No 17|2012 € 12,00

PhotoResearcher

ESHPh European Society for the History of Photography

The Hidden Image: Latency in Photography and Cryptography in the 19th Century

Nadja Lenz

The fact that a latent image – in the form of a latent script image –exists in early analogue photography as well as in early cryptography encourages a comparative study.[1]

The blackening of silver salts with light and the reaction of gallic acid with metallic salts causing a latent script image were already known in cryptography centuries before the discovery of photography. Recipes for so-called sympathetic scripts[2] were based on these chemical processes. But, to which extent did the inventors of photography deal with cryptography? What kind of relationship exists between cryptography and photography and how are these two processes similar to each other?

History of concepts

The term 'latency' comes from the Latin word 'latens', and means 'hidden'. Only since the beginning of the 19th century, has the adjective 'latent' – in connection with a term describing a condition such as 'latent warmth', 'latent heat' and 'latent illnesses' – characterized a scientific phenomenon. The term was formerly mainly used in a religious or philosophical context.[3]

The metaphor 'image latente' (latent image) was already used in the French daily newspaper *Le Constitutionnel* in connection with the announcement of the daguerreotype process in the year 1839[4] and was taken over by the British press shortly thereafter.

As far as the pioneers and advocates of photography are concerned, the said term still had to be established. In contrast to Henry Fox Talbot, who frequently mentions the term 'latent image' in his records, the scientists John Herschel and François Arago talk of the 'dormant picture' and 'image dormante' respectively.[5] Further terms used by Henry Fox Talbot are: 'latent picture',[6] 'latent representation',[7] 'invisible picture',[8] and 'invisible impression',[9] as well as the circumscription '[the] image was impressed in a short period, but invisible …'.[10] All these explain the invisible state of the photographic picture after exposure but before developing.

The term 'cryptography' comes from the Greek κρυπτός, kryptós, 'hidden' and γράφειν, gráphein "to write". The objective of cryptography is to guarantee four different characteristics for the content to be communicated: 1) Confidentiality: only authorized persons are able

1. This is the subject of my thesis *Das latente Bild in den Anfängen der Fotografie. Entdeckung des Unsichtbaren, Verschlüsselung des Sichtbaren* under the guidance of Prof. Herta Wolf, Institute of Art History at the University of Cologne. An earlier version of this article was presented on 16 April 2009 as part of Prof. Dr. Herta Wolf's graduate colloquium on *Conceptualisations in the Early Days of Photography* organised by the University of Duisburg-Essen, in Cologne in 2009.
2. From the Greek "Sympatheia" – "Sympathy", because the inks were mainly used for writing love-letters. Invisible inks are normally clear fluids, which become colourless when dry and visible again under the influence of warmth (with cobalt salts) or by the chemical gassing with hydrogen sulphide (with lead salts).
3. Sabine Müller, 'Diesseits des Diskurses', in: Franz X. Eder (ed.), *Historische Diskursanalysen: Genealogie, Theorie, Anwendungen*, Wiesbaden: Verlag für Sozialanalysen 2006, 138.
4. *Le Constitutionnel*, August 21, 1839. The reference can be found in: R. Derek Wood, 'The Daguerreotype and Development of the Latent Image: Une Analogie Remarquable', in: *Journal of Photographic Science*, September/October 1996, 44 (5), 1980, 165 – 167.
5. 'Papier photogénique, dit amphitype, He M. Herschell [sic]', in: Edmond de Valicourt (ed.), *Nouveau manuel complet de photographie sur métal, sur papier et sur verre albumine et collodion*, vol. 2, Paris 1862, 308.
6. Larry John Schaaf, *Records of the Dawn of Photography: Talbot's Notebooks P & Q*, Cambridge University Press 1996, Q 41.
7. Schaaf 1996 (reference 6), Q 43.
8. Schaaf 1996 (reference 6), Q 55.
9. Schaaf 1996 (reference 6), Q 77.
10. Concept of a letter, William Henry Fox Talbot to Alfred François Bouard, October 22, 1847, http://foxtalbot.dmu.ac.uk/letters/letters.html (20/12/2011), *The correspondence of William Henry Fox Talbot*, Project Director: Professor Larry J. Schaaf, Document number: 6021.

Figure 1
Julia Margaret Cameron, *J.F.W. Herschel*, Hawkhurst, Kent April 1867, albumen silver print, 35.4 x 27.3 cm. The J. Paul Getty Museum, Los Angeles.

to understand the contents of a message; 2) Authenticity (authorship): The sender of a message is unambiguously identifiable; 3) Integrity: The recipient is able to determine whether the contents of a message have been changed without authorization, and 4) Commitment: It is not possible for the sender of a message to deny its authorship.

When comparing photography and cryptography from the aspect of latency, it is helpful to consider the nature and the value of the latent condition.

The nature of latency

Basically, a distinction can be made between two individual kinds of latency:

Material latency stands for hiddenness through the lack of contrast. The latent image of analogue photography and of early cryptography – the script image of sympathetic inks – represents this kind of latency of chemical-physical processes. Moreover, latency and visibility describe a chronological order – a before and after; form and contents are hidden.

Immaterial latency means hiddenness by abstraction: Something hidden, which reveals its contents only after being decoded and understood. Latency and visibility can exist simultaneously; the form is visible but the contents are not revealed.

Material Latency in Cryptography

In cryptography, latency is generated by coating the carrier material, normally paper, with sympathetic ink. Recipes for sympathetic inks, with which the written vanishes when dry, were developed from the 14th to the 16th century, the period of individual handwritten ciphers and fantasy signs. Until the end of the 19th century, innovative recipes for secret writings were still published in scientific journals (figs. 1 and 2).

Six categories of sympathetic scripts based on different processes are known in the area of cryptography: Secret writings which have to be 1) sprinkled with powder, 2) scraped or rubbed, 3) warmed or heated, 4) exposed to the air, 5) moistened or immersed into another liquid or 6) exposed to vapours in order to make them readable again.

Figure 2
J.F.W. Herschel, *"Slough. April 22. 1839. Hyposulphite fixing. To be read transparent or a reflecting eye piece" (Secret writing).* National Media Museum, Bradford, BD1 1 NQ.

An analysis of the categories 5) and 6) is especially interesting when making a comparison. In early photography, the latent image was made visible by immersing it in gallic acid (Calotype method) or by vaporization with mercury vapour (Daguerreotype method).

Material Latency in Photography

In order to analyse the processes that play a role in the production of a latent image, it was necessary to understand the nature of the light, which was still a completely mysterious electromagnetic phenomenon in 1839. The theories of that time regarding the development of a latent image can be roughly summarized in three directions: Physical processes, chemical reactions or a combination of both were used[13] for explanation. All research was based on studies of silver halides. It was commonly assumed that the substances silver iodide, silver bromide and, consequently, silver chloride react in a similar way.[14]

Louis Mandé Daguerre, as well as Alexandre Edmond Becquerel, Joseph Henry and John Draper, assumed that electricity played a role in the image forming process. If electricity produces light, light should be able to produce electricity.

But only the quantum theory led to an exact understanding of the processes that have an effect on the development of the latent image. Contemporary science created a relationship between the two main variables: the amount of the effective radiation to the amount of the physically and chemically changed matter. The latent image is generated by the exposure of the light-sensitive film on a carrier material. During this process, a rather small number of the silver ions in the silver salt crystals are reduced to metallic silver atoms. These silver nuclei generate the latent image. In early photography, the carrier material also partly had the function of the light-sensitive layer (e.g. with the Daguerreotype, a process in which silver-plated and polished copper-plates had been sensitized with iodine or bromine vapour).

Before the diagnosis of the latent image in the process of photography, the light-sensitive image carriers had been exposed to the sun and one waited until a motif became visible (photogenic drawing). Exposure and development were all the same, the sunlight functioned as the developer.

Since the start of the use the latent image in analogue photography, the small silver crystals on the exposed parts have been auto-catalytically enlarged by a developer fluid (e.g. with the silver-bromide gelatine print). In this way, the silver ions of the silver bromide in

13. E. P. Wightman, 'Theories of the Latent Image and Reversal', in: *The journal of physical chemistry*, 1915, 19 (7), 571–588.
14. William Jerome Harrison, *The Chemistry of Photography*, New York 1892, 182.

A [Sprachlinie.] B

	1	2	3	4	5	6	7	8	9	10	[Sprachlinie.]						10	9	8	7	6	5	4	3	2	1	
1	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	1
2	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	2
3	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	3
4	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	4
5	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	5
H 6	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	6 C
7	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	7
8	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	8
9	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	9
10	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	10
	k	l	m	u	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	
	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	
[Wahllinie.]	m	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	
	n	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	
	o	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	
	p	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	
10	q	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	10
9	r	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	9
8	s	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	8
7	t	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	7
6	u	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	6
G 5	v	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	5 D
4	w	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	4
3	x	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	3
2	y	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	2
1	z	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	1
	1	2	3	4	5	6	7	8	9	10							10	9	8	7	6	5	4	3	2	1	

F E

Figure 3
Hans Schneikert, *Moderne Darstellung der gebräuchlichsten und nützlichsten Geheimschriften mit besonderer Berücksichtigung der Graphologie als Hilfsmittel zur Dechiffrierung, Verbesserung und Neubildung von Geheimschriften*, Mannheim 1908, 12.

direct proximity to the silver nuclei are reduced to silver as well and appear black.

As already during the process of generation, the picture carrier can also influence the development (visualization) of a latent image. Thomas Wedgwood noticed that an image becomes visible more quickly on light-sensitive coated leather than on paper with the same coating.[15] Leather contains tannic acid (tannins), a derivation of gallic acid.

As R. Derek Wood explains in his article: *The Daguerreotype and Development of the Latent Image: Une Analogie Remarquable*[16], the first announcements concerning the photographic process assumed that the reading public was already aware of the sympathetic reaction of gallic acid with metal salts.[17] Early alchemists knew of the image intensifying potential of the oak-apple. According to Wood, knowledge of the process probably explains why some scientists had already experimented with gallic acid before 1839 – and therefore, before Henry Fox Talbot. In a letter to Talbot dated February 28, 1839, John Herschel mentioned the reaction of gallic acid with silver nitrate and he also refers officially to its relevance for the photographic process in an article written for the Royal Society dated March 14, 1839.

Immaterial Latency in Cryptography

The latency of cryptography has been mainly immaterial since the time of Gutenberg. Typographical coding with moveable letters, encrypting and decoding moved away from the chemical "handicraft" method in favour of semantic letters and juggling numbers: through sublimation/transposition or masking with irrelevant issues (confusion).[18] (fig. 3) In cryptography, a change from the material to the immaterial latency appeared.

Immaterial Latency in Photography

Immaterial latency in photography has existed only since the onset of digitalization in the middle of the 20^{th} century and is therefore not the subject of this essay.[19]

15. Humphry Davy, 'An Account of a Method of copying Paintings upon Glass, and of making Profiles, by the agency of Light upon Nitrate of Silver. Invented by T. Wedgwood, Esq. With observations by H. Davy', in: *Journals of the Royal Institution of London*, vol. 1, no. 9 (22/6/1802), 170-74.
16. R. Derek Wood, 'The Daguerreotype and Development of the Latent Image: Une Analogie Remarquable', in: *Journal of Photographic Science,* September/October 1996, 44 (5), 1980, 165 - 167.
17. R. Derek Wood, 'Latent Developments from Gallic Acid 1839', in: *Journal of Photographic Science,* January/February 1980, 36 – 41.
18. Precisely speaking, cryptography uses a "manifold" immaterial latency: The recipient of an encrypted message needs to not only know the key but also to have knowledge of the language in which the contents is written – if it has not been semantically encrypted (e.g. by using metaphors). The same holds true for the decryption of visual contents. Understanding a picture needs more cognitive processes than "simply" seeing and understanding.
19. The immaterial aspects hidden in photography have only existed since it became possible to transform light sources into digital signals. Accordingly, a "latent image" is generated by exposure and encoding. This process is reversible – under the presumption that the corresponding hard- and software is available. The decoding is done by the re-conversion of the digital signals into light waves. A mathematical key stands for the developer fluid, which processes digital signals to be reproduced in an image output device. Besides the encoded pure image information, data concerning the development process (diaphragm, length of exposure, type of camera, etc.), the originator and the rights of use (with commercial utilization) can also be part of the encryption and can be transferred together with the transmission. Even in the case of later processing, this information will not necessarily get lost. These additional data are normally not visible on the decoded picture.

Figure 4
Charles Richard Meade,
Portrait of Louis-Jacques-Mandé Daguerre,
Brie-sur-Marne 1848, Daguerreotype,
hand-colored, image: 15.7 x 11.5 cm,
object (whole): 22.1 x 17.8 cm.
The J. Paul Getty Museum, Los Angeles.

The use of latency

Hiding for the sake of secrecy is the point of departure of cryptography. Here, latency is the mandatory means to an end. This does not hold true for photography: The visible image as the result of the exposure is important. A latent image is rather a labile part of the photographic process. Appreciation of the practical use of this "image in a state of suspension" as well as its ability to inspire creativity and experimentation, only came at a later date. Contrary to this, hiding for the sake of secrecy was the starting point of cryptography.

Apparently, the latent image, together with the photographic developer, was discovered accidentally as a side effect of the photographic process. It is not known why Daguerre (fig. 4) decided to use mercury for the development of his plates. There is a persistent story about the cupboard in which he stored his chemicals. He put an exposed silver iodide plate into the cupboard and later discovered that the developed image had become visible. Daguerre traced the development back to the mercury vapour which had formed inside the cupboard. The sources do not agree on the extent to which mercury has contributed to the development of the photographic plate: Some mention a bowl with mercury,[20] some a broken thermometer[21] and others refer to mercury which had been deposited in the cracks and joints of the cupboard.

Mercury has a low vapour pressure; thus, a drop will be sufficient to produce mercury vapour inside a cabinet for chemicals. Whether this vapour is, however, sufficient to develop the AgBr-free particles of the crystals and silver clusters, is answered by the physicist, Ludger Wöste:

I believe it is possible that the side-by-side storage of exposed photo-sensitive plates and an open mercury source can lead to the emergence of an image on the plates. If stored in an unrefrigerated and sheltered place such as a cupboard, the vapour pressure of mercury in the air is sufficiently high as to cause the silver halide crystals on the plate (regardless of exposure) to come into contact with mercury atoms. This is enough to stabilize the latent image, i.e. the reduction of the exposed crystals to metallic silver.[23]

20. Josef Maria Eder, *Ausführliches Handbuch der Photographie, Erster Teil – Erste Hälfte,* Halle an der Saale 1891, 125. William Jerome Harrison, *The Chemistry of Photography*, New York 1892, 207.
21. Heinz Haberkorn, *Anfänge der Fotografie: Entstehungsbedingungen eines neuen Mediums*, Reinbek: Rowolth 1981, 73.
22. Wilhelm Schmidt, 'Die Photographie, ihre Entstehung und Entwicklung', Berlin 1886, in: *Sammlung wissenschaftlicher Vorträge*, Berlin 1870, (8) 248.
23. Dr. Ludger Wöste, Freie Universität Berlin and Nadja Lenz, personal communication, March 2009.

It is said that Talbot also accidentally discovered the potential of a latent photographic image in 1841. When he exposed some photographically treated sheets of paper for only a short time to prove their sensitivity, he put one sheet aside. He picked it up again later and discovered that it showed a negative image.[24] Later photographic research confirms, however, that Talbot's use of gallic acid can be traced back to a conversation with a seller of optical instruments (Andrew Ross & Co, Regent Street, London), who told him about the experiments Joseph Bancroft Reade had performed.[25] As Reade stated in 1865, he had also discovered the existence of the latent photographic image by chance. Regarding the use of gallic acid, however, he referred to the experiments carried out by Wedgwood[26].

In photography, latency was felt as being mystic because one was not able to explain the exact procedures leading to the development of a latent image. In a letter to the French scientist Biot, Talbot writes that:

I offer it as a new method of secret writing, which offers a great deal of security. Should a letter which has been thus written invisibly, falls into foreign hands, when he opens it, he will find nothing more than blank paper. But, by thus exposing it to daylight, he will have destroyed it, and the writing will thus become forever indecipherable. I recommend this experiment to diplomats, and to lovers of mystery.[27]

And, detection of the latent image in 1839 also considerably increased the suitability of photography for everyday use. It became possible to interrupt the transition-free process from exposure to development by storing the latent image in darkness. This resulted in an enormous gain in time and mobility for the early photographers. Complex equipment for the purpose of immediately developing and conserving the motif directly after being photographed was no longer necessary. In addition, the length of exposure could be considerably shortened through knowledge of the different 'reaction accelerating' components in the developer fluid.

Early photography and cryptography – differences and similarities

The reasons which led to the origin of photography and cryptography are different. In photography, it was the desire to portrait the moment; in cryptography, the safe transmission of confidential messages. The generation of a latent image in secret writing is the mandatory means to an end, whereas it is only an intermediate step in photography.

The opposite motives – making something visible or hiding it – however, led early photographers and cryptographers to use similar means and to the development of similar processes. Whether the different goals in the past were the only reason for the different rate of development of the two media is another question.

24. Josef Maria Eder, *Der Collodion- und Daguerreotyp-Process und ältere Negativ-Processe*, Halle/Saale 1884, 78.
25. R. Derek Wood, 'Latent Developments from Gallic Acid, 1839', in: *Journal of Photographic Science*, January/February 1980, 36 - 41.
26. Rev. J. B. Reade, 'The Origin of the Daguerreotype and Talbotype: Discovery by Accident and Induction', in: *Photographic News*, September 8, 1865, vol. 9, 423-5.
27. Concept of a letter, William Henry Fox Talbot to Jean-Baptiste Biot, January 17, 1841, http://foxtalbot.dmu.ac.uk/letters/letters.html (20/12/2011), *The Correspondence of William Henry Fox Talbot*, Project Director: Professor Larry J. Schaaf, Document number: 4556. Original in French language.

The moment in which an image is in a latent condition is different in photography and cryptography: In early cryptography, the image was formed by writing that became latent when it dried and visible once again after being developed. In photography, the image is generated by exposure and development after which the image becomes visible for the first time.

But there are many commonalities between photography and cryptography, especially in connection with the chemical relationships affecting latency. It is no coincidence that photography is based on ingredients of chemical-based secret writings. In the 19th century, in the early days of scientific chemistry, alchemy was still regarded seriously although some considered it out of date and not precise from a scientific point of view.[28] One of the substances alchemists discovered in their search for the "philosopher's stone" was named Luna Cornea or horn silver. They recognized that this substance blackened when exposed to light.[29]

Johann Heinrich Schulze (1687–1744), who – in 1720 – attempted to refine an earlier experiment by Christian Adolph Balduin, should also be mentioned. He did not discover the "philosopher's stone" but phosphorus. Just as accidentally, Schulze discovered the property of light to blacken silver nitrate.

Later, Jean Hellot made paper light-sensitive by using silver nitrate. He was interested in the possibilities of the art of secret writing and detected that a weak silver nitrate solution in water could function as invisible ink. He had written on a white sheet of paper with diluted silver nitrate solution – as long as he kept this paper in darkness, it remained white. Exposed to the sunlight, what he had written became legible in a kind of blue-grey colour within one hour. However, Hellot assumed this blackening to be a result of the impurity of the nitric acid, in which he suspected sulphur.[30]

Joseph Nicéphore Niépce, the discoverer of heliography, who was afraid that his work could fall into the wrong hands, used a numerical secret writing in his written conversation with Daguerre. He replaced key terms by numbers. In February 1830, Daguerre sent a letter to Niépce drawing his attention to the fact that their common attempts to improve the heliographic process may have been successful:

This is the breakthrough of promptitude. The same happens to 53 [distillation] as to 14 [day]. The remains of 53 [distillation] after 55 [evaporation] do not corrode after applying 21 [solvent]. The parts which received during 14 [day], facilitate (sic!) 55 [evaporation]. What remains on the plate is equally uncorrodible by 21 [solvent]. So 14 [day] seems to have a similar effect as 24 [fire], which proves that the principle applies to both processes.[31]

28. Russell Roberts, Michael Gray, *Specimens and Marvels: William Henry Fox Talbot and the Invention of Photography*, New York: Aperture 2000, 9-10.
29. Hermann W. Vogel, Hans Spörl (eds.), P*hotographie. Ein kurzes Lehrbuch für Liebhaber und Fachleute*, Braunschweig 1909, 1.
30. 'Histoire de l'Académie Royale des Sciences, année 1727. Avec des Mémoires de Mathématique et pour Physique pour la même Annèe. Sur une nouvelle encre sympathétique', in: Josef Maria Eder (ed.), *Quellenschriften zu den frühesten Anfängen der Photographie bis zum XVIII. Jahrhundert*, Halle/Saale 1913, 103 –116.
31. Letter from Daguerre to Niépce, February 1830. Jean-Louis Marignier, 'Experimenteller Nachvollzug der Forschungsarbeiten von Nicéphore Niépce', in: *Spektrum der Wissenschaft*, February 2, 1997, 57.

