nation of the world. Although the total number of calotypes made in the 19th century might be counted in the thousands, this was still less than the yearly production of daguerreotypes in most major cities in the United States in the 1850s. The business of the daguerreotype was profitable for many daguerreotypists, the plate manufacturers, and the frame and case makers.

The American daguerreotypists in particular produced superior portraits (Figure 46). A technique perfected in America called galvanizing involved giving the silver plate an additional coating of electroplated silver. Galvanizing contributed to greater sensitivity, which was important for portraits, and it provided a better polish, resulting in a wider range of tonality. The works of Thomas Easterly and of the celebrated team of Albert Southworth and Josiah Hawes (Figure 33) remain as both technical and artistic masterworks. The daguerreotype was well established in the early 1850s as a commercial and artistic success, though it also had drawbacks. The images were generally small, laterally reversed direct positives that required copying or a second sitting if an additional image was desired.

Although not impossible, landscape work was a technical commitment and not commercially profitable considering the effort required to make a single plate. When properly illuminated, daguerreotypes were (and still are) awe inspiring; however, they were seldom viewed at the best advantage. This failure resulted in a confusion of negative and positive images juxtaposed with the reflection of the viewer.

Negatives on Glass

In 1847 a new negative process, producing the niépceotype, was published in France by Abel Niépce de Saint Victor (Figure 10). After initial experiments with starch, Niépce de Saint Victor came upon the use of egg albumen as a binder for silver iodide on glass plates. Variants of the same albumen process were simultaneously invented by John Whipple, in Boston, and the Langenheim brothers, in Philadelphia. Development of these dry plates was identical to the calotype, but they required much more time. Exposures too were much longer than those required for the calotype, but the results were worth the effort. Even by today's standards, the resolution of these plates was nearly grainless. The Langenheims took advantage of this characteristic and in 1848 invented the hyalotype (Figures 30 and 31). This was a positive transparency on glass that was contact-printed from albumen negatives.

The Niépceotype process was never to be used for studio portraiture, but for landscape and architectural subjects it was technically without equal even after the collodion process was invented. It was, however, still a tedious process, and after 1851 the only reasonable applications of the albumen process were for when a dry process was advantageous or for the production of lantern slides and stereo transparencies where resolution was important.

A major essay made during the latter part of the Crimean War in the mid-1850s was documented with large albumen plates by James Robertson (Figure 48), and Felice Beato. After the war Robertson and Beato made images in the Middle East, continuing a series started before the war, and in war-torn India. The pictures of the Siege of Lucknow and the Kashmir Gate at Delhi feature the first true glimpses of the horrors of war.

The Wet Plate Process

In 1848 Frederick Scott Archer (Figures 2 and 34), an English sculptor and amateur calotypist, experimented with collodion as a binder for silver halides as a means to improve the calotype. The term *collodion,* from the Greek word meaning "to stick," was used to describe a colorless fluid made by dissolving nitrated cotton in ether and alcohol. When poured onto glass, collodion dried to a thin, clear plastic film. In their calotype manuals of 1850, both Robert Bingham, in England, and Gustave Le Gray (Figure 44), in France, published the possible benefits of using collodion, but the first complete working formula of the wet collodion process was published by Archer in 1851 in *The Chemist.*

Archer's formula began with coating a glass plate with iodized collodion. The collodion film was then sensitized, while still wet, by placing the plate in a solution of silver nitrate. After exposure in a camera, the latent image was developed with either gallic or pyrogallic acid. The image was then fixed with hypo and washed. The fragile collodion film retained the alcohol and ether solvents throughout sensitizing, exposure, and processing, which is why it was known as the wet plate process.

Contested unsuccessfully by Talbot as an infringement on his calotype process, Archer's wet plate technique came at a time when the calotype, the waxed-paper, the daguerreotype, and the albumen processes were all being used. Originally the process was conceived by Archer to include coating the fixed image with a rubber solution and stripping the film from the glass plate. The thin rubber-coated collodion film was then to be transferred onto a secondary paper support for printing. The stripping and transfer method was quickly abandoned as unnecessary, though it eventually became an important technique used in the graphic arts industry until the 1960s.