Figure 5
Joseph Nicéphore Niépce, *Un Clair de Lune*, c. 1827, photograph on pewter. The Royal Photographic Society Collection at National Media Museum/SSPL.

Some publications on photography mention Niépce as the discoverer of the latent photographic image.[32] This assumption is due to a misunderstanding in descriptions of his heliographic process. In his "Notice sur l'héliographie", Niépce does mention a hidden image that he made visible with the help of a solvent.[33] However, this was not actually a latent photographic image: The colouration of the bitumen covered the image after exposure. It was washed out in a further stage of development and, in this way, became visible.[34]

However, investigations carried out on his photograph – *Un Claire de Lune* (fig. 5) – by the Getty Conservation Institute (GCI) in 2010 show that Niépce was already practising a photographic process described by the Institute as "Physautotype" in 1827. To achieve this, the CHI illuminated the image medium with a special Fourier Transform Infrared Spectrometer

32. Cf. G. C. Hermann Halleur, Franz Schubert, Gustave Louis Maurice Strauss, *The Art of Photography: Instructions in the Art of Producing Photographic Pictures in Any Color, and on Any Material: for the Use of Beginners, and Also of Persons who Have Already Attained Some Proficiency in the Art, and of Engravers on Copper, Stone, Wood, Etc.*, J. Weale 1854, 4. John Sartain, Caroline Matilda Kirkland, J. S. Hart, 'Photography – its origin, progress, and present state', in: *Sartain's Union Magazine of Literature and Art*, vol. 10, Philadelphia 1852, 447.
33. 'Notice sur l'héliographie', in: M. L'Abbé Migne, *Nouvelle encyclopédie théologique*, Paris 1860, 738. 34. Jacques Roquencourt, 'Daguerre et l'optique', in: *Études photographiques*, vol. 5, November 1998, 26-49.
34. Jacques Roquencourt, 'Daguerre et l'optique', in: *Études photographiques*, vol. 5, November 1998, 26-49.

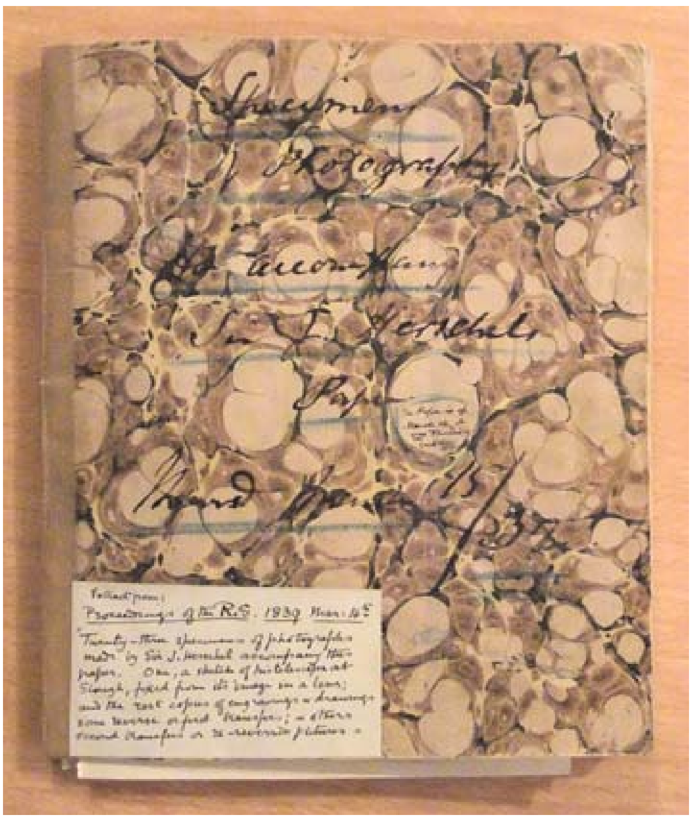


Figure 6
Cover of Herschel's notebook, *Specimens of photography. Extract from: Proceedings of the R. S. 1839 Mars 14th. Twenty-three specimens of photographs made by Sir J. Herschel accompany his paper. One a sketch of his telescope at Slough, fixed from its image in a lens; and the rest copies of engravings or drawings some reverse or first transfers; & others second transfers or re-reversed pictures.* National Media Museum, Bradford, BD1 1 NQ.

to obtain information on the substances used. Heated lavender oil was discovered on the pewter medium. Bitumen, as used in the process of heliography, was missing. A more exact analysis has, so far, not been carried out. Although the CGI has classified *Un Claire de Lune* as the first photograph, it appears certain that no strengthening of the picture occurred at a later time seeing that the Getty Institute was unable to detect any other chemical substances.[35]

In the book *Kryptographik. Lehrbuch der Geheimschreibekunst (Chiffrir- und Dechiffrirkunst) in Staats- und Privatgeschäften* by Johann Ludwig Klüber, dated 1809, a process of cryptography which comes remarkably close to the production of a Daguerreotype and the substances needed for it is described.

Solubilize lead (II) oxide in distilled vinegar. Filter it and allow to rest until it becomes clearer. Store the liquid in a bottle of glass. Then start writing, but make sure you do not dry what is written with fire. If the writing is to become visible, one must only bring it into contact with sulphurated hydrogen gas, which is done in the following way. Pour half a pint of pure water over a lot (= 1/30 of a pound) of potassium sulphide (available from pharmacies), shake it well, allow to rest for a quarter of an hour, then pour the liquid into a glass container and seal it with a cork stopper. The writing must be placed just above the opening of the glass and the letters will emerge in a brownish red colour. If a few drops of any kind of acid are added, the letters should get a metallic lustre.[36]

The physician Ludger Wöste[37] elaborated that:

At least in association with silver lustre the description contains all essential ingredients of the silver photography, so that I can well imagine that the author produced with his secret writing a quite robust latent image, which he then developed with the procedure according to his description.

A paper with secret writing dated 22 April 1839 was found in Herschel's estate with a note by Herschel on the upper edge stating that he had fixed this with hyposulfite.

Seeing that he had been working on his first photo-chemical pictures, which he presented to the Royal Society as part of his lecture entitled *Note on the Art of Photography, or the application of*

35. Cf.: Nadja Lenz, 'Neue wissenschaftliche Erkenntnisse zu den ältesten fotografischen Bildern der Welt', in: Rundbrief Fotografie, vol. 18 (2011), no. 1 / N.F. 69, 41-42. In his work: 'Première reconstitution du deuxième procédé photographique du monde'published in: *Le photographe*, November 1992, 26-33, Jean–Louis Margnier drew attention to an earlier process used by Daguerre and Niépce in 1832 that he described as 'Physautotype'.

36. Johann Ludwig Klüber, Kryptographik: *Lehrbuch der Geheimschreibekunst (Chiffrir- und Dechiffrirkunst) in Staats- und Privatgeschäften*, Tübingen 1809, 408-409.

37. Dr. Ludger Wöste, Freie Universität Berlin and Nadja Lenz, personal communication, March 2009.

Figure 7
Pill box and nitrate of mercury which Herschel used for his chemical experiments. National Maritime Museum, Greenwich.

the Chemical Rays of Light to the purposes of Pictorial Representation on 14 March 1839, shortly before this and that he mentions hyposulfite being used as a fixing agent for the first time, it still remains to be clarified if photo-chemical parallels exist between the objects going beyond the substance. (Figs. 6 and 7)
Herschel made the Royal Society away of the (playful?) image-intensifying effect of mercury chloride (mercury(I)chloride) ($HgCl_2$) in his 1840 report. The process – later called magic photographs or Indian-ink outlines – made it possible to make paper photographs invisible by applying mercury chloride and make them visible again by applying neutral hyposulfite. With the publication of this process, Herschel refers to the existing parallels to the latent (script)-image of secret writing.

By far the most remarkable fixing process with which I am acquainted, however, consists in washing over the picture with a weak solution of corrosive sublimate, and then laying it for a few moments in water. This at once and completely obliterates the picture, reducing it to the state of perfectly white paper, on which the nicest examination [if the process be perfectly executed] can detect no trace, and in which it can be used for any other purpose, as drawing, writing, etc., being completely insensible to light. Nevertheless, the picture, though invisible, is only dormant, and may be instantly revived in all its force by merely brushing it over with a solution of a neutral hyposulphite, after which it remains as insensible as before to the action of light. And thus it may be successively obliterated and revived as often as we please. It hardly requires mention that the property in question furnishes a means of painting in mezzotinto [i.e. of commencing on black paper and working in the lights], as also a mode of secret writing, and a variety of similar applications.[39]

Dealing with secret writings also contributed to cross-process changes and optimizations: In the same year, in which John Herschel announced the magic-photographs process, 1840, Robert Hunt used his experience for optimizing Daguerreotypes: After the latent image had been made visible, it became even clearer by the treatment with mercury chloride.
Talbot also gives some hints regarding chemical experiments with secret writings in his notebooks between 1833 and 1836. The first, in notebook Q in March 1831, states that:

39. J.F.W. Herschel 1840 (reference 38). With regard to further investigations in respect of Herschel's work with secret writings, see also: R. S. Schultze, 'Photographic Researches of Sir John F.W. Herschel. Rediscovery and Description of Original. Material on the Photographic Researches of Sir John F.W. Herschel, 1839 – 1844', in: *Journal of Photographic Science*, The Royal Photographic Society of Great Britain, March 1965, vol. 13, 1965, 57 – 68.

letters written with Sul Chrome when heated are slightly greenish sulph Nickel. They become raised white and fused sulph Iron. Brownish black it requires great to heat to develop it. Common salt & Sulph Copper mixed [tho' both dry and slightly damp] immed/y turn green owing to the form/n of muriate of copper [chloride][40]

Conclusion

Early photographers dealt extensively with the findings of cryptography, both in their search for suitable substances to produce light-sensitive layers as well as in experimental research into suitable developers to visualise a latent image or document. Mercury and gallic acid played a key role. It comes as no surprise that gallic acid, in particular, received special attention seeing that it was a component of the ink used for documents of a diplomatic character. Hyposulfite, on the other hand, was suitable for use as a fixing agent for both cryptographic and photographic documents.

Photographically and cryptographically motivated experiments on material latency were always useful in the scientific classification of the chemical substances employed. Whether almost by chance – as in the case of Jean Hellot – or exactingly scientific – in John Herschel's case – this made it possible to arrive at new conclusions on chemical and chemical-physical effects.

Cryptography not only made a major contribution to the discovery of photography, it still plays a pioneer role. Long before the discovery of photography, cryptography used immaterial latency to store and transmit information. Photography has only made use of immaterial latency for the same purpose since the middle of the 20th century.

Acknowledgements:
I would like to thank the following individuals for their help and advice, leads and access to their knowledge and research: Herta Wolf, R. Derek Wood, Carolin Artz and Markus Lenz.

40. Michael Gray, 'Secret Writing', in: Mike Weaver (ed.), *Henry Fox Talbot: Selected Texts and Bibliography*, vol. 3, Oxford 1992, 71 – 73.

Selene's Visible Face: Lunar Cartography and 19th Century Astronomical Photography

Carmen Pérez González

For my daughter Luna

To copy millions and millions of hieroglyphics with which even the outside of all the great monuments of Thebes, Memphis, etc., are covered, scores of years, and whole legions of painters would be required. One individual, with a Daguerreotype, would affect the labour in a very short space of time. Provide the Institute of Egypt with two or three sets of apparatus, and in several of the large plates of the celebrated work, the fruits of our immortal expedition, vast extents of real hieroglyphics will soon replace the fictitious ones; and the drawings will every where surpass in copy and local colour the works of the most skilful painters; and the photographic pictures being submitted in their formation to the rules of geometry, will allow us, with the assistance of a very few further data, to attain the exact dimensions of the highest parts of edifices and the most difficult of access.[1]

These were the first words spoken on 3 July 1839 by François Arago (1786-1853), Permanent Secretary of the Academy of Sciences, when he informed the French Chamber of Deputies about a remarkable invention by the French scholar Louis-Jacques Mandé Daguerre (1787-1851). The invention produced a finely detailed photographic image on a polished metal plate. Arago, who had himself contributed to the debate on hieroglyphic decipherment, formally proposed the application of the daguerreotype to the study of Egypt. He repeated his proposal to a larger audience at the August joint session of the Academy of Sciences and Fine Arts. The daguerreotype, from the very first moment of its inception, was seen as a significant scientific tool for recording monuments and even as one for making photographic maps of the Moon; an example remarked upon by Arago himself:

The preparation on which Mr. Daguerre operates is a reactive, much more liable to the effects of light than any that has hitherto been made use of. The rays of the moon, we do not say naturally but condensed in the focus of a lens of the largest size, never produced any physical effect. The sheets of plated metal prepared by Mr. Daguerre on the contrary, become so white when exposed to the same light and to the subsequent operations, that we may really hope to make a photographic map of our satellite. That is to say that in a few minutes, one of the longest, most minute and delicate labours of astronomy may be effected.[2]

Indeed, Arago's expectations as to the use of the daguerreotype as a scientific tool (precisely, to master the representation of a scientific object in a picture) were achieved as early as March 1840. This was the year that the American physician John William Draper (1811–1882) managed to take the first daguerreotype of the Moon after a 20-minute exposure. Nevertheless, in the

1. Beaumount Newhall & Daguerre, *Daguerre (An historical and descriptive account of the various processes of the Daguerreotype and the Diorama, by Daguerre)*, Winter House, first edition 1971, 21–22.
2. Newhall 1971 (reference 1), 26.

early years of the history of celestial photography, this fact was not known, and this historical event of being the first person to successfully photograph the Moon was wrongly given to someone else. As stated by A. Brothers in a paper read at a meeting of the Photographic Section of the Literary and Philosophical Society of Manchester on 14 December 1865:

The credit of having produced the first photograph of a celestial object is generally given to the late Mr. Bond, of Cambridge, U.S.; but it appears from a paper by Professor H. Draper, of New York, published in April 1864, that in the year 1840 his father, Dr. J. W. Draper, was the first who succeeded in photographing the moon.[3]

During the 15 years after that first daguerreotype, great efforts were made to refine the technical aspects of the daguerreotype applied to astronomy. Did these improvements in the photographic technique help to realize Arago's most ambitious expectations regarding mapping the surface of the Moon with the help of photography? When were the earliest photographic maps of our satellite produced? In order to give an answer to these questions, it is important to undertake a brief historical survey of maps of the Moon made before the introduction of photography in 1839 and the evolution of lunar cartography up to the first photographic maps of our satellite.

When researching on telescopic (pre-photographic) maps and daguerreotypes of the Moon, the first, most obvious and expected, observation is that all of them depict the same side of the Moon, the visible face of our satellite. The reason that one side of the Moon is never visible from the Earth is because our satellite spins once on its axis in precisely the same amount of time it takes to revolve around the Earth. If its rate of rotation were slightly different than its rate of revolution, we would eventually be exposed to the entire surface of the Moon. However, these two intervals have been equal for all of recorded history. Therefore, all extant lunar maps and daguerreotypes made from the Earth show us the same lunar image; only being different from each other (in the case of the daguerreotypes) depending on *which* side of the Moon's visible face they reveal to us. The first thing that comes to the attention of a researcher studying lunar daguerreotypes is the fact that most of them were taken during a *half moon*, and never full moon, phase of the planet. There is a simple explanation for this: If the Moon is in its *full moon* phase, it reflects much more light than is suitable to register the main lunar topographical features properly. The *first quarter* and *third quarter* moons (both often called a *half moon*) happen when the angle between the Moon, Earth and Sun is 90 degrees;[4] we see exactly half of the moon illuminated and half in shadow. During a *full moon*, rays of sunlight hit the visible portion of the Moon perpendicular to the surface. As a result

3. A. Brothers, 'Celestial Photography', in: *Astronomical Register*, 4 (25), 1866, 34–38, 34.
4. For a simple and clear earth-moon-sun diagram that will help to visualize the phases of the moon, see: http://www.moonconnection.com/moon_phases.phtml (12 March 2012).

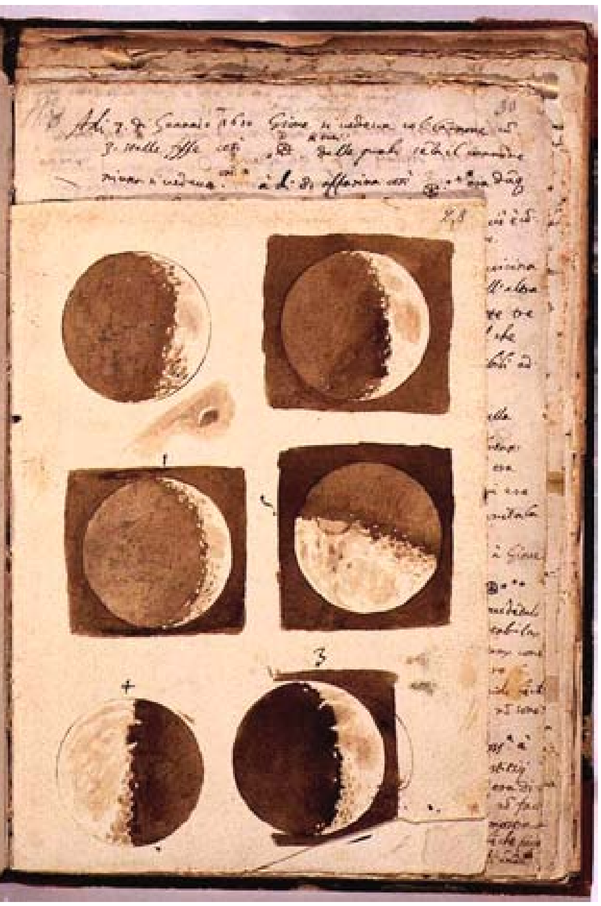


Figure 1
Galileo Galilei, *Engravings of Phases of the Moon*, published in *Sidereus Nuncius, Magna, Longeqve Admirabilia Spectacula pandens, suspiciendáque proponens vnicuique, praesertim verò Philosophis, atq[ue] Astronomis*, Venetiis: Baglionus 1610, 28.

there is much less surface detail visible during a *full moon* than other phases when sunlight hits the Moon at a much shallower angle. In addition, the brightness of a *full moon*, compared to a phase when a smaller percentage of the surface is illuminated, tends to wash out substantial amounts of detail and can actually leave an afterimage on an observer's eye that can persist for several minutes. *First quarter* (six to nine days past new moon) is generally considered the best time to observe the Moon, which surely explains why most of the lunar daguerreotypes that have survived the ages show this phase.

To achieve Arago's expectations regarding producing photographic maps of the Moon, the first thing that pioneer astronomical daguerreotypists had to take into consideration was precisely the fact that the Moon could only be photographed by parts, systematically through its recurrent phases, following the *synodic period* or *lunation*, which is the time required for the Moon to move to the same position (same phase) as seen by an observer on earth. Therefore, pioneer lunar photographers had to systematically observe the Moon recurrently in the same phases, carefully annotating the day and time of the capture, to take photographs of almost the same portion of the Moon's face that could be compared and potentially used as pieces of a puzzle to reconstruct lunar maps, collages of different lunar phases.

In the 400 years following the invention of the telescope, the Moon was studied and mapped by several observers using different techniques. The astronomer and specialist in Lunar studies Ewen A. Whitaker proposed four periods in the study of our satellite:[5] The first observers used the newly invented telescope from 1610 to 1650. The Moon was recognized as a new world to explore. This period marked the birth of Selenography. After a long period of inactivity, a second phase began in the early 19th century. Observers used achromatic refractors and filar micrometers to study and map the Moon with outstanding precision. Scientific cartography of the Moon was born. The third period started in 1890 when the large telescopes at Lick and Paris observatories began a systematic photographic survey of the Moon. The fourth and last period was, of course, close-up detailed observations performed by spacecraft and manned exploration of the Moon.[6]

Early telescopic maps of the Moon, 1610-1839

Galileo Galilei (1564–1642) was the first astronomer to publish drawings and descriptions of the moon surface made directly by observing our satellite through a telescope. He published

5. See: Ewen A. Whitaker, *Mapping and Naming the Moon. A History of Lunar Cartography and Nomenclature*, Cambridge: Cambridge University Press 1999, xvi-xvii.

6. Thanks are due to Pedro Ré for feedback on this matter. See: http://www.astrosurf.com/re/first_lunar_maps.pdf (12h March 2012).

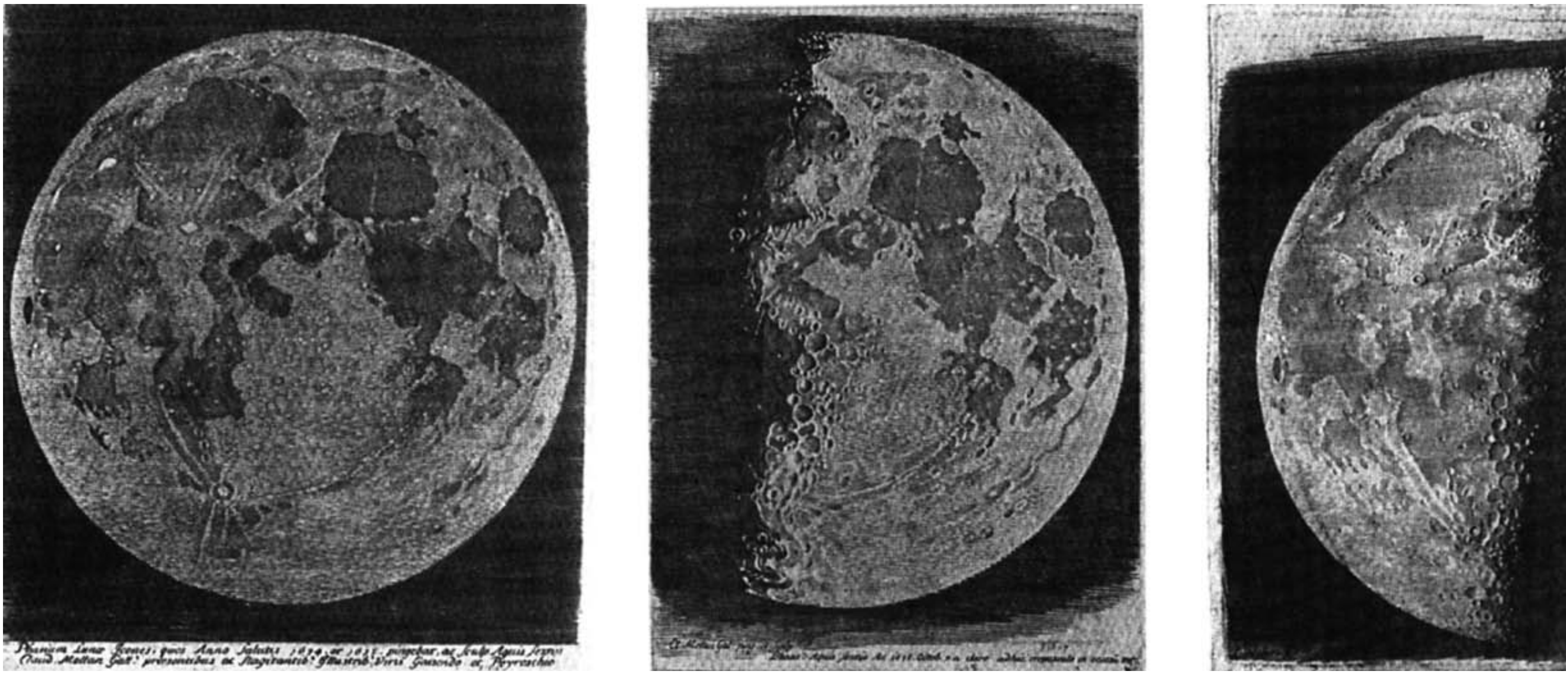


Figure 2
(a, b) Claude Mellan and Pierre Gassendi, Engravings of the Moon, 1635-37. Cabinet des Estampes, Bibliothèque Nationale, Brussels. (c) Claude Mellan, *Phasium Lunae Icones, quos Anno Salutis 1634 et 1635 pingebat, ac Scupl. Aquis Sextiis Claud. Mellan Gall. praesentibus ac flagitantibs illustriss viris Gassendo et Peyrenchio[s.l.], [s.a],nº 17277/L-17.* Biblioteca del Real Instituto y Observatorio de la Armada, Cádiz.

these sketches in his book *Sidereus Nuncius* (i.e. Sidereal Message) in 1610[7] (fig. 1). This was the first scientific treatise based on observations of this kind and he deduced that the darker regions of the Moon were flat, low-lying areas, while the brighter regions were rough and covered with mountains. After him, several astronomers published further sketches of our satellite, the most remarkable of all being three engravings made by the prominent and skilled French engraver and painter Claud Mellan (1598–1688), who prepared engravings of three different lunar phases that were reproduced early in 1637 (fig. 2a, b, c). The first image shows the *full moon* phase, and we can perfectly recognize the main lunar topographical features: In the upper left part, we see the *Mare Imbrium* with the *Mare Nubium* in the lower left. In the other half of the engraving, we can see the *Mare Serenitatis* in the upper section and, below it, the *Mare Tranquilitatis.* In figure 2b (*third quarter*) we can clearly identify the most-often depicted part of the Moon in daguerreotypy: The Serenitatis Basin Region, with its most famous features: *the Serenitatis* and *Tranquilitatis* Basins, the northern part of the *Fecunditatis* Basin, and the western part of the *Crisium* Basin. In the last engraving (*first quarter*), we can recognize the *Oceanus Procelarum.* These engravings were commissioned by the French philosopher, priest, mathematician and astronomer Pierre Gassendi (1591–1655). Gassendi developed a rudimentary nomenclature scheme – which, however, was never published – consisting of 14 names grouped into four categories: *Mare, Vallis, Rupes,* and *Mons* (Sea, Valley, Cliff, Mount or Mountain). The *Gassendi* lunar crater is named after him.

The first real map of the Moon was made and published by the Dutch cartographer Michael Florent van Langren (1600–1675) in 1645 (fig. 3). Van Langren held the title of "Royal Mathematician and Cosmographer" first to the Belgian royal house and later to King Philip IV of Spain. He was the first to assign names to various lunar features. He defined exactly 325 names for the most important topographical lunar features but few were widely accepted as they were closely linked to the Spanish royal court. The *Langrenus* crater on the Moon is

7. *Galileo Galilei, Siderevs// Nvncivs: Magna, Longeqve Admirabilia Spectacula pandens, suspiciendáque proponens vnicuique, praesertim verò Philosophis, atq[ue] Astronomis,* Venetiis: Baglionus 1610. For an excellent translation and insightful review of the reception of this book, see: Albert van Helden, *Sidereus Nuncius or the Sideral Messenger. Galileo Galilei*, Chicago: University of Chicago Press 1989.

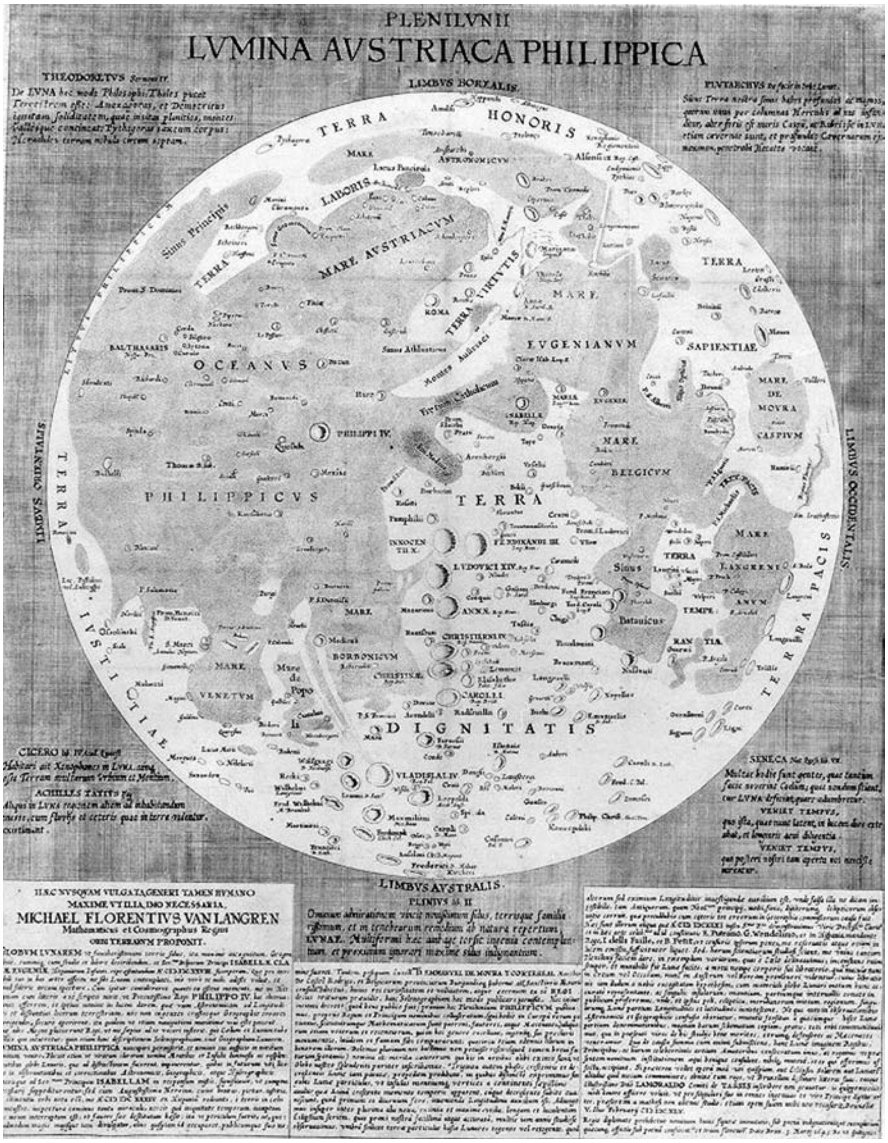


Figure 3
Michael Florentius van Langren, *Plenilunii lumina Austriaca Philippica*, Brussel 1645, copper engraving, 49 x 38 cm, diameter 34 cm. Crawford Collection, Royal Observatory, Edinburgh.

named after him. This is one of the few names given by van Langren, which are still in use. From this date until the beginning of the 17th century, several maps were made and printed improving the definition of the lunar features and also the nomenclature. The last of these maps to be realized before photography was introduced was the work of the German astronomers Johann Heinrich Mädler (1794–1874) and Wilhelm Beer (1797–1850). Their *Mappa Selenographica* was published in four volumes between 1834 and 1836,[8] accompanied in 1837 by a volume with 368 numbered features and many measurements of the diameters of craters and elevation of mountains.

Lunar daguerreotypes enter the picture

Only two years after the publication of Mädler and Beer's lunar map, the introduction of the daguerreotype made it possible to produce faithful reproductions of our satellite without needing the extremely long times necessary to draw the Moon's topography as seen through the telescope. Nevertheless, early attempts at photographing the Moon through a telescope were especially difficult because of the inherent limitations of the photographic process at that time, which still required long exposure times. In the case of the Moon, the need of guiding the telescope at the lunar rate was an additional problem caused by these long exposure times. Therefore, astronomical daguerreotypy required the mastery of a combination of both photographic technique and mechanical skills. The process of taking a daguerreotype of our satellite was very lengthy, not only because of the long exposure needed, but also due to the time required to properly and precisely prepare all the instruments involved: The telescope was made into a camera by positioning the unexposed plate in a holder at the eyepiece of the telescope; in addition, the telescope had to have a very precise tracking mechanism that had to be moved during the exposures to compensate for the movement of the Earth in relation to other celestial bodies. This was to avoid that images would appear blurred, smeared or out-of-focus on the plate. Astronomers were traditionally among the most patient observers of all

8. For further information on lunar maps, see: Whitaker 1999 (reference 5).

scientists, having to spend long hours at night in front of the telescope to record whatever event or measurement they wanted to. Being well trained as they were (many of them spending many hours drawing the Moon by direct naked-eye observation through the telescope), this laborious and long process was masterly undertaken by the pioneers of astronomical photography. It is a fact that, in those early years of astrophotography, the eye could filter what was observed to a certain degree and, subsequently, register very much finer detail than a photograph could achieve. However, photographs are stable, permanent records that can be measured and studied in detail indoors and at any time. This, not the refinement or preciseness of their reproduction, was the greatest potential of daguerreotypes at the time. Some contemporary scientists realized the new medium's limitations, but faithfully kept regarding photography as a potential scientific tool in the advancement of astronomy, and of astronomical cartography in particular. One of them was the British scholar Professor Phillips:

Figure 5
John William Draper, *The Moon*, c. 1840, daguerreotype, 8.25 x 6.98 cm, New York University Archives.

.... if the utmost success of the photographer should only produce a picture of the larger features of the moon, this will be a gift of the highest value, since it will be a basis, an accurate and practical foundation of the minuter details, which, with such aid, the artist may confidently sketch.[9]

As noted at the beginning of this paper, most authorities in the field cite Draper as the first to successfully photograph the Moon and a series of his early scientific daguerreotypes is contained in the Draper Collection of the New York University Archives. But, if lunar images were ever recorded on them, they have fully vanished, except for one (fig. 5), which is the oldest extent photograph of the Moon by Draper. As stated by Don Trombino: "by comparing the co-longitude and moonrise of the last quarter moons during the last part of 1840, Mr. John Pazmino, a director of the Amateur Astronomers Association of New York, determined that this picture was taken 1840 March 26".[10]

Another gorgeous daguerreotype of the moon by photographer and publisher Samuel Dwight Humphrey (dates unknown), *View of the moon, multiple exposures*, was taken on 1 September 1849 and is now kept at the Harvard College Observatory in Boston (fig. 6). A multiple exposure daguerreotype of the full moon bears some notations on the side of the image, which indicates the length of exposure for each image: 2 m, 60 s, 30s, 15, 5 s, 3 s, 2 s, 1 s and 0.5 s. By comparing the numbers, we can probe that the shape of the moon

9. Brothers 1866 (reference 3), 35.
10. Don Trombino, 'Dr. John William Draper', *The Journal of the British Astronomical Association*, Vol. 90, Eighty-Ninth Session, 1979 December to 1980 October (edited by Colin A. Ronan), London 1980, 569.

Figure 6
Samuel Dwight Humphrey, *View of the moon, multiple exposures*, September 1, 1849, sixth plate daguerreotype. Harvard College Observatory (OB-1).

Figure 7
John Adams Whipple and William Cranch Bond, *The Moon*, 1851, daguerreotype 10.16 x 12.7 cm. National Media Museum/Science & Society Picture Library, London, Inv. Nr. 1943-0045, M.F.H. Cat. No. 37.

is distorted more in the longer exposures, which hints at the fact that the telescope did not have a tracking mechanism and, therefore, the astronomer was not able to track our satellite's movement. Humphrey actually took two such daguerreotypes. An important turn in the history of astrophotography was provided when Humphrey sent one of the images from these early astrophotographic experiments to Jared Sparks, President of Harvard College. They aroused tremendous interest in the potential of daguerreotypy in the field of astronomy in Mr. Sparks who then decided to invest in the college observatory and astronomical daguerreotypy.[11] As a result of this effort, an alliance between two leading astronomers was born: the first director of the Harvard College Observatory William Cranch Bond (1789–1859) and a leading daguerreotypist in Boston John Adams Whipple (1822–1891). This association marks the true beginning of celestial photography. One fine example of the lunar daguerreotypes produced by the Whipple-Bond alliance, dated 1851, is kept at the Harvard College Observatory (fig. 7). In this image of the Moon in its *first quarter*, we can identify the *Serenitatis* Basin Region, with the *Mare Serenitatis,* the *Mare Tranquilitatis,* and the *Mare Crisium.* Regarding Bond, A. Brothers stated:

> *Mr. Bond's photographs of the moon were made in 1850. The telescope used by him was the Cambridge (U.S.) reflector of fifteen inches aperture, which gave an image of the moon at the focus of the object glass two inches in diameter.*[12]

Figure 8
John Adams Whipple, *View of the Moon*,
February 26, 1852,
quarter plate daguerreotype.
Harvard College Observatory (OB-7).

Another example of such scientific photographs is an image, taken by the American inventor and early photographer John Adams Whipple (1822-1891), *View of the Moon*, February 26, 1852, a quarter plate kept at the Harvard College Observatory (fig. 8) and taken with the "Great Refractor" telescope, which was the largest telescope in the world at that time. This image depicts the Moon in its *waning crescent* phase and we can, therefore, recognize the *Oceanus Procelarum.* At the Great Exhibition in 1851,[13] the jury reserved its highest praise for one of these early daguerreotypes of the Moon taken by Whipple. Given that the judges were some of the day's leading astronomers and opticians, their bestowal of their "highest commendation" and a prize medal on images that advanced the world's scientific knowledge is not particularly

11. For details on this interesting event, see: M. Susan Barger and Williams B. White, *The Daguerreotype. Nineteenth-Century Technology and Science*, Washington and London: Smithsonian Institution Press 1991, 86–89.
12. Brothers 1866 (reference 3), 35.

13. For more information on the daguerreotypes shown at this important event, see: *Journal of the Great Exhibition in 1851,* Zadock Thomson, Burlington, Nichols & Warren 1852; and John R. Davis, *The Great Exhibition*, Stroud: Sutton Publishing 1999.

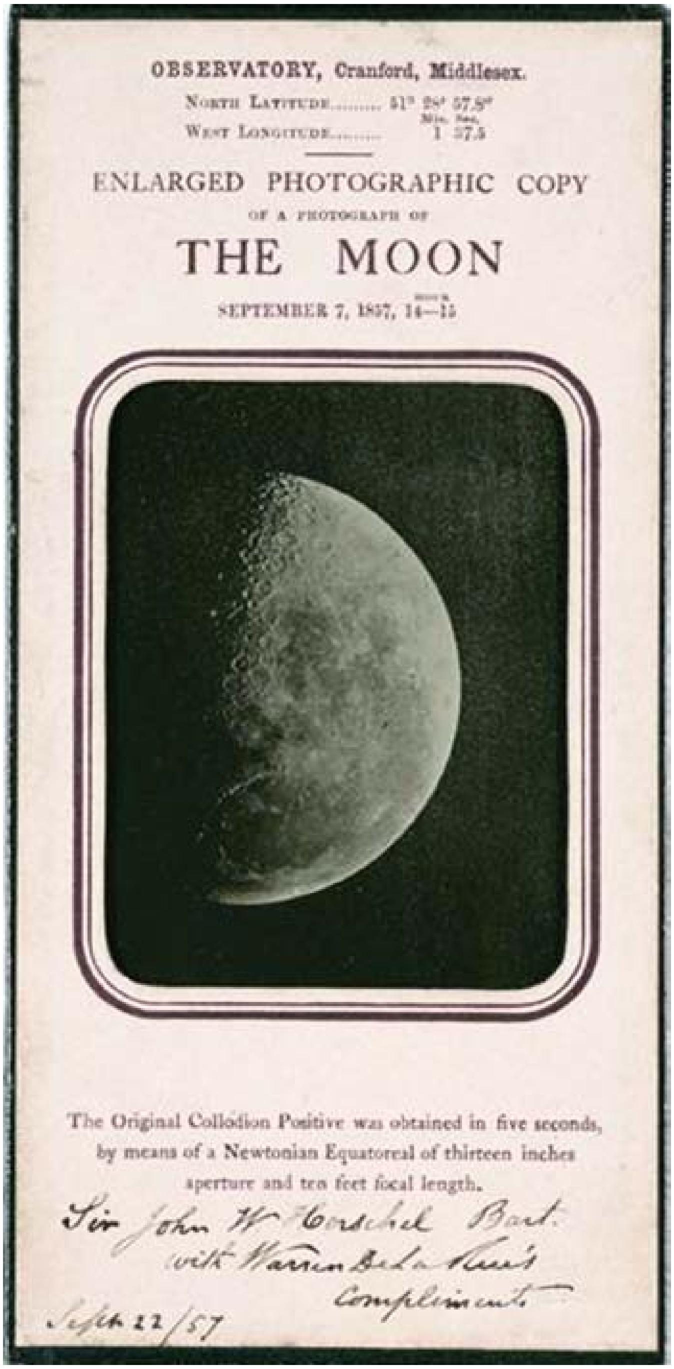


Figure 9
Warren de la Rue, *The Moon*, Sept. 7th, 1857, enlarged photographic copy of a photograph of the Moon, 8.25 x 5.71 cm, National Media Museum/Science & Society Picture Library, London, M.F.H. Cat. No. 41.9.

surprising. The report declared the image to be "one of the most satisfactory attempts that has yet been made to realize, by a photographic process, the telescopic appearance of a heavenly body, and must be regarded as indicating the commencement of a new era in astronomical representation." In *Art and Industry as represented in the exhibition of the Crystal Palace, New York 1853-4,* there is a whole chapter devoted to the daguerreotypes exhibited there, with a reference to Whipple's lunar daguerreotypes.[14]

It is interesting to note that these lunar (and solar) daguerreotypes were exhibited next to the scientific exhibits (in the far end of the nave of the exhibition hall at the 1851 Great Exhibition), rather than towards the centre of the building with other aesthetic goods.[15] A fact that reminds us that photography was still regarded as a scientific tool rather than a technique with artistic possibilities.