Exposure times were reduced by half with the wet plate technique, making portraiture in the studio possible when ferrous sulfate was used for development. Although more sensitive than the calotype, the wet collodion negative process as generally practiced in the studio was not faster than the daguerreotype of the 1850s.

Collodion negatives were used to make salted paper prints, originally called crystalotypes by Whipple (Figure 40), but were perfectly matched to the albumen printing process introduced by Louis Deserie Blanquart-Evrard in 1850. The synergy of the collodion negative (Figure 68) and albumen print was to become the basis of the most commercially successful and universally practiced photographic process in the 19th century until it was eventually replaced by the gelatin emulsion plate in the 1880s.

By 1855 the collodion process had eclipsed the daguerreotype for commercial portraiture and was quickly being adopted by the amateur as well. The great photographic journals such as the *Photographic News, The British Journal of Photography, La Lumiere, Humphrey's Journal*, and the *Photographic and Fine Art Journal* were all introduced in the early 1850s. Such publications fueled the steady advancement of photography and were the "chat rooms" of the era, featuring well-documented research by chemists, empirical discoveries by the working class, and petty arguments between strong personalities.

The Art of Photography

From the 1860s onward, the photographic journals occasionally touched on the subject of art and photography, though like many art forms, there was little consensus. Photographic societies and photo-exchange clubs were formed in many cities, and exhibitions based on the salon style were held and judged. It is customary to mention in histories of photography the celebrated artists of the wet plate process such as Julia Margaret Cameron (Figures 7 and 61), Oscar Gustave Rejlander (Figure 57), and Gaspar Felix Tournachon, also known as Nadar.

At the time, however, much of their work was not generally recognized by the public or the greater photographic community. Critics also failed to take photography seriously as an art form, an attitude that continued for many years to come.

Cameron's genius was not recognized until late in the century when the pictorialists were deconstructing the convention of photography. Nadar on the other hand came to own a very successful Parisian Photo Gallery. His operators posed the subjects, processed the plates, and delivered the prints, producing commercial portraiture that was technically enviable though generally without the soul of his own early work.

The great landscapes documented with collodion such as those of Gustave Le Gray (Figure 44), Francis Frith (Figure 52), Leopoldo and Giuseppe Alinari, and John Thomson (Figure 67) were pictorial achievements by any standards and were made under very difficult conditions. The wet plate process was challenging enough in a studio, but to pour plates within a portable darkroom was an enormous task made more taxing when the plates were large. In Western America, Carleton Watkins, Eadweard Muybridge, William Henry Jackson (Figure 71), and Timothy O'Sullivan (Figure 65) also produced work under equally difficult conditions. In most cases the works of these landscape photographers were the first recorded images of a region. The final product, however, was most often seen by the general public not as an albumen print but as a wood engraving from the print.

Heavily retouched solar enlargements printed on salted and albumen paper were offered by progressive photographers in larger towns and cities throughout the 1860s and 1870s, but at great expense. The process of enlarging did not become commonplace until the acceptance of silver bromide developing papers, beginning in the late 1880s.

The most common connection of the public with photography in the 1860s was the commercial albumen print in the form of the small *carte de visite* (Figure 55) (calling card) portrait or a stereograph—two albumen prints on a card designed to be seen in three dimensions with a special viewer. By the late 1860s, the larger cabinet card photograph was also introduced. Cabinet cards (Figure 73) and *cartes de visite* ushered in an industry of mounts and album manufacturing. Larger framed prints were available at the portrait studios, but the two smaller portrait formats were the bread and butter of the working photographer until the end of the century. Stereographs remained popular until after the turn of the century and were usually a specialty item made by landscape photographers and sold by subscription or in stores.

Collodion Variants and the Positive Processes

The mid-1850s proved to be a fertile era for both new processes and variants of the collodion process. Soon after its introduction, collodion was used for stereo transparencies, microphotographic transparencies, and lantern slides. Direct collodion positives, called alabasterines by Archer, were originally made by bleaching an underexposed plate with bichloride of mercury. When ferrous sulfate was adopted as the developer and cyanide as the fixer for collodion positives, the plates were more sensitive and the positive images did not require bleaching. Exposures of these plates in the studio were faster than exposures for the daguerreotype. The plates were also a cheaper and easier-to-view alternative. These plates were generally known as collodion positives, verreotypes, daguerreotypes without reflection, or daguerreotypes on glass. Though the actual image-making technique was usually the same, there were many variants, and those who introduced them were quick to apply a new name to each type.