Shortly after these outstanding achievements with the daguerreotype, the collodion process was discovered and started being applied successfully from 1852 onwards, also for lunar portraiture. The daguerreotype then became obsolete. The British astronomer and chemist Warren de la Rue (1815–1889), attracted to astronomy by the influence of the Scottish engineer and inventor James Nasmyth (1808–1890), produced fine photographs of our satellite upon telescope observation with a self-constructed 13-inch reflecting telescope (1850) (fig. 9).[16] In this image of the Moon, we can see the *first quarter* phase, with the *Serenitatis Basin* clearly depicted. Nasmyth, his mentor, built his own 20-inch reflecting telescope and made detailed observations of the Moon. Nasmyth co-wrote *The Moon: Considered as a Planet, a World, and a Satellite,* together with the British astronomer James Carpenter (1840–1899), which was issued by the leading British publisher of guidebooks, John Murray. This book contains an interesting series of "lunar" photographs: Nasmyth built plaster models based on his visual observations of the Moon and then photographed the models.[17] A crater of the Moon is named after him. De la Rue produced excellent stereoscopic pictures of the Moon and he became a respected pioneer in the early years of celestial photography, as noted by Brothers:

14. *Art and Industry as represented in the exhibition of the Crystal Palace, New York, 1853-4*, 176.
15. Davis 1999 (reference 13), 148.
16. For more information on Warren de la Rue and his work, see: David le Conte, 'Warren De la Rue – Pioneer astronomical photographer', in: *The Antiquarian Astronomer* (5), Febr. 2011, 14–35.
17. Albert Edward Musson, *Science and Technology in the Industrial Revolution*, Manchester: Manchester University Press 1969, 491.

Figure 10a
Lewis M. Rutherfurd, *Full Moon*, c. 1860, stereographic photography, 17.8 x 8.8 cm. Pedro Ré's private collection.

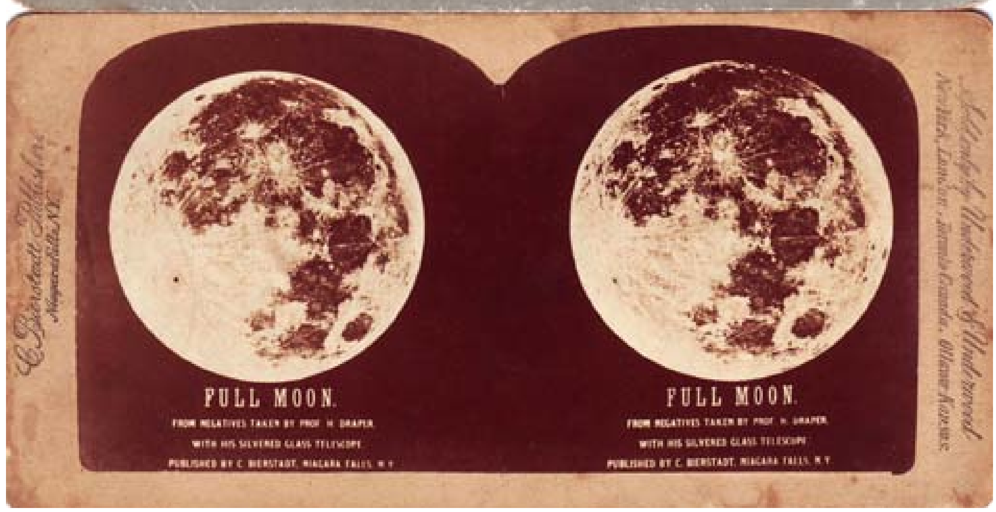


Figure 10b
Henry Draper, *Full Moon*, c. 1863, stereographic photograph, 17.8 x 8.8 cm. Pedro Ré's private collection.

At the meeting of the British Association at Aberdeen, in 1859, Mr. de la Rue read a very valuable paper on Celestial Photography. An abstract of this paper was published at the time in the British Journal of Photography, and in August and September of the following year further details of Mr. de la Rue's method of working were given in the same Journal.[18]

De la Rue is well-known for having taken gorgeous stereoscopic images of our satellite in the mid 1850s.[19] These stereoscopic views of the Moon became quite popular by the beginning of the 1860s. The two photographs of our satellite in the *full moon* phase used for one of the stereo cards shown in the next image (fig. 10) were taken by noted pioneer astronomical photographer Henry Draper (1837–1882). His father, John William Draper, as we already noted above, had been the first to photograph the Moon in 1840. Henry took a series of detailed photographs of the Moon in 1863 using a reflecting telescope and these photographs were used to make the stereoscopic pictures of the Moon including the one shown. The American amateur astronomer Lewis Morris Rutherfurd (1816–1892), produced many high-quality photographs of the Moon starting in 1856; a large number of them were used to produce stereoscopic pictures of our satellite, including photographs taken in the *full moon* phase, as the one shown also in figure 10.[20]

18. Brothers 1866 (reference 3), 37.
19. For further reading on stereoscopic images of the Moon, see: Warren De la Rue, 'Stereoscopic Photographs of the Moon', in: *Monthly Notices of the Royal Astronomical Society*, vol. 19, 40, 1858; and T.B. Greenslade Jr., 'The First Stereoscopic Pictures of the Moon', in: *American Journal of Physics*, vol. 40, issue 4, April 1972, 536.
20. For more information about life and work of Lewis M. Rutherford, see: Deborah Jean Warner, 'Lewis M. Rutherford: Pioneer astronomical photographer and spectroscopist', in: *Technology and Culture*, Vol 12, No. 2 (April 1971), 190-216.

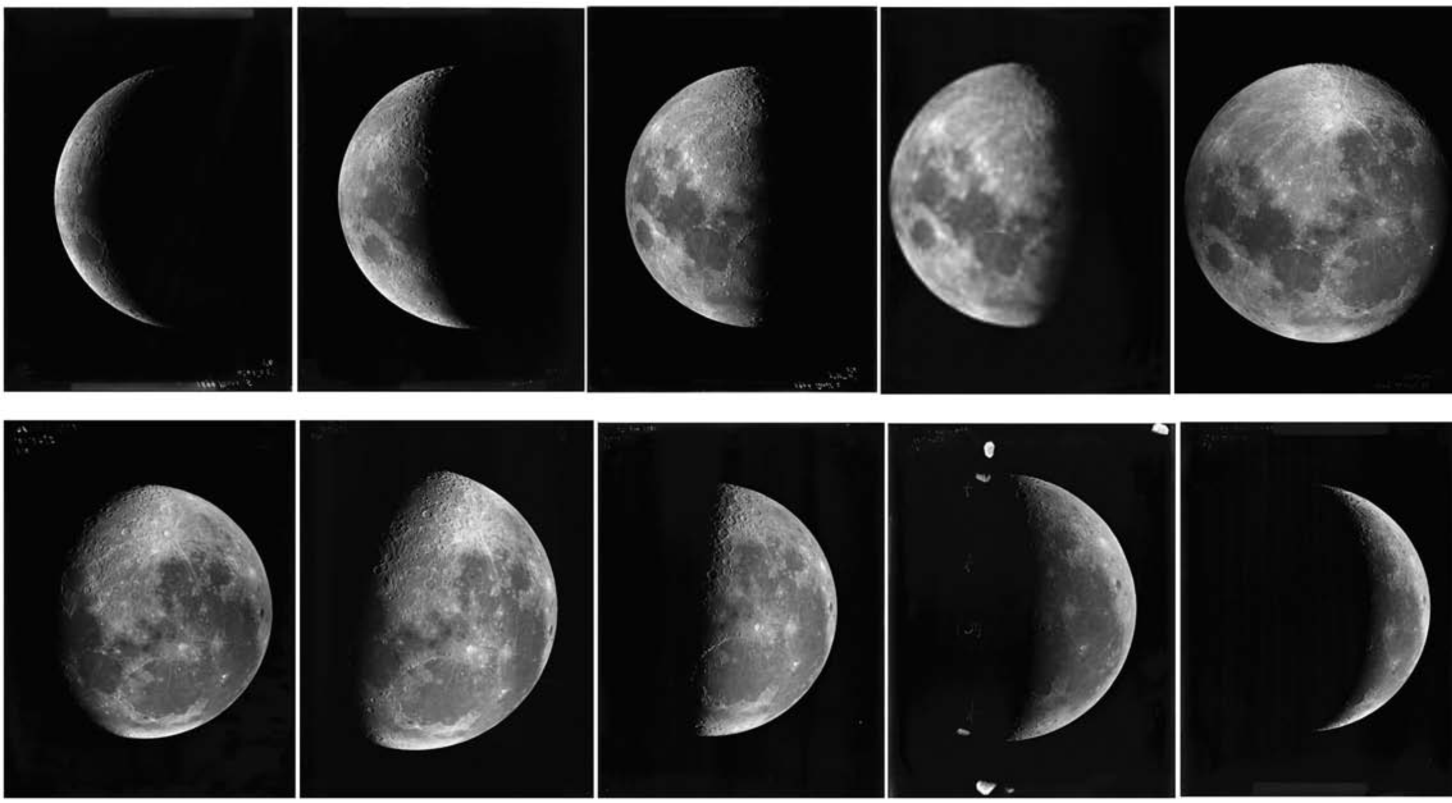


Figure 12
Moritz Loewy, Pierre-Henri Puiseux,
Atlas photographique de la lune, héliogravures,
Paris, 1896-1910.
Collections de l'Observatoire de Paris.

Lunar cartography after the invention of photography, 1839-1900

Nonetheless, no matter how much interest those early specimens received, it remained a fact that the accuracy and preciseness offered by the daguerreotypes and later processes was insufficient to substitute for the preciseness of the astronomer's eye. Arago's optimistic thoughts about the use of photography to improve the quality of the lunar maps were therefore not realized during the years in which the daguerreotype process was active. Maps produced with the naked eye through the telescope after the invention of photography include those by Tobias Mayer (1748), Lecouturier and Chapuis (1860), and Flammarion (1890); all of them presenting a noticeable improvement when compared to earlier pre-photographic maps.

By the end of the 19th century, photographic emulsions had improved so much that position measurements of lunar features became very accurate and also increased in numbers, so that were more reliable than the old naked-eye telescope measurements. It was not until the last decade of the 19th century that the first photographic map of the moon was achieved.[21] This first successful enterprise was launched at the Observatoire de Paris in 1896, and lasted for 14 years. Two French astronomers, Moritz Loewy (1833–1907) and Pierre-Henri Puiseux (1855–1928), had systematically taken photographs of our satellite from 1896 to 1909 (fig. 12), working on an atlas of the Moon composed of 100,000 photographs.[22] *L'Atlas photographique de la Lune* (1910) became the definitive basis for lunar geography for over half a century. The *Loewy* and *Puiseux* craters on the Moon are named after these two astronomers. In this sequence of photographs of our satellite, we can see the Moon growing from the *waning crescent* (a and b), to the third quarter (c), to the *full moon* (d), to the *waxing gibbous* (e and f), *first quarter* (g), and *waxing crescent* (h and i). Arago's expectations were not achieved until 60 years after he had envisioned the potential of applying photography to astronomy. The way in which photography further helped to develop lunar cartography in the 20th and 21st century is an appealing topic, but goes beyond the scope of this article.

As for the first photographs of the *far side* of the Moon (also called the *dark side* of the Moon), humanity had to wait until the Soviet Luna 3[23] probe in 1959, hence the history of lunar cartography experimented a tremendous achievement as these early photographs of our satellite were seminal to attempt a tentative *Atlas of the Far Side of the Moon* using image processing to improve the pictures.[24]

Acknowledgments:
I am grateful to Alison Douane (curator at Harvard College Observatory), Sophia Brothers (Science & Society Picture Library, London) and Nancy Cricco (New York University Library) for permission to print several lunar daguerreotypes, as well as to Emile Kaftan for his help in obtaining authorization to reproduce the lunar photographs kept at L'Observatoire de Paris. In addition, I should like to thank Pedro Ré (Faculdade de Ciências da Universidade de Lisboa, Portugal) for his feedback on the topic; he also kindly gave me permission to reproduce the two stereoscopic photographs of the Moon.

21. For a historical overview of history of astrophotography, an excellent resource is: Ré, Pedro, History of Astrophotography, on-line book: http://www.astrosurf.com/re/history_astrophotography_PRe.pdf: 52-55. Also an excellent exhibition catalogue on the topic of early astrophotography is: Q. Bajac, A. de G. Saint-Cyr, Dans le champ des *étoiles. Les photographes et le ciel (1850–2000),* Paris: Éditions de la Réunion des Musées Nationaux 2000.
22. For details on this project, see: Ré (reference 21), 52.
23. The third space probe to be sent to the vicinity of the moon.
24. To see the first images of the far side of the Moon: http://nssdc.gsfc.nasa.gov/imgcat/html/mission_page/EM_Luna_3_page1.html
To see a website with those images after image processing: http://www.astrosurf.com/nunes/explor/explor_luna3.htm (12 March 2012)

Leaf Prints
Early Cameraless Photography and Botany

Katharina Steidl

Histories of photography generally let their story begin by pointing out the ancestors of the art. These include experiments on the blackening effect of light on silver salts in the 18th century, as well as the drawing aid known as the “camera obscura”; a darkened room or portable box with a little hole in it capable of producing an upside-down image of the outside scenery. The combination of these led to what is now commonly understood as photography: the creation of a camera-made image. This definition ignores the importance of those photographs made without a camera, which were not only produced at the beginning of – or even before – photography but throughout the entire 19th century.

Cameraless images, or photograms as they are called today, were fundamental for the conceptualization of photography. Through an examination of images made without a camera, William Henry Fox Talbot, the English inventor of photography, was not only able to develop certain ideas concerning an automatic, self-generated image through direct observation, but also to evolve a concept of objectivity based on the constitutive moment of the contact between the object and photosensitive surface. To a large extent, this was the result of his interest in botany and established illustration techniques in the botanical field. An analysis of Talbot’s early photograms of plants opens up discussions about how to visualize botanical compendia, as well as the extent to which the connection between botany and gender influenced the perception of the photogram. From the beginning, there were strong links between photography with or without a camera and concepts of visibility and invisibility. This not only meant the visualization or transformation of something invisible or not visible to the human eye into a visible pictorial representation; it also says something about how vision, perception and the photographic image were amalgamated leading to certain stylistic preferences or compositions in photography. Furthermore, it can be said that depictions in cameraless and camera photography are based on adopted representational models that differ from each other to a great extent.

Pictures of flowers and leaves

Shortly after the French announcement of photography, William Henry Fox Talbot presented his photographic invention at a meeting held at the Royal Institution on January 25, 1839. On this occasion, Talbot introduced his method of paper photography named “photogenic drawing”. This term encompassed both photographs taken with a camera and photograms. To produce such photographs without a camera, he arranged flat objects such as lace patterns and leaves of plants directly on a photosensitive surface and exposed them to the rays of the sun (fig. 1).

Michael Faraday announced the new discovery to the more than 300 people attending the lecture on that evening with the following words: “No human hand has hith-

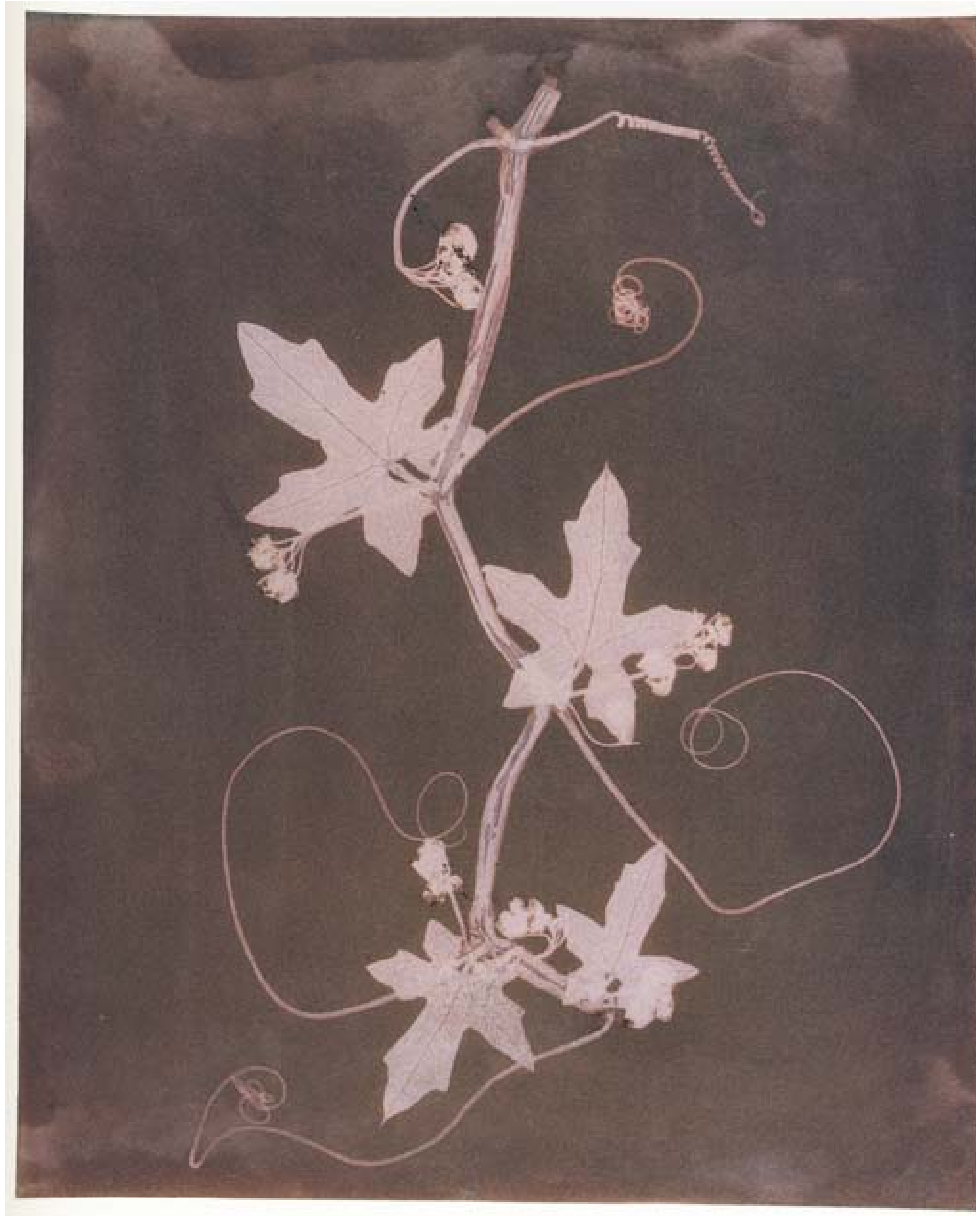


Figure 1
William Henry Fox Talbot, *Botanical Specimen*, photogenic drawing negative, c. 1835, 22,4 x 18,3 cm.
National Media Museum Bradford.

erto traced such lines as these drawings display: And what man may hereafter do, now that Dame Nature has become his drawing mistress, it is impossible to predict."[1] With these lines, Faraday made associations between two media: photography and drawing. But most of all, he pointed towards a gendered form of drawing, as nature was thought to be feminine and drawing in those days was a popular female pastime.[2] After this, the audience was able to examine examples of Talbot's photogenic drawings on the walls of the upper library.[3] There were camera-obscura pictures among the exhibits but contact prints of plants, flowers, leaves and laces that Talbot had possibly produced in the years 1835 to 1838 were more numerous. On February 2, a letter from Talbot to the editor of *The Literary Gazette* was published in which he commented on this presentation. Although he emphasized that he could only show "what I happened to have with me in town", he managed to present the audience a variety of photograms, copies from engravings and camera photographs:

1. Anonym, 'Royal Institution', in: *The Literary Gazette and Journal of the Belles Lettres, Arts, Sciences, &c.*, no. 1150, 2 February 1839, 74–75.
2. See Ann Bermingham, *Learning to Draw. Studies in the Cultural History of a Polite and Useful Art*, New Haven: Yale University Press 2000; Carol Armstrong, 'Cameraless: From Natural Illustrations and Nature Prints to Manual and Photogenic Drawings and Other Botanographs', in: Ibid. and Catherine de Zegher (eds.), *Ocean Flowers. Impressions from Nature*, exhibition catalogue, New York 2004, 87–165.
3. See Mike Weaver (ed.), *Henry Fox Talbot. Selected Texts and Bibliography*, Oxford: Clip Press 1992, 45f.

Among them were pictures of flowers and leaves; a pattern of lace; figures taken from painted glass; a view of Venice copied from an engraving; some images formed by the Solar Microscope, viz. a slice of wood very highly magnified, exhibiting the pores of two kinds, one set much smaller than the other, and more numerous. Another Microscopic sketch, exhibiting the reticulations on the wing of an insect. Finally: various pictures, representing the architecture of my house in the country; all these made with the Camera Obscura in the summer of 1835.[4]

Stressing that "the most remarkable of these, is undoubtedly the copying of a distant object," he nevertheless insisted on the fact that, "one perhaps more calculated for universal use is the power of depicting exact facsimiles of smaller objects which are in the vicinity of the operator, such as flowers, leaves, engravings, &c., which may be accomplished with great facility, and often with a degree of rapidity that is almost marvellous."[5] Even though he stated that camera photography made it possible to obtain images or copies of the outer world, Talbot diagnosed a universal or general use in the contact printing process of the photogram. It could therefore be argued that he saw much greater potential in his cameraless technique of copying botanical specimen, laces or engravings. Besides, in this context, the term "facsimile" allows a definition of the photogram as an exact representation or 1:1 copy of the original leaf created through contact.

In his first account on photography, which was read to the Royal Society on 31 January 1839 and published privately, he made a strong connection between photography and botany. Entitled *Some account of the art of photogenic drawing, or, the process by which natural objects may be made to delineate themselves without the aid of the artist's pencil*, he described his first experiences with contact prints of flowers and leaves, either fresh or dried from his herbarium.[6] With this printing process, which he called a "natural process", he "expected that a kind of image or picture would be produced, resembling to a certain degree the object from which it was derived."[7] This resemblance between the image and object – which Talbot hoped to be almost, but not totally, identical – needs to be understood as a visualization through transformation. In the case of his photogenic drawings of plants and leaves, he declared that these objects were depicted "with the utmost truth and fidelity, exhibiting even the venation of the leaves, the minute hairs that clothe the plant, &c."[8] In this point, it could be said that, for Talbot, photograms could resemble the original to a certain degree, in so far as cameraless photographs are able to highlight or uncover certain qualities of the object and, at the same time, reveal other structures only schematically. Photogenic drawings of botanical specimens, in particular, accentuate the nearly invisible structures of venation and trichome with great accuracy. Depending on their transparency, this method could also result in an image predominantly

4. William Henry Fox Talbot, 'Photogenic Drawing: To the Editor of the Literary Gazette', in: *The Literary Gazette and Journal of the Belles Lettres, Arts, Sciences, &c.*, No. 1150, 2 February 1839, 73–74.
5. Talbot 1839 (reference 4), 73.
6. William Henry Fox Talbot, 'Some Account of the Art of Photogenic Drawing, or, the Process by Which Natural Objects May be Made to Delineate Themselves without the Aid of the Artist's Pencil', reprint in: Beaumont Newhall (ed.), *Photography: Essays and Images,* New York: Museum of Modern Art 1980, 23–31.
7. Talbot 1980 (reference 6), 23.
8. Talbot 1980 (reference 6), 24.

Figure 2
'Bryonia Alba', Plate 260 from David Heinrich Hoppe and Johann Mayr, *Ectypa Plantarum Ratisbonensium, oder Abdrücke derjenigen Pflanzen, welche um Regensburg wild wachsen*, Erstes Hundert, Regensburg 1787.

defined by its outlines or nuances of shading between light and dark.

He mentions that his contact printing process would be particularly useful for naturalists travelling to distant countries as they would not need to draw the plants they discovered but could simply make a photogenic drawing of them.

Photogenic drawings and nature printing

To create cameraless photographs, the object to be photographed and the surface of the paper need to be in direct contact with each other, producing an image of the botanical specimen in light and shadow. The translucent parts of the object would result in a darker impression; more transparent parts would produce a lighter coloration. This method of placing a plant in direct contact with a surface to make an impression was a common technique in botany known as "nature printing". Mainly used in 18^{th}-century Germany, and to some extent also in Britain, printing from nature at the time meant covering a plant with black ink and pressing it onto a piece of paper, which subsequently left a black impression mostly defined by its outline (fig. 2). Delicate storage formats in botany such as herbaria, in which plant specimens were collected, could therefore be replaced and easily be exchanged. Compared to engravings or paintings made by an artist, nature printing was an inexpensive alternative for illustration in botany. The leading argument for this technique was that plants could be copied without any interference on the part of the scientist or artist to provide an unsophisticated conception of nature. In particular, the visual effect of an impression evokes a special kind of presence in the image totally different from other forms of reproduction. A mechanical method like nature printing could realize the ideal of the unmediated access to nature revealing an image which was considered true to nature. Complex structures like the venation and trichome of a plant were easily and precisely reproduced. In terms of time, this method coincides with the popularization of science. Not only scientists, naturalists and apothecaries ordered such books, amateurs and interested lay people were also among the subscribers.[9]

9. See Kerrin Klinger, 'Ectypa Plantarum und Dilettantismus um 1800. Zur Naturtreue botanischer Pflanzenselbstdrucke', in: Olaf Breidbach (ed.), *Natur im Kasten*, exhibition catalogue, Jena 2010, 80–96.

It is very likely that Talbot was aware of this printing technique as he and his family had a lifelong interest in botany.[10] As a schoolboy, he and a friend compiled an inventory entitled *Plants Indigenous to Harrow: Flora Harroviensis* in 1814–1815. In 1826, he made an expedition to the Ionian Islands and Corfu where he identified several new plants. Furthermore, he corresponded with leading botanists, discussing and classifying plants he had recently discovered and, in this way, steadily increased his knowledge of botany. Among his correspondents were William Jackson Hooker, Antonio Bertoloni and John Lindley. His election as a fellow of the Linnean Society in 1829 is an indication that he was one of the most notable botanists of the period. At Lacock Abbey, his home after 1827, Talbot arranged a botanical garden and collected specimens for his herbarium, later using them for his botanical photogenic drawings. In this garden, which was restored by the National Trust in 1999, he also added a conservatory for exotic and delicate plants. The seeds and bulbs for the garden were exchanged with professional botanists, collected during botanical trips or purchased from nurseries.[11] In a letter to John Herschel he emphasizes his interest as follows: "Botany is a science to which I am particularly attracted and have paid much attention during my travels through many parts of Europe."[12]

Figure 5
William Henry Fox Talbot, *Leaf*, photogenic drawing negative, c. 1840, 8,9 x 8,6 cm.
National Media Museum Bradford.

The photogram as botanical illustration

The photogram as an illustration technique in botany was a major objective for Talbot. Shortly after the announcement of paper photography, he tried to realize a botanical publication with photogenic drawings of plants in collaboration with leading botanists of his time. To promote his idea of a botanical œuvre with cameraless images, he corresponded with the Italian botanist Antonio Bertoloni sending him a total of thirty-six photogenic drawings.[13] Despite Talbot's efforts to perform a joint botany project, Bertoloni did not seem convinced as this undertaking was never fulfilled.

In March 1839, he also sent cameraless photographs to William Hooker, a well-known botanist of his time, suggesting they undertake a joint project on British or foreign plants. But Hooker expressed his doubts, mentioning that plants should be represented "either by outline or with the shadows of the flower (which of course express shape) distinctly marked." He continues: "Your beautiful Campanula hederacea was very pretty as to general

10. See Russel Roberts, 'The Order of Nature', in: Catherine Coleman (ed.), *Huellas de la Luz. El Arte y los Experimentos de William Henry Fox Talbot*, exhibition catalogue, Madrid 2001, 367–368; H. J. P. Arnold, *William Henry Fox Talbot. Pioneer of Photography and Man of Science*, London: Hutchinson 1977, 34–35, 254–266.
11. See Katie Fretwell, 'Fox Talbot's Botanic Garden', in: *Apollo*, vol. 159, no. 506, 2004, 25–28.
12. William Henry Fox Talbot to John Herschel, 9 March 1833, HS 17:269, Royal Society Archives, London. For the correspondence of Talbot see ‹http://foxtalbot.dmu.ac.uk› (27.01.2011)
13. See Graham Smith, 'Talbot and Botany. The Bertoloni Album', in: *History of Photography*, vol. 17, no. 1, 1993, 33-48; Malcolm Daniel, 'L'Album Bertoloni', in: Giuseppina Benassati and Andrea Emiliani (eds.), *Fotografia & Fotografi a Bologna, 1839-1900*, exhibition catalogue, Bologna 1992, 73–78. Bertoloni collected Talbot's photogenic drawings in an album entitled *Album di Disegni Fotogenici*, which is now held at the Metropolitan Museum in New York.

Figure 6
William Henry Fox Talbot, *Astrantia Major*, 13 November 1838, Photogenic Drawing Negative, 17,3 x 9,5 cm. National Media Museum Bradford.

Figure 7
'Astrantia Major', Plate 749, from Albert Gottfried Dietrich, *Flora Regni Borussici: Flora des Königreichs Preussen oder Abbildung und Beschreibung der in Preussen wiederwachsenden Pflanzen*, vol. 11, Berlin 1843.

effect – but it did not express the swelling of the flower, nor the calyx, nor the veins of the leaves distinctly."[14] In fact, a lot of cameraless pictures made by Talbot were able to visualize the venation of the leaves of a plant, which otherwise would not easily be recognized through direct or unmediated observation as seen in figure 5. Depending on the thickness of the plant, quite often only the outlines are represented in the photogenic drawings giving no distinct internal details of the object. Comparing one of Talbot's photogenic drawings of Astrantia Major, made in November 1838 at the same time as the pictures he sent to Hooker, and a botanical illustration of the same plant published in 1843 by the German botanist Albert Gottfried Dietrich in his *Flora Regni Borussici*, clarifies what a botanical illustration around 1840 needed to reveal (figs. 6 and 7).[15] Talbot's photogenic drawing depicts a single plant in light brown on a brownish background. Mainly delineated by its outline and marginal internal details, this depiction of an umbellifer would result in an ambiguous identification in botany. In contrast, the coloured lithograph represents not a single, but a typical plant and depicts all the essential, and therefore characteristic, parts necessary for identifying the species. In addition to the delineation of the roots, the inflorescence and the seeds in outline drawing, the plant itself is given in its natural colours. The major part of the picture is dominated by the sprout that, due to its height of about 30–100 cm, is cut into two parts: a lower segment with the beginning of the roots and an upper segment with flowers and seeds. While the photogram can only reproduce a single plant in 1:1, an illustration allows the artist to represent

14. Arnold 1977 (reference 10), 265.
15. Albert Gottfried Dietrich, *Flora Regni Borussici. Flora des Königreichs Preussen oder Abbildung und Beschreibung der in Preussen wildwachsenden Pflanzen*, vol. 11, Berlin: Oehmigke 1843.

Figure 9
The Mirror of Literature, Amusement and Instruction, cover of 20 April 1839, printed by J. Limbird.

specimens in reduced or augmented size and accentuate the characteristic parts of a typical plant. As monochromatic pictures, the only claim of being true to nature that photograms have, results from the constitutive element of the contact. Therefore, efforts to include photogenic drawings in botany rely to a great extent on models such as nature printing and the mechanical impression of a plant on paper, affirming its truth through contact.

When dealing with its formal appearance, it could also be argued that photography without a camera relies on ancestors like silhouettes, cut-outs and outline-drawings that had been popular since the mid-18^{th} century when discussions about the contour as "linear abstraction" arose.[16] Leaving aside linear perspective and spatial illusionism, both in artistic as well as in scientific illustration, a tendency towards stylization through a concentration on outline drawing was prominent.[17] This contour line made it possible to visualize those elements of the form which were considered "characteristic". In 18^{th}-century publications using nature-printing techniques, the black contour line of a single plant produced by this process sometimes seemed to be insufficient as quite a lot of illustrations were manipulated by overpainting in opaque colours and sometimes even flowers, fruits etc. were added.[18]

Photogenic drawings in journals

To promote and introduce their readers to Talbot's invention of photography, journals including the low-price weekly *The Mirror of Literature, Amusement and Instruction* published several articles explaining the formal and chemical characteristics of photogenic drawings (fig. 9). On 20 April 1839, this magazine printed the first reproduction of a photogenic drawing of three ferns with white parts illustrating the possibilities and impossibilities of this medium to visualize opacity, transparency and translucence. This *Fac-simile of a Photogenic Drawing* was made in woodcut after a photogram by Golding Bird, "a distinguished botanist", who followed Talbot's newly invented process.[19] Coloured in brownish-red tint to match that of the original, the title page caused great excitement and interest among its readers. In the subsequent issue, it was noted that:

16. Robert Rosenblum, *The International Style of 1800. A Study in Linear Abstraction*, reprint, New York: Garland 1976.
17. See Werner Busch, 'Umrißzeichnungen und Arabeske als Kunstprinzipien des 19. Jahrhunderts', in: Regine Timm (ed.), *Buchillustration im 19. Jahrhundert*, Wiesbaden: Harrassowitz 1988, 117–148; Claudia Blümle and Armin Schäfer, 'Organismus und Kunstwerk. Zur Einführung', in: Ibid (ed.), *Struktur, Figur, Kontur. Abstraktion in Kunst und Lebenswissenschaften*, Zürich: Diaphanes 2007, 9–25.
18. Peter Heilmann argues that Kniphof printed each plant six times, three times on each side. In doing so, the first dark copy and the last light one were coloured, whereas the second one was left in its original condition. See Peter Heilmann, 'Über den Naturselbstdruck und seine Anwendung', in: Silke Opitz (ed.), *Die Sache selbst,* exhibition catalogue, Weimar 2002, 100–109, 103.
19. Anonymous, 'A Treatise on Photogenic Drawing', in: *The Mirror of Literature, Amusement and Instruction*, 20 April 1839, 243–244, 243. This article is a partial reprint of: Golding Bird, 'Observations on the Application of Heliographic or Photogenic Drawing to Botanical Purposes; with an Account of an Economic Mode of Preparing the Paper', in: *The Magazine of Natural History*, vol. 3, New Series, April 1839, 188–192.

Figure 10
The Magazine of Science and School of Arts, cover of 27 April 1839, printed by G. Francis.

The fac-simile of the photographic drawing in our last number has produced a much greater sensation than we had anticipated; but still we are not surprised at this excitement, for the engraving gave a most accurate idea of the photogenic picture, which represents the fern with such extreme fidelity that not only its veins, but the imperfections, and accidental folding of the leaves of the specimen are copied, - the greater opacity on the folded parts being represented by the large white patches on our fac-simile.[20]

According to this remark, the photogenic drawings were not so much praised for the exact identification of the plant as for the precise representation of the ferns discernible by their minute details and imperfections. In the reprint of an article accompanying and explicating the cover illustration, Bird compares the French and the English photographic processes declaring his preference for the latter. Dr. Bird identifies the major application of the photogenic drawing process for botanical purposes, as the botanist might "procure beautiful outline drawings of many plants, with a degree of accuracy which, otherwise, he could not hope to obtain."[21] One could not only visualize "every scale, nay, every projecting hair," but also the venation and "the character and habit of the plant."[22] But not all plants seem to be appropriate for the photogenic drawing process: "Among those classes of plants which appear to be more fitted than others for representation by this process, may be ranked the ferns, grasses, and umbelliferous plants."[23]

In the ex-post preface accompanying volume thirty-three in 1839, the editor of *The Mirror* states a "present thirst for Botanical knowledge", which he recognizes most of all in "the instruction of the female sex." He continues by emphasizing the journal's reports on photogenic drawing calling it an "accomplishment" and "very pleasing and astonishing art."[24] This analogization of botany, female accomplishments and the simple and abstracting technique of the photogram gets more explicit in another magazine devoted to rational and scientific amusement, as well as to processes employed in the fine and ornamental arts.

On 27 April 1839, the front cover of "The Magazine of Science and School of Arts" presented three schematic woodcuts after photogenic drawings of a lace pattern and flowers as seen in figure 10.[25] Among the objects generating the best effect in cameraless photography, the accompanying report mentions "lace, especially black lace – printed and checked muslin – feathers – dried plants, particularly the ferns, the sea-weeds, and the light grasses ..."[26] After a description of photographs made with a camera obscura and those made without a camera, the article concludes:

20. Anonymous, 'The New Art – Photography', in: *The Mirror of Literature, Amusement and Instruction*, 27 April 1839, 262-263, 262.
21. Anonymous 1839 (reference 18), 243.
22. Anonymous 1839 (reference 18), 244.
23. Anonymous 1839 (reference 18), 244.
24. Editor, 'Preface', in: *The Mirror of Literature, Amusement and Instruction*, vol. 33, 1839, n.p.
25. To be more precise, the woodcuts were obtained by directly exposing the objects on wood made light sensitive. See G. Francis, 'Important Application of Photogenic Drawing', in: *The Magazine of Science and School of Arts*, 27 April 1839, 28.
26. Anonymous, 'Photogenic Drawing', in: *The Magazine of Science and School of Arts*, 27 April 1839, 26–28, 28.

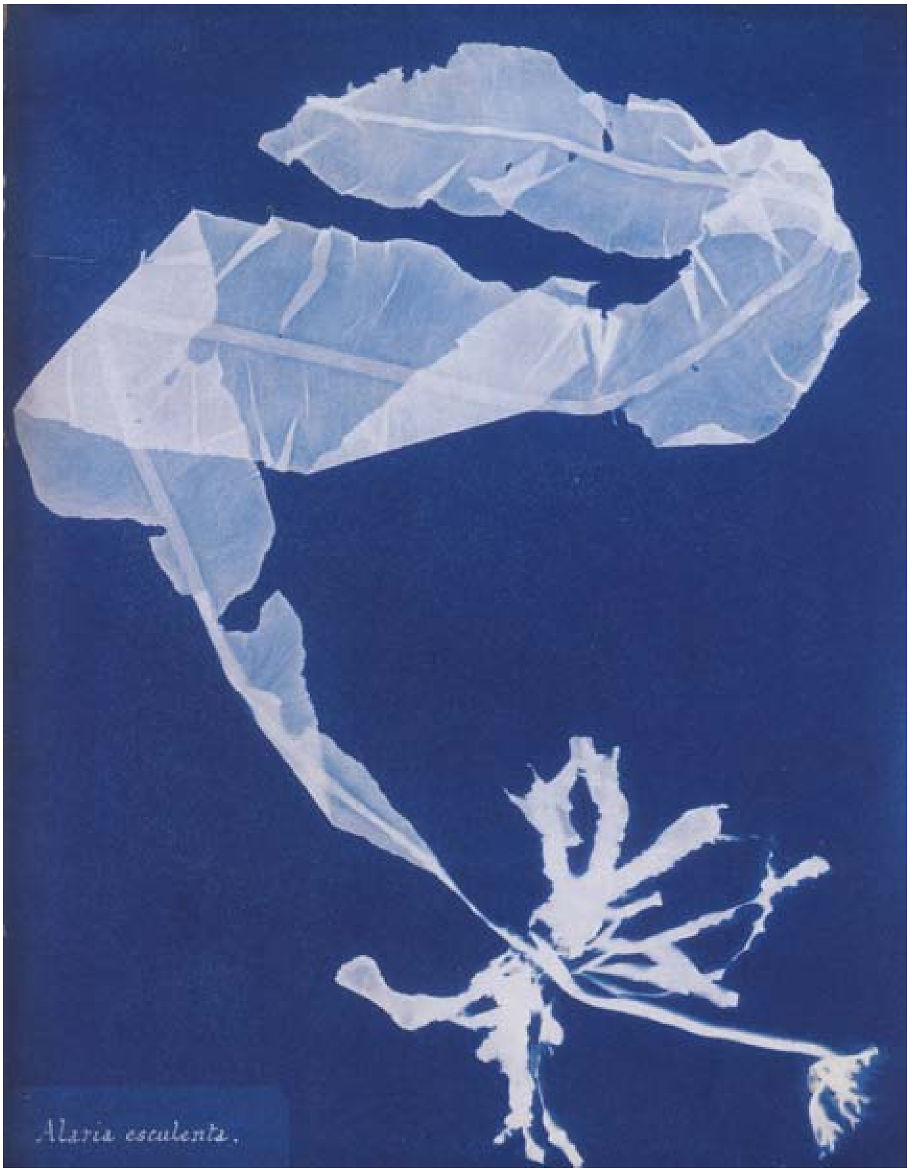


Figure 11
Anna Atkins, 'Alaria esculenta', from *Photographs of British Algae*, Part XII, 1849/1850. Kelvingrove Art Gallery and Museum.