A patent was awarded to James Anson Cutting in 1854 for a method of sealing these positive images on glass with balsam, using the same technique as that used for covering a microscope slide. Cutting called his variant of the collodion positive process *ambrotype*, from the Greek word meaning "imperishable." Cutting eventually changed his middle name to Ambrose to commemorate the process. Though the name *ambrotype* was specific to Cutting's patented sealing technique, the word quickly evolved to be the generic term for all such images (Figure 47).

Direct positive collodion images on japanned iron plates were invented simultaneously by photographers working in England, France, and the United States. In 1853 Adolphe Alexandre Martin first published the process in France. Hamilton Smith, in the United States, and William Kloen, in England, both patented the process in 1856. Smith, who called his plates melainotypes, sold the rights to Peter Neff, who manufactured them. Victor Griswold, a competitor, also manufactured japanned plates, calling them ferrotypes, a name that would eventually be adopted by the general public along with the less-formal "tintype" (Figures 76 and 80).

It is important to understand that those who made commercial ambrotype or ferrotype images were not considered photographers. Although the term *photography* is often applied indiscriminately to any photosensitive process used in the mid-19th century, it is technically specific to the making of negatives used to produce prints. Those whose work cannot be strictly classified as photography were known as daguerreotypists, ambrotypists, and ferrotypists or tintypists.

Positive collodion transfers onto patent leather (Figure 45), oilcloth, and painted paper were called pannotypes and were also born in this era, along with the milk-glass positive (Figure 63), printed from a negative onto a sheet of white glass. But neither of these would approach the popularity of the tintype, which eventually replaced the ambrotype in the 1860s and continued to be made in various sizes throughout the 19th century.

Collodion Variants and the Negative Processes

In an attempt to make the collodion process possible without erecting a darkroom on location, some amateurs began experimenting with making preserved or dry collodion plates in the 1850s. Humectant-based processes relying on oxymel, a medical compound of honey and acetic acid, and various syrups to keep the sensitive plate damp were very successful. These plates, however, were up to five times slower than the conventional wet plate. The dry tannin and Taupenot plates were also very slow. These techniques, although an interesting footnote in the evolution of the collodion process, were never sensitive enough to be useful for anything but landscape work and were seldom used. Most landscape photographers preferred to see the plate develop on site should they need to make a second exposure.

In the late 1870s, collodion emulsions were being used by curious amateurs. Based on the technique that used initial silver chloride emulsions for collodion printing-out papers, collodion emulsions were made by mixing halide and silver together in the collodion rather than sensitizing an iodized plate in a separate silver bath. Although the collodion emulsion process for negatives did not come into general use, it was the basis for the gelatin emulsion process and the production of collodion chloride printing-out papers used well into the next century.

Concerns of Permanency

The correct processing of paper prints from collodion negatives was not fully understood during the 1840s and early 1850s, and the consequence of fading prompted committees in both England and France to investigate the problem and search for alternatives. Despite the gold-toning procedure applied to all albumen prints, most of these prints were prone to fading. This was usually caused by incomplete fixing or washing.

From this climate of questioning came the carbon printing process introduced by Alphonse Louis Poitevin and the developed-out salt printing processes of Thomas Sutton and Louis Deserie Blanquart-Evrard. The cool tones of developed-out salt prints were not embraced by photographers or the public, though the process was much more stable than any other printed-out technique. The process eventually found its niche with the technique of solar enlarging, which was introduced in the late 1850s. The typical printed-out solar enlargement from a collodion negative required more than an hour of exposure. Exposures on developed-out salted papers were counted in minutes.

The carbon process, based on the light sensitivity of pigmented gelatin treated with potassium bichromate, did not achieve its technical potential until the single-transfer variant patented by Sir Joseph Wilson Swan was universally adopted in 1864. Despite the superiority of the carbon process to albumen prints in both tonality and permanence, they were tedious to make, particularly for a single print. Carbon prints were better suited to making large runs of a single image but not for the typical studio portrait (Figure 66). Photographers preferred to make albumen prints over carbon prints until albumen printing was replaced with the collodio-chloride