We have hitherto considered this art as applicable only to the delineation of flat and trivial objects, and as rather conducive to amusement than utility; but as paper acts not only by direct but reflected light, it may be made subservient to much more important uses, by the assistance of such lenses and mirrors as reflect the images given to natural objects upon a screen or medium. The chief instruments of this character are the camera obscura and the solar microscope.[27]

According to this conclusion, the photogenic drawing process of flat objects was regarded as being inferior to camera photography and merely a pastime method to reproduce "trivial" objects.

Women and photogenic drawing

As, at the time, botany was regarded as a legitimate female pursuit, which permitted easier access to scientific circles, quite a lot of women were engaged in collecting plants, preparing herbaria and making botanical albums.[28] The illustration process of photogenic drawing seemed appropriate for women involved in natural history and allowed them scientific and artistic expression.

In the first reviews, instruction manuals and handbooks of photography, the process of photogenic drawing without a camera and its repeated description to impress objects such as lace patterns, leaves and plants was frequently put in the context of botany, feminine recreation or amusement and not regarded as being suitable for scientific purposes. To return to the beginning of my article, a possible answer to the question of why photograms from the 19th century have generally not found a place in the history of photography could lead us to the feminization of this medium and its consecutive classification as items not worth collecting. As a consequence of the research undertaken by Larry Schaaf and Carol Armstrong, Anna Atkins is now included among the renowned cameraless photographers working with John Herschel's cyanotype (blueprinting) process (fig. 11).[29] Nevertheless there are a number of less

27. Anonymous, 'Photogenic Drawing', in: *The Magazine of Science and School of Arts*, 4 May 1839, 34–35, 34.
28. Ann B. Shteir, *Cultivating Women, Cultivating Science. Flora's Daughters and Botany in England, 1760 to 1860*, Baltimore: Johns Hopkins University Press 1996.
29. Larry Schaaf, *Sun Gardens. Victorian Photograms by Anna Atkins*, New York: Aperture 1985; Carol Armstrong, *Scences in a Library. Reading the Photograph in the Book, 1843-1875*, Cambridge, Mass.: MIT Press 1998.

Figure 12
Cecilia Glaisher, *Bree's fern*, salted paper print mounted on cardboard, c. 1854-56, 59 x 38 cm, intended for a publication entitled „The British Ferns Represented in a Series of Photographs from Nature by Mrs. Glaisher from Specimens Selected by Mr. Newman".
Linnean Society.

Figure 13
Anonymous, *Botanical specimen (primrose)*, albumen silver print, 20,8 x 13,8 cm.
National Gallery of Art Washington.

well-known photographers such as Cecilia Glaisher (fig. 12) and anonymous photographers (fig. 13) who made cameraless photographs around 1850/60. Either as scientific illustrations in the case of Glaisher, who attempted to publish her photograms of ferns in collaboration with the publisher Edward Newman, or as a collectible album created by an anonymous British photographer with objects including whole plants, feathers, insects etc.[30] Figure 13 shows a page with an illustration of a plant from an album now held in the National Gallery of Art Washington; it consists of individual parts reassembled to form a single plant of the primrose type. This composite picture refers to its ancestors in scientific illustration but, at the same time, also demonstrates an aesthetic approach as it does not hide its constructedness.

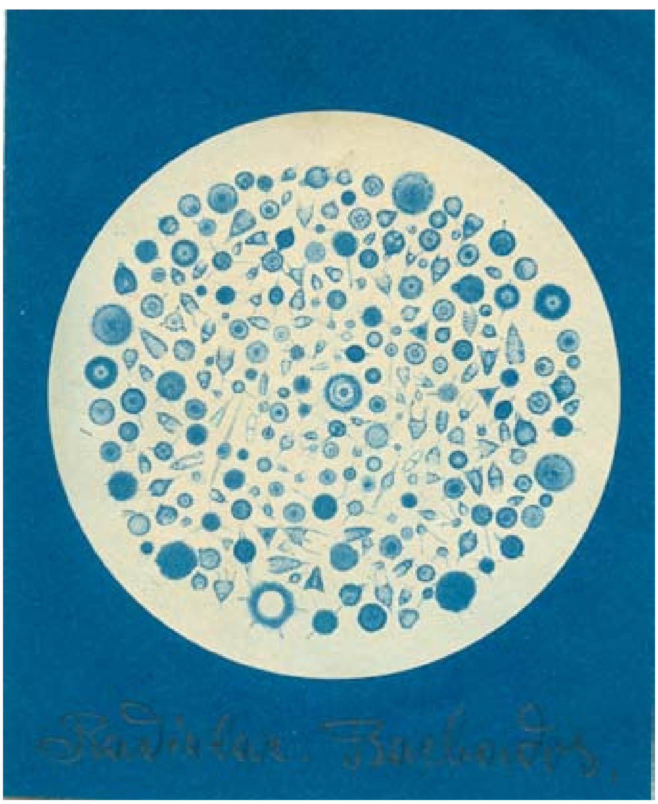
What I have tried to demonstrate is the intermingling of botany and cameraless photography resulting in the feminization of photography without a camera and its subsequent marginalization and invisibility in the history of photography. Although photogenic drawings could reveal invisible or hardly visible details of the plant structure such as venation or hair, drawings and engravings remained the general illustration method in botany. Emphasizing the automatic production method and the accurateness achieved through the direct contact between the object and photosensitive surface, photogenic drawings of botanical specimens need to be analyzed in closer connection with methods like nature printing where they will be seen to have a different genealogy than camera photography.

30. On Glaisher's photographs, see Caroline Marten, *Photographed from Nature by Mrs. Glaisher. The Fern Photographs by Cecilia Louisa Glaisher*, M.A. thesis, London Institute, 2002; The anonymous print comes from an album with 51 albumen silver print photograms. De-accessioned from the Gloucester Public Library in England, it was sold as lot 20 at Sotheby's New York, October 8, 1997 and acquired jointly by Simon Lowinsky and Dan Solomon, who then split it.

Cyanotype Micrographs: Scientific Interests or Visual Pleasure

Ulla Fischer-Westhauser

In autumn 2011, three cyanotypes showing kaleidoscope-like patterns presented by the Gallery Lumiere des Roses, Montreuil at Paris Photo[1] attracted immediate attention (figs. 1-3). Their captions read "Julius Wiesner (1838 – 1916), Radiolar Barbados (Autriche vers 1870)". All three images are inscribed on the front in pencil by an unknown hand: "Fächer-Rosette" [fan-shaped rosette], "Pleurosigma Rosette" and "Radiolar Barbados". The little items arranged in the images show radiolarians (fig. 1) and diatoms (figs. 2 and 3), single-celled organisms, research objects of microbiology. It is noteworthy that the photographs are cyanotypes, as this is the first evidence for the use of this printing technique in early microphotography.[2] The following research will look into micrographs as an aid in the sciences and the use of cyanotypes, as well as their aesthetic effects.



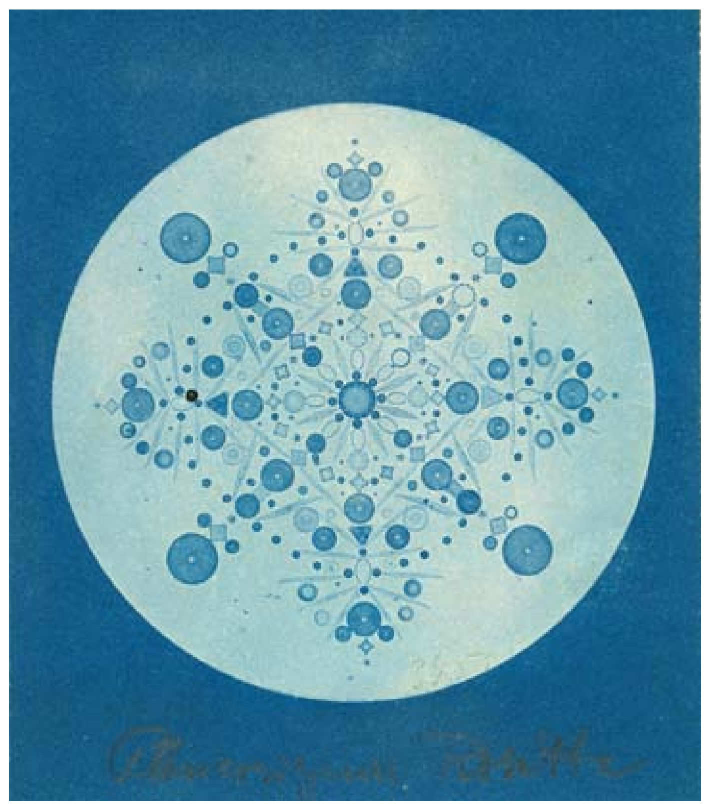


Figure 1
Unknown photographer (estate of Julius Wiesner), *Radiolar Barbados* (slide preparation attributed to Eduard Thum, Leipzig), 1880-1890, cyanotype, 9,8 x 7,9 cm.
© Gallery Lumiere des Roses, Montreuil.

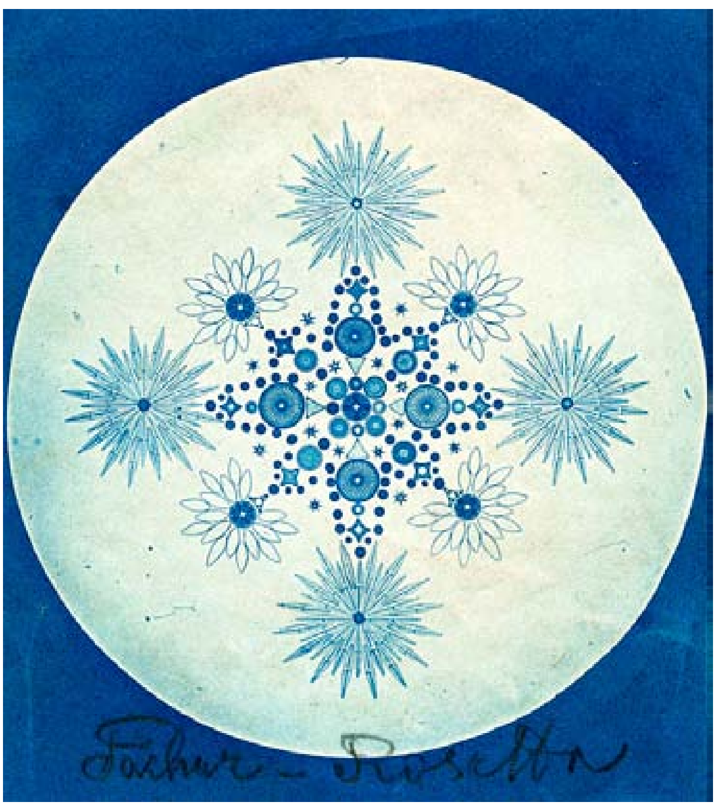
Figure 2
Unknown photographer (estate of Julius Wiesner), *Pleurosigma Rosette* (diatom slide preparation attributed to Eduard Thum, Leipzig), 1880-1890, cyanotype, 9,8 x 7,9 cm.
© Gallery Lumiere des Roses, Montrieul.

The three blue prints are to be seen in the context of the rapid technological and scientific developments of the microscope and the widespread public desire for illustrations of the invisible since the second half of the 19th century. After the publication of Darwin's *On the*

1. Paris Photo 9–13 November 2012. Now they are privately owned.
2. Correspondence with Olaf Breidbach, University of Jena (email 3 January 2012).

Origin of Species by Means of Natural Selection in 1859, protozoology became an area of study that attracted a great deal of attention and led to much research into the role these single-celled organisms might possibly play in determining a stage on the evolutionary path between the plant and animal worlds.[3] The German naturalist, biologist and philosopher Ernst Haeckel (1834–1919) promoted and popularized Darwin's work in German speaking countries. The great variety of shapes the mono-cellular beings offered inspired him to produce finely detailed drawings of idealized protists, alongside foraminifera and diatoms, and thus popularized them among contemporary researchers, both scientists and amateurs.[4] Haeckel copied photographs for his drawings[5] as proof of their quality, validity and precision. However, his albumen prints have no independent aesthetic quality.[6]

Figure 3
Unknown photographer (estate of Julius Wiesner), *Fächer Rosette* (diatom slide preparation attributed to Eduard Thum, Leipzig), 1880-1890, cyanotype, 9,8 x 7,9 cm.
© Gallery Lumiere des Roses, Montrieul.



Radiolarians are mono-cellular organisms or protozoans with a diameter of 0.1–0.2 mm that produce intricate mineral skeletons and are found as zooplankton throughout the ocean. Diatoms as well can hardly be seen with the naked eye; their sizes range from one thousandth to two millimetres. They are a major group of single-celled algae, belonging to the most common types of phytoplankton. Their cells are contained within a silicic acid cell wall and they look like tiny boxes with a lid. Put under a microscope, the glass-like skeleton becomes visible. Diatoms can be found, in salt, as well as in fresh, water all over the planet and appear in thousands of different shapes. Seen under the microscope, the tiny structures resembling little never-before-seen icons, were able to broaden the canon of forms in art and architecture.[7]

Microscopy and photography

Considering the rapid technological development of microphotography since c. 1880, it must not be disregarded that its history goes back to the beginnings of the 17th century. The invention of the microscope around 1600 opened up a completely new world to the viewer. A vast spectrum of

3. Ann Thomas, 'The search for pattern', in: ibid (ed.), *Beauty of Another Order: Photography in Science*, New Haven: Yale University Press 1997, 101.
4. Ernst Haeckel, *Kunstformen der Natur*, Leipzig: Bibliographisches Institut, 1898–1904.
5. Ernst Heackel, *Die Natur als Künstlerin*, Berlin 1913. As can be seen in figure 7 in Jennifer Tucker's article on page 65, the three-dimensionality of radiolarians only could be made visible from the 1930s onwards with the electron microscope.
6. Olaf Breidbach, 'Mikrofotografie im 19.Jahrhundert', in: Ludger Derenthal, Christiane Stahl (eds.), *Mikrofotografie. Schönheit jenseits des Sichtbaren*, exhibition catalogue, Berlin, Dresden, Ostfieldern Ruit: Hatje Cantz 2010, 21.
7. The number of different diatom species, that is their biodiversity, is estimated at 1 million, with only 20,000 species having been described. The ecological significance of these organisms is very high because diatoms produce about 25% of the world's oxygen. For this article, I refer to a short overview on diatoms by Helene Kranz, 'Diatomeen oder Kieselalgen', in: ibid, *Diatomeen im 19. Jahrhundert. Typenplatten und Salonpräparate von Johann Diedrich Möller*, Abhandlungen des Naturwissenschaftlichen Vereins, Hamburg Nr. 41/2009, Hamburg: Goecke & Evers 2009, 21–28. See also: Frank Eric Round, R.M. Crawford, D.G. Mann, *The Diatoms. Biology and Morphology of the Genera*, Cambridge: Cambridge University Press 2009.

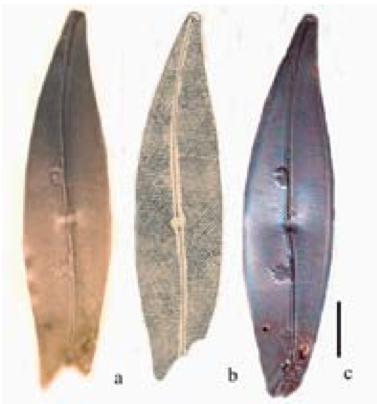


Figure 4
Three different illustrations of *Pleurosigma neogradense Pant*, Felsőesztergály (Horné Strháre, Slovakia). (a) micrograph by József Pantocsek (taken under Reichert microscope, equipped with 1/20 oil immersion objective and 2X ocular. (b.) drawing by J. Pantocsek 1886 XXI. fig. 315., (c.) micrograph by Krisztina Buczkó (scalebar: 10 µm). Unpublished manuscript by Krisztina Buczkó, *The Pantocsek Diatom and micrograph collection from 19th to 21st century*, Hungarian Natural History Museum, Department of Botany, Budapest.

previously invisible objects was brought to light with the help of a system of polished glass lenses.[8] The technique was not restricted to the sciences; from the 18th century onwards, viewing microscopic specimens in public shows became popular as a pastime pleasure. In Victorian homes the microscope even became a so-called conversation piece, items linked to science or scholarship.

From around 1840 onwards, the new technology of photography became important as a method of making things visible and, as a consequence, microphotography emerged as a "hybrid of a microscope and a camera"[9]. Photography gave the impression of showing an objective and reliable reality but, from the beginning, it oscillated between art and scientific argumentation, creative production of art and scientific production of evidence. The promise of reflecting reality led photography to becoming a privileged medium in the laboratory.[10] But this process took quite a long time. At the beginning, microphotography was praised as the method of choice for documenting scientific observations of microscopic material. The method of the "scholarly eye" and the "trained hand" for reproducing a microscopic object was discredited as antiquated. It was thought that measurability and quantifiability of microscopic objects was far more precise in photographic reproductions than in the original sample. It seemed that there were a lot more details to be traced in a photograph. And it was argued that photographs fulfilled the demand for absolute objectivity, free of the subjective judgement and prejudice of the scientist and the inadequacy of the draughtsman. This was especially evident during the early period of microphotography.[11]

Critics of these arguments among scientists pointed out the many deficiencies of microphotography. The quality of a picture made of an object under the lenses of a microscope depended on the quality of the technical instruments and the lenses, the light situation and the photographic equipment. Therefore, serious scientists continued to draw their objects until the late 19th century and used microphotography as an additional aid. They observed the development of instruments, which were shown at exhibitions such as the World Exposition in Paris in 1867, where microscopes were exhibited in a separate department.

The Austrian plant physiologist Julius Wiesner, who had published a book on microscopy,[12] functioned as an expert on microscopes for the final report on the exposition. He commented on a microphotograph of "'Pleurosigma Angulatum Nr. 7' by Lackerbauer in Nachet's exhibition [...]. It seems that precisely the microscope has little to expect from photography, which has already produced so many, varied advantages. The production of three-dimensional images cannot be carried out with the equipment of an assembled microscope, and the production of photographs of exact optical sections can also not be achieved. You always get something in between, neither fish nor fowl, which does not further science, and does not even earn their makers cheap fame for pleasing the layman."[13]

8. On the History of the microscope: Dieter Gerlach, *Die Geschichte der Mikroskopie*, Frankfurt/Main 2009.
9. A detailed analysis of the use of microphotography is provided by: Sebastian Scholz, "Bildwelten, welche im Kleinsten wohnen": Vom Medien-Werden der Mikrofotografie zwischen Sichtbarem und Unsichtbarem', in: Susanne Scholz, Julika Griem (eds.), *Medialisierungen des Unsichtbaren um 1900*, Munich: Wilhelm Fink Verlag 2010, 65.
10. Scholz 2010 (reference 9), 65.
11. Cf. Olaf Breidbach, 'Representation of Microcosm – The Claim for Objectivity in the 19th Century Scientific Microphotography', in: *Journal of the History of Biology*, vol. 35, no. 2, Dordrecht: Springer 2010, 221-250. See also Breidbach 2010 (reference 6), 11–24.
12. Julius Wiesner, *Einleitung in die technische Mikroskopie nebst mikroskopisch-technischen Untersuchungen*, Vienna 1867.
13. Julius Wiesner in: *Sonderdruck Ausstellungsbericht Weltausstellung Paris 1867*, 8. 'Mikroskopische Photographien', S 172 / III. (Translation by the author).

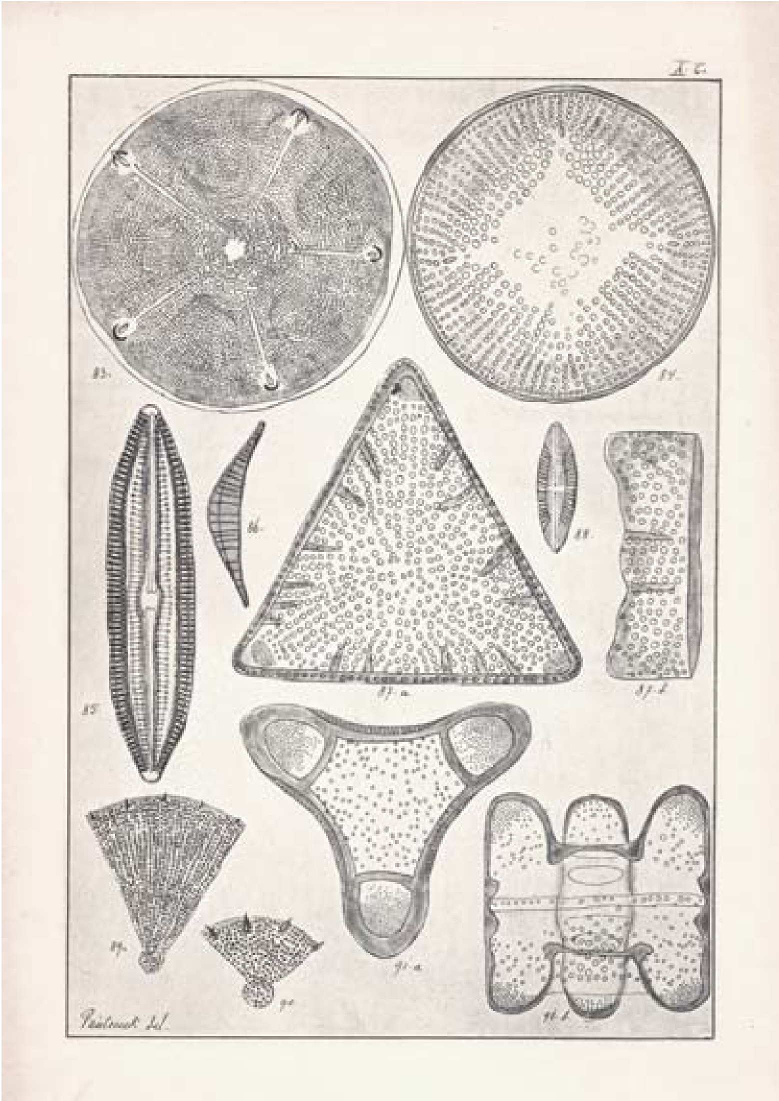


Figure 5
'Marine Bacillarien' plate X, from Josef Pantoczek, *Beiträge zur Kenntnis der fossilen Bacillarien Ungarns*, Nagy-Tapolcsány: Julius Platzko 1886. Austrian National Library, Picture Archives and Graphic Department, 261976-C (=121-84) Fid.

Ten years later, scientists were still discussing the advantages and disadvantages of microphotographs in science and why drawing was the preferred technique. They found that "the production of a really beautiful microphotograph is very difficult because, in a manner of speaking, the photomicroscope works too truthfully as it also depicts every little speck of dust, unnoticed or ignored by the viewer, exactly and also shows details, which the draughtsman often omits deliberately because they are not so important or unclear; that is why weaker enlargements produce clearer and sharper pictures."[14]

Researchers in the 19th century saw the advantage of drawing in its ability to describe the "ideal" or "characteristic" object of nature. In a scientific drawing, a single representative could be composed out of a number of objects, avoiding all accidental and unimportant components and concentrating on the typical of the object.[15] As long as photographs, and especially microphotographs, could not be printed in high quality in scientific publications, etchings and lithographs offered far more information to the reader. While scientists only gradually made use of photography as a method for scientific argumentation,[16] amateurs – both in microscopy and photography - worked steadily on the improvement of the instruments and showed their results in exhibitions and lectures.[17] A very clear representative of these arguments can be seen in figure four based on an image by the Hungarian physician and amateur diatomist József Pantocsek (1846-1916), who took more than three hundred diatom photomicrographs but gave up taking pictures for documentation in 1884 and returned to accurate drawings.[18]

Diatoms in science and leisure-time activities

It is evident that the three blue prints are from the estate of Julius Wiesner,[19] but it is also quite certain that the pictures were not taken by him although he made use of photographic

14. 'Ueber das Bildmikroskop', von Prof J[akob] Rumpf. Vortrag mit Demonstrationen, gehalten am 14. November 1877', in: *Verein zur Verbreitung naturwissenschaftlicher Kenntnisse*, vol. XVIII, 27 (Translation by the author).
15. Cf. Jutta Schickore,'Fixierung mikroskopischer Beobachtungen: Zeichnung, Dauerpräparat, Mikrofotografie', in: Peter Geimer (ed.), *Ordnungen der Sichtbarkeit*, Frankfurt/Main: Suhrkamp 2002, 289–310.
16. It became apparent with Robert Koch's photographic images of bacteria in 1880, cf.: Scholz 2010 (reference 9), 68f.
17. For example, microphotography was a recurring topic in the meetings of the Viennese Photographic Society and found increasing expression in articles, drawings and book reviews in the Society's publication *Photographische Correspondenz*.
18. Information by the Hungarian diatom researcher Krisztina Buczkó in her article 'The Pantocsek diatom and photomicrograph collection from 19th to 21st century', which will be published in March 2012 in *Nova Hedwigia Beihefte* (Krisztina Buczkó per email 16 February 2012).
19. Information from Philippe Jacquier, Gallery Lumere des Roses, Montreuil, France (email from 18 November 2011).

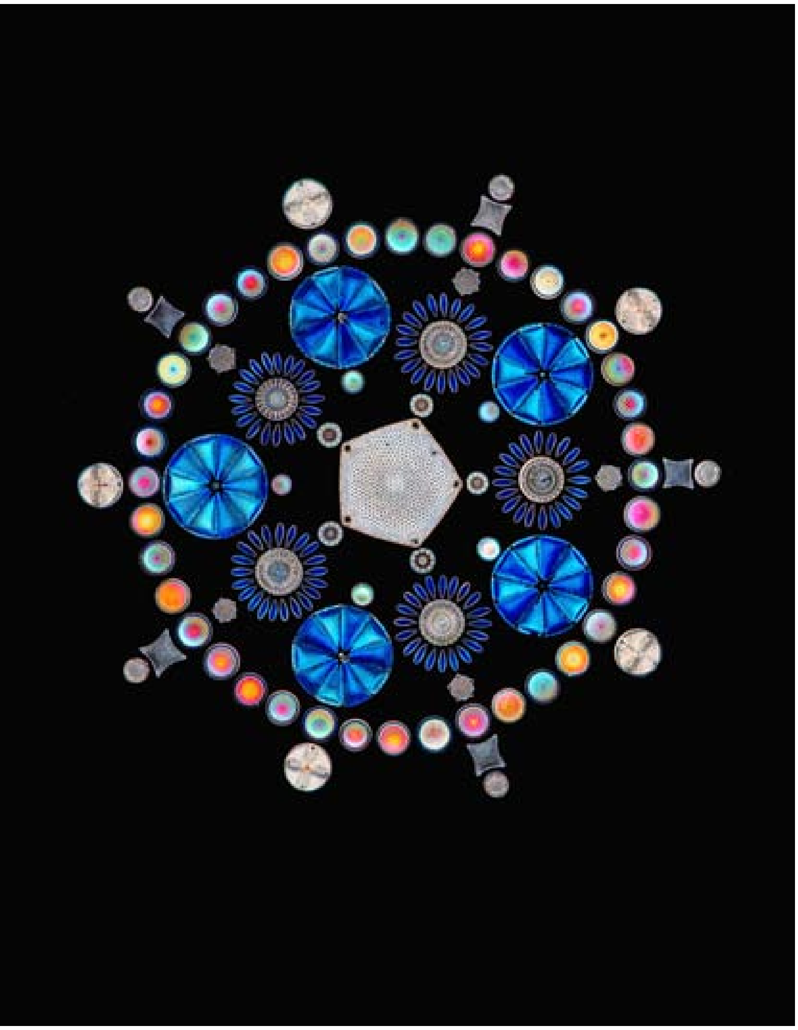
Figure 6
Preparation slides by Albert Grunow c. 1860.
Estate of Albert Grunow. Natural History Museum, Vienna.

processes in his work.[20] As already stated above, he preferred drawings as illustrative material. As a plant physiologist, he communicated with all the leading colleagues in the field, as well as amateur researchers, of his time. It is therefore quite possible that he was in close contact with renowned amateur diatom researchers such as the already mentioned Jószef Pantocsek (fig. 5) and Albert Grunow[21] (fig. 6), in addition to Ferdinand Pfeiffer von Wellheim.[22] Single-celled organisms were of great interest to researchers as their various shapes and glasslike shells made them very attractive under the light microscope. Most of the investigators were skilled amateurs; the topicality of the subject explained the fascination it held for microphotographers who were not practising scientists.[23] Wiesner travelled a lot; among other places, he even visited Java. It appears possible that he took samples of diatoms and radiolarians, as so many researchers of his time did, with him. It was a common praxis that the makers of microscopic samples did not collect themselves, but received their material from diverse sources. They were in personal contact with expedition crews, captains of commercial vessels, travelling scientists, salesmen and amateur researchers.[24]

As a social phenomenon of the 19th century, natural sciences found a broad audience among interested lay persons. In their search for new stimulation, members of the middle class in particular attended lectures and some of them started to practice science as amateurs whereby their research was integrated into scientific work. Their work was appreciated whenever great masses of data had to be collected; work that could only be managed by many observers.[25]

As already outlined, microscopes found their way into middle and upper class households. Special preparations called "exhibition mounts" were produced for this fashion and sold for entertainment. They had no scientific value but held a lot of surprises. They were miniature works of art, invisible to the naked eye but, under a microscope, these pictures made of arranged materials, such as humming bird feathers, butterfly scales, part of insects, radiolarians and shells of diatoms

20. The important plant physiologist Wiesner worked on microscopes and on photographic papers and chemicals. He experimented with photosensitive papers within his fundamental work on the light consumption of plants: ibid, *Der Lichtgenuß der Pflanzen: photometrische und physiologische Untersuchungen mit besonderer Rücksichtnahme auf Lebensweise, geographische Verbreitung und Kultur der Pflanzen* (Leipzig 1907). The photographic illustrations in the book were taken by his assistant Alois Jencic. I am grateful to Irene Lichtscheidl, head of the department Core Facility Cell Imaging and Ultrastructure Research, University Vienna for bringing this book to my attention.
21. Grunow's diatom collection, together with his drawings, is stored in the Museum for Natural History in Vienna.
22. His estate with correspondence and manuscripts, as well as diplomas and certificates, fill seven boxes in the Viennese City Archives. The amount of papers made it impossible to find correspondence relating to the topic discussed in an adequate time. A short overview of his biography and work is given by Hildegard Tezner, 'Universitätsprofessor Julius von Wiesner – Portrait einer Persönlichkeit des Wiener Kulturlebens', in: *Wiener Geschichtsblätter*, Society for the History of Vienna, 1962–1965, 434–441. 23. Ann Thomas (reference 3), 101.
24. Cf. Kranz 2009 (reference 7), 41f.
25. Cf. Jennifer Tucker, 'The Social Photographic Eye', in: Cory Keller (ed.), *Brought to Light: Photography and the Invisible 1840-1900*, exhibition catalogue San Francisco MOMA: Yale University Press 2008, 42.



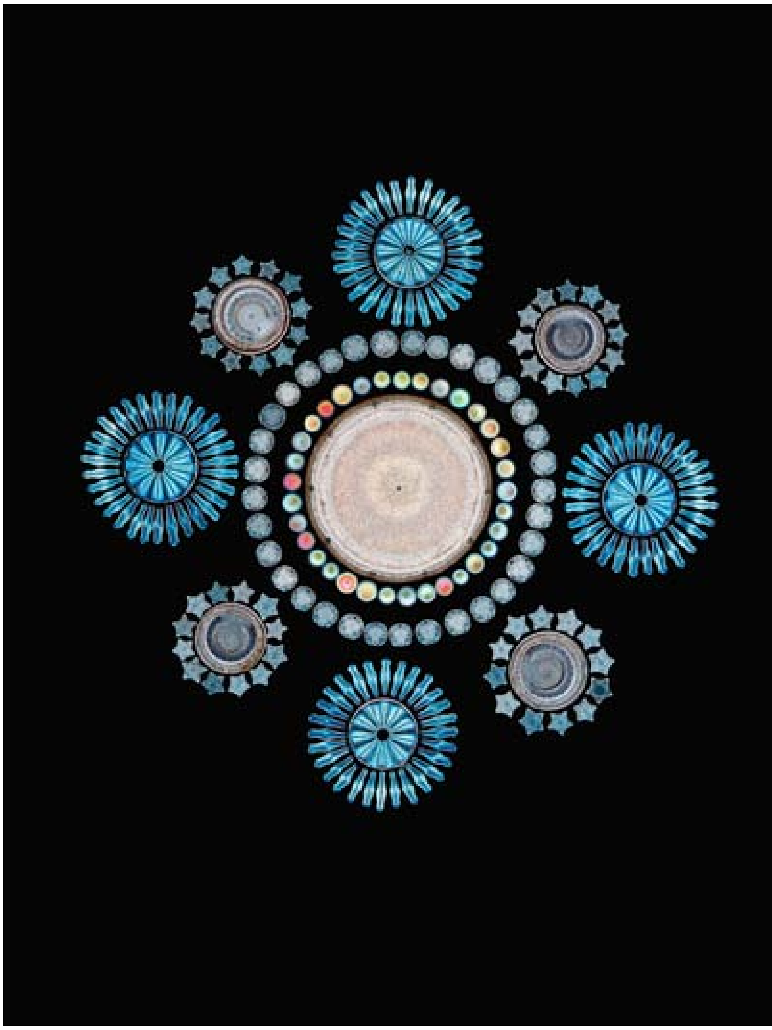


Figure 7 a-b
Johann Diedrich Möller: Exhibition Mounts, 1888-1892 (irregularly arranged diatom 'Typenplatten'), photographs by Matthias Burba 2009, microscop: Carl Zeiss Jena Amplival/Vertival, altered to CF 250 optics, lens: CF 250 6,3 Apochromat, CZJ, eyepiece PW 6,4 X, CZJ, dark field, with a touch of incident light. Slide preparations: Möller - Wedel GmbH Collection. Courtesy Matthias Burba. Comparing these images and the observation of the specimens under a microscope from 1892 there is no appreciable difference concerning colour fidelity and brilliance.

became visible.[26] Diatoms were especially attractive under the polarization light microscope. They appeared in the colours of the light spectrum caused by the refraction of light on their manifold surface structures (fig. 7). A special delight was provided by their arrangements in patterns and tiny pictures, not visible to the naked eye. It was a very exceptional technique, fashionable among various skilled amateur diatomists, but few persons were able to become a master in this delicate craft.[27] Due to the quality of the specimens in figures one to three with their ornamental patterns, the given date 1870 seems too early and it is more probable that the pictures were taken between 1880 and 1890 at the earliest.

From about the middle of the 19th century, developments in optical technology in the form of achromatic and apochromatic objectives made viewing more precise. In order to compare the optical quality of various microscopes, it was a common method to view the patterns of insect scales. When they had become too course and imprecise, the skeletons of diatoms came into use, because their surface showed a greater variety of very delicate structures. To prove the quality of lenses, only single diatoms were used, mostly 'Pleurosigma Angulatum' (fig. 4), which means that, as far as can be determined, the micrographs of the arranged diatoms (figs. 2–3) have no scientific function and are therefore images of "exhibition mounts". Only

26. View examples and information in: www.victorianmicroscopeslides.com/slideexb.htm (27 February 2012).
27. The art of arranging diatoms is described in Kranz 2010 (reference 7), 40-52 and 67. See also: Brian Bracegirdle, *Microscopical Mounts and Mounters*, London: Queckett Microscopical Club, 1998. Besides a microscope, special chemicals and preparation glasses, it requires a very steady hand and a great deal of patience, and a special manipulation instrument such as a sharpened horsehair on a special handle.

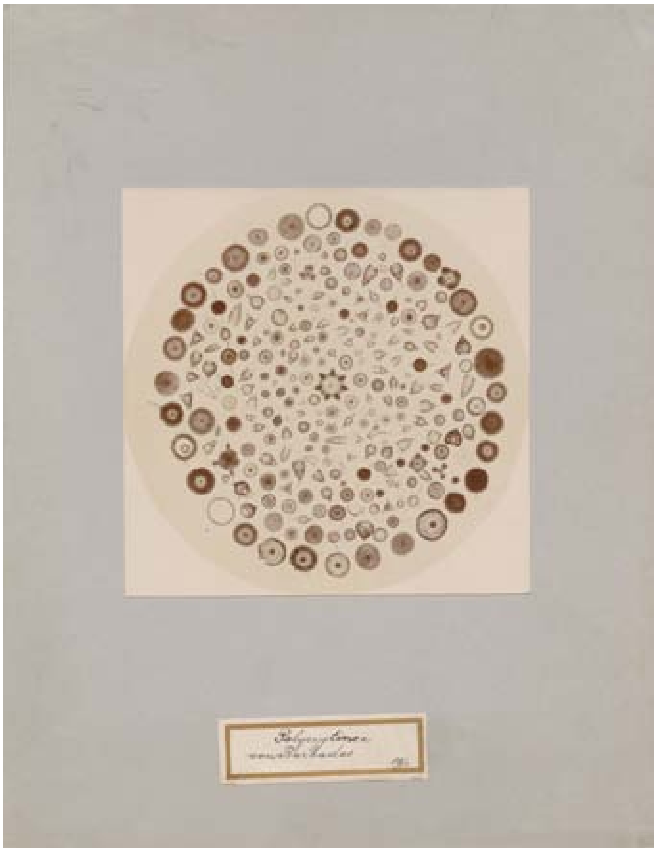


Figure 8
Ferdinand Pfeiffer von Wellheim, *Polycysteninen von Barbados 19/1*, c. 1895, albumen print, 10,8 x 10,8 cm. Museum of Natural History, Vienna.

the micrograph of the circular specimen of the radiolarians (fig. 1) seems to be a scientific specimen, although it also shows a manipulated object. At first sight, the radiolarians in the sample seem to have a natural order, but they are arranged in a circular pattern. The reason for this is obvious; a natural sample contains too many objects. Regarding the focus of the 19th century microscope, only objects ordered on one level could be viewed properly. The arranged specimens were called "Typenplatten" (type plates, specimen slides).[28] Lavish "Typenplatten" only came into fashion in the late 19th century, when the production techniques had become fully developed. The most exquisite of them were produced and sold by Johann Diedrich Möller, a microscope manufacturer in Wedel near Hamburg. He made specimens for private clients and scientists in Europe and overseas.[29]

Möller's specimens and exhibition mounts show characteristic patterns that cannot be traced in figures one to three. The diatom "Typenplatte" and exhibition mounts which the images are taken from were more likely produced by another important manufacturer, Eduard Thum in Leipzig. Images of diatom plates photographed from Thum's specimen by the Austrian amateur microphotographer Ferdinand Pfeiffer von Wellheim taken around 1895 greatly resemble figure one (fig. 8).[30] Among other things, Wellheim took microphotographs of diatoms and mounted them in albums together with descriptions. Most of them are scientific images with only a single or a few objects, but several are arranged and their captions identify them as made by Eduard Thum.

Aesthetics in science

Compared with Wellheim's precise albumen prints, the blue prints and the modern colourful image of the diatom sample, the cyanotypes seem to be outstanding, not only because of their rareness. Wellheim's albumen print is sharp and very detailed creating a strong contrast to the three blue prints. As their illumination is not quite homogenous, it seems evident that no carbon filament lamp was used when taking them. Compared to the slight magnification, a solar microscope connected to a projection screen (where the camera obscura lens is replaced by the front mount of the microscope) was enough to achieve the adequate quality in strong sunlight.[31]

Although the cyanotype was the third photographic process that was discovered after the daguerreotype and the collotype process, the three blue prints are exceptional. Sir John Herschel (1792–1871) was the first to describe the method in a memorandum *On the Action*

28. This term was coined by Albert Grunow, cf. Kranz 2009 (reference 7), 15.
29. On Möller see: Mathias Burba, 'Johann Diedrich Möller (1844–1907) – Über die Kunst Diatomeen zu legen', in: *Mikrokosmos* 96 (1), 2007, 7–17 and Kranz 2010 (reference 7).
30. (Vienna 1859–1935) lawyer and amateur microscopist and photographer. Parts of his estate (albums and stereo glass plates) are stored in the archives of the Museum for Natural History Vienna and in the archives of Vienna University. The collections of the Graphische Lehr- und Versuchsanstalt Vienna (on permanent loan to the Albertina) hold a similar micrograph by Hans Hauswaldt, taken in 1900, published in: Corey Keller (ed.) 2008 (reference 25), plate 32.
31. Olaf Breidbach (email from 3 January 2012).

of the Rays of the Solar Spectrum on Vegetable Colours, and on Some New Photographic Processes at the Royal Society in 1842: Certain iron salts leave behind a blue deposit when they come into contact with water after being exposed to light. The contact prints are developed by sunlight. As it was an easy method of taking photographs, it soon became popular, especially among architects and engineers. The cyanotype had an estimable technical and artistic advantage over other reproductive media, because it could be developed in dim light and was cheaper than silver based methods.[32]

The cyanotype process was not a medium for artists, but a tool to produce quick and cheap copies and prints. It is plausible that scientists and/or microphotographers used them for controlling their results, quick exchanges of information, or as a basis for discussion and did not pay any special attention to them having a later value. This argument can be supported by the fact that the three cyanotypes are directly inscribed on the front without showing any regard for the general impression of the image.

For George Didi Huberman, direct impressions or imprints of objects are an extreme form of representation that subverts desirable optical distance, convention, the evidence of our eye and, ultimately, legibility.[33] The reproduction reawakens and reactivates initial sensory perceptions of the object, but it is, and will always remain, the image of something. These thoughts can be applied profitably to the cyanotype and the luminous blue inherent in the simple process by which it is created. The immediacy of the reproduction generated by exposure to the sun or other form of light in a cyanotype is exceptional, even in the field of photography, as the original motif is deprived of its colour and "bathed in a mysterious blue, contrasts being produced solely by variations in the tonal value."[34]

Contemporary scientists showed a pronounced consciousness for the aesthetic qualities of their research objects; a phenomenon that seems to run through most of the research areas. For example, the famous x-ray images by Josef Maria Eder and Eduard Valenta in their work *Versuche über Photographie mittelst der Röntgen'schen Strahlen* (1896) have no scientific, but great aesthetic, value. This was similar with many scientists who, consciously or not, did not manage to evade moments of designing and staging.[35]

32. Around 1875, the first mass-produced cyanotype paper came on the market: "Ferro-Prussiat" by Marion & Co, London. The paper was used for copies of maps and drawings. A history on the cyanotype process is given by Rainer Kassel, *Faszination des Blauen, die Cyanotypie*, dissertation, FH Bielefeld 1991/92: www.dmuenzberg.de/cykassl.htm (16 February 2012). Anna Atkins was the first to use cyanotypes for her artistic work on British plants: She produced blue prints of dried botanic specimens from her collection, images without a camera: Anna Atkins, *Photographs of British Algae. Cyanotype Impressions*, reprint in: *Sun gardens. Victorian Photograms by Anna Atkins*, text by Larry Schaaf, New York: Aperture Books, 1985.

33. Georges Didi Huberman, *Ähnlichkeit und Berührung: Archäologie, Anachronismus und Modernität des Abdrucks*, Cologne 1999, 1.

34. George Poulet, *Aurora Argentina, von Santa Fé nach Tucumán. Cyanotypien 1890–1894*, Munich: Galerie Daniel Blau 2005, 22.

35. Cf. Peter Geimer, 'Sichtbar / "Unsichtbar": Szenen einer Zweiteilung', in: Scholz 2010 (reference 8), 30. Even today scientists are not able to avoid "the aesthetics of the invisible", as described in Heidemarie Halbritter's article on page 44.

Aesthetics of the Invisible
Pollen Grains as Art Forms of Nature

Heidemarie Halbritter
Michael Hesse

Human beings are optically attracted by artistic paintings, with or without colours, irrespective of whether the painted objects or details are placed symmetrically or asymmetrically. The artistic objects may represent anything; natural reality or pure fantasy. Man gives special notice to objects that apply to aesthetics such as Mandelbrot Sets (fractals). The Mandelbrot Set is a particular mathematical set of points whose boundary generates a distinctive and easily recognisable two-dimensional fractal shape.[1] Natural forms very often resemble art forms as Ernst Haeckel demonstrated more than 100 years ago in *Kunstformen der Natur* (*Art Forms of Nature*, 1898–1904).[2] His many famous and excellent drawings and plates included depictions of diatoms, coral algae, calcispongiae, or discomedusae.

Haeckel did not mention pollen; at that time pollen photomicrographs were still lacking and even drawings of pollen were very rare although pollen grains actually represent genuine art forms of nature for human beings. If viewed at high magnifications, pollen has an aesthetic appearance and it is not important if pollen pictures are only black-and-white or artificially coloured. (Fig. 1)

Pollen is a frequently overlooked part of living nature. The tiny pollen grains are produced by anthers (the male parts of flowers) and are the point of origin and carrier for the male gametes (sperm cells). What makes pollen grains so unique? Pollen grains represent an extra generation in seed plants, the highly reduced male gametophyte (the enclosing sporoderm and the cellular content, consisting of two or three cells, and the pollen tube). Therefore, pollen grains are not simply parts of a plant, such as leaves or seeds, but are the haploid counterpart of the much larger diploid plant body "as we see it in nature". During transport, pollen grains are completely separated from the parent plant and perfectly adapted for their role – the transfer of male genetic material – and are able to resist hostile environmental stress on their way to the female flower parts. These tiny (male haploid) organisms usually have the following variable parameters: the pollen shape and size, the number, type and position of apertures, and the pollen wall with its extremely diverse structure and sculpture. The characters of these parameters in comparative pollen (and spore) morphology and plant systematics are at least as important as any other morphological character of the diploid generation.[3]

Pollen grains are usually highly symmetric, aesthetically attractive, and often have a faultless appearance. Because pollen usually show a specific combination of characters in ornamentation, size and shape, pollen grains are frequently called "fingerprints of their parent plants" or, in reversal, the specific combination of pollen characters may often be used as a compass needle pointing towards its parent plant. (Fig. 2)

Pollen represents an important part of the so-called plant circle. The usually conspicuous, often large (diploid), plant "as we see it in nature" is by far the greater part

1. Benoit B. Mandelbrot; *Fractals and Chaos: The Mandelbrot Set and Beyond*, New York: Springer, 2004. See also: Internet links: http://library.thinkquest.org/3493/frames/fractal.html, or http://www.miqel.com/fractals_math_patterns/visual-math-natural-fractals.htmlr. (01/2012).

2. Ernst Haeckel, *Kunstformen der Natur*, Leipzig: Bibliographisches Institut 1898-1904.

3. Michael Hesse et al., *Pollen Terminology, an illustrated handbook.* Vienna: Springer, 2009.

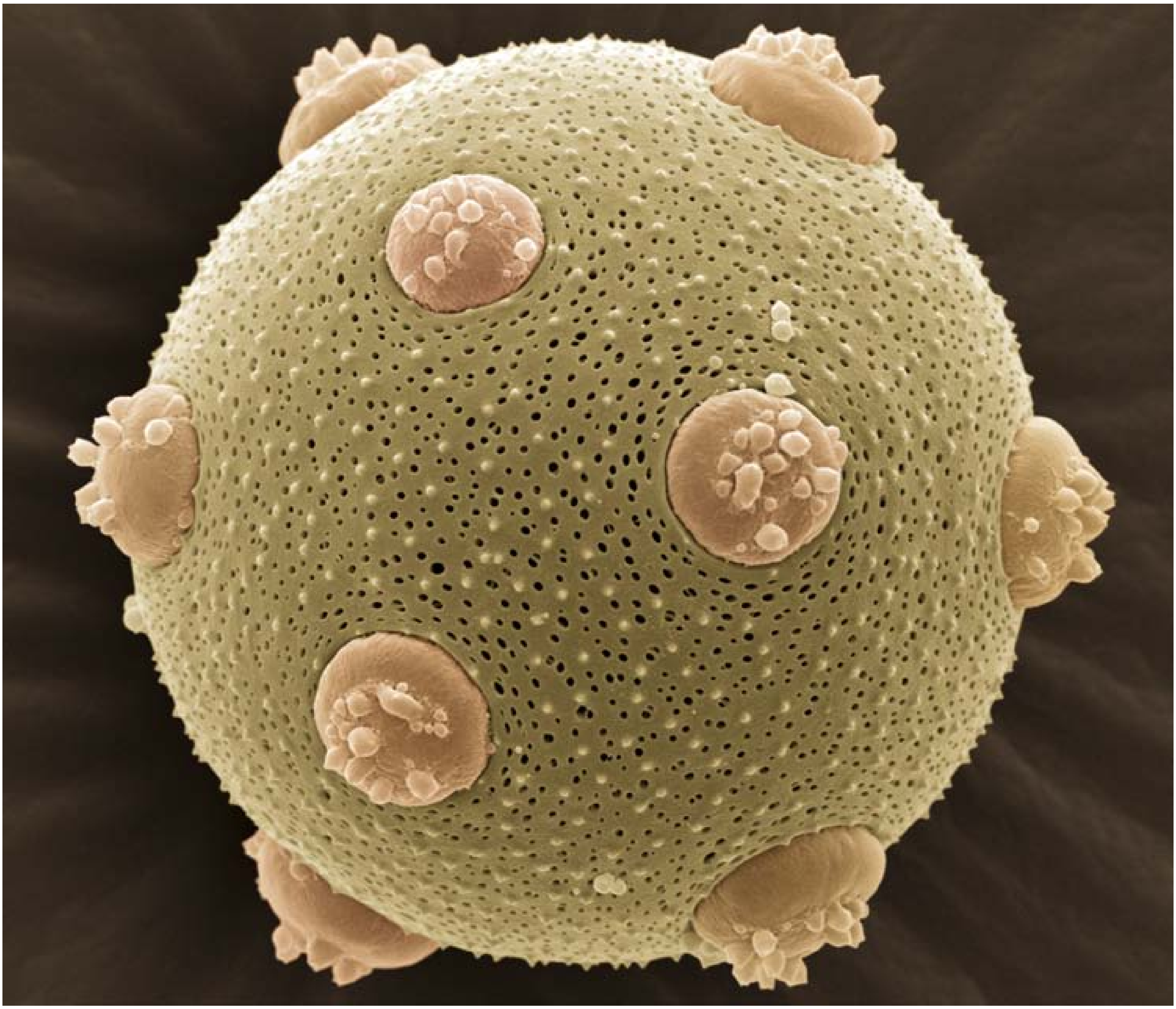


Figure 1
Heidemarie Halbritter, Pollen grain of *Cerastium uniflorum* (Caryophyllaceae), artificially coloured, Scanning Electron Microscope, c. 3500 times. University of Vienna: Department of Structural and Functional Botany.
The grains are spherical with a diameter of about 40µm. There are always 12 apertures (potential germination sites for the pollen tube) highly symmetrically arranged.

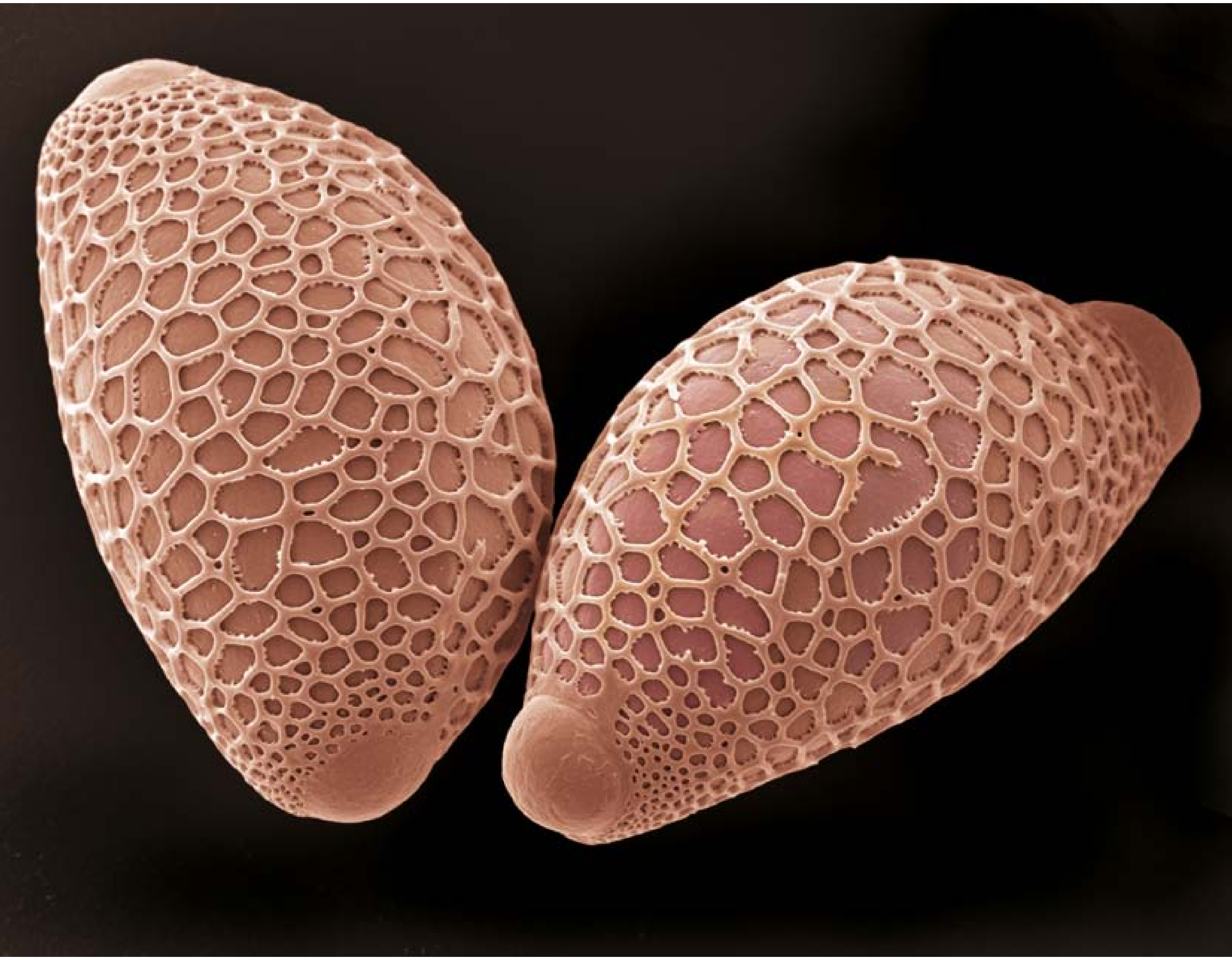


Figure 2
Heidemarie Halbritter, Two pollen grains of *Quesnelia liboniana* (Bromeliaceae, artificially coloured), Scanning Electron Microscope, c. 1300 times. University of Vienna: Department of Structural and Functional Botany.
The grains are quite big, about 70µm in diameter (long axis). There are 2 smooth apertures, the outer layer of the pollen wall forms a netlike pattern (reticulum).

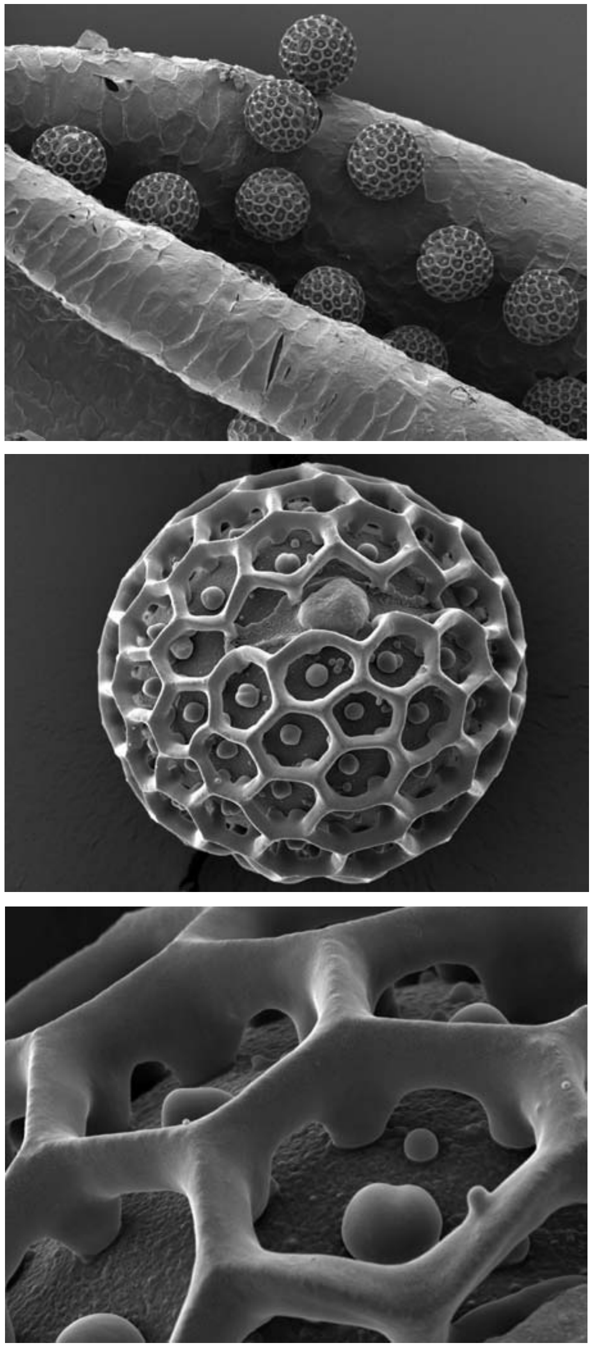


Figure 3
Heidemarie Halbritter, *Eranthemum wattii* (Acanthaceae), Scanning Electron Microscope, c. 230 times (a), c. 1300 times (b) and c. 5200 times (c).
University of Vienna: Department of Structural and Functional Botany.
Figure 3a. Part of open anther with pollen grains.
Figure 3b. The spherical pollen grains have 3 apertures and are about 65 µm in diameter.
Figure 3c. Detail of the pollen wall consisting of a net of regular meshes on small columns.

of this life cycle. The hidden side of this plant circle is much shorter (representing the formation of gametes and their fusion to a new diploid plant). The haploid pollen grains become transferred from the anthers to the female parts of the flower either by wind or by insects, birds or mammals, and sometimes even by water. In all cases, the pollen is brought to the stigma of female flowers where a pollen tube holding the two sperm cells, the male gametes, is formed. Pollen grains usually show one or more apertures. The aperture may form a pollen tube including the two sperm cells. Sexual reproduction is performed by the haploid gametes fusing with the female gametes, the eggs in the embryo sacs: The fertilized egg nucleus produces a new diploid plant, and the life circle is now closed.

Up to the middle of the last century, and even later, the light microscope was the one and only piece of technical equipment capable of making pollen grains visible and documenting the pollen features. As early as 1682, Nehemiah Grew (1641-1712) described the constancy of pollen form within the same species in his famous work *The Anatomy of Plants*,[4] in other words, he founded pollen morphology and was the first to recognize that all plants have "their" pollen. In 1675, Marcello Malpighi was the first to describe pollen grains as having germination furrows.[5] Only a few years later in 1694, Rudolf Jakob Camerarius detected the functional role of pollen for the pollination of flowers.[6] In the 18th century, the study of pollen stagnated to a great extent. The 19th century saw a great improvement in light microscopes, helping to make it possible to create more or less exact drawings of pollen grains and their details. The first micro-photos of pollen grains were taken in 1905.[7] Gunnar Erdtman, the leading palynologist of the 20th century, published the first micrograph-documented textbooks in the 1950s.[8] He

4. Nehemiah Grew, *The Anatomy of Plants*, London: W. Rawlins 1682.
5. Marcello Malpighi, *Anatomia Plantarum*, two volumes, London: Royal Society, 1675 and 1679.
6. R.J. Camerarius, *De sexu plantarum epistola*, Tübingen, Germany 1694, in a letter to Valentini, a botanist in Gießen, Germany (cited by Martin Möbius, *Geschichte der Botanik*, Stuttgart: G. Fischer Verlag, 2nd ed., 1968, 341).
7. Prof. Herbert Straka, Kiehl (personal communication 1984 during a palynological meeting in Vienna at Vienna University).
8. Gunnar Erdtman, *Pollen Morphology and Plant Taxonomy. Angiosperms*, Stockholm: Almqvist and Wiksell, 1952. Erdtman, *Pollen and Spore Morphology. Plant Taxonomy. Gymnospermae, Pteridophyta, Bryophyta*, Stockholm: Almqvist and Wiksell 1957.

founded the first journal exclusively devoted to pollen and spores (*Grana Palynologica*, which still exists as *GRANA*). This was a breakthrough; other journals followed in the second half of the 20th century and all publications included light or electron micrographs.

Pollen atlases focusing on micrographs, without exhaustive descriptions,[9] are not rare but only deal with small groups of plants. Pollen textbooks now usually contain many micrographs together with comprehensive descriptions.[10] It should be noted that light microscope pictures, up to now the "workhorse" of palynologists and therefore frequently used, are no longer state-of-the-art: Scanning Electron Microscope (SEM) pictures contain much more information. (Fig. 3 a, b, c)

There are constraints or drawbacks caused by the physics of light microscopy for pollen researchers. Despite many fruitful efforts in photographing and documentation, detailed features of pollen grains are invisible to the naked eye and hardly visible with the light microscope. Pollen diameters mostly range from c. 20 µm to c. 50 µm; however, smaller or even much larger pollen grains are not infrequent. The sub-microscopic dimensions in pollen features are given in micrometres (one thousand micrometres make a millimetre). Pollen researchers were limited by many pollen features in sub-light-microscopic dimensions, i.e. below the resolution of the light microscope (c. 0.2 µm). Such details are only visible with the electron microscope, which enlarges details of sub-microscopic dimensions to a magnification of – say – 100,000 times or even more, up to a (theoretical) limit of c. 0.2 nm.

As already stated, the state-of the-art instrument in palynology[11] is the Scanning Electron Microscope. Put simply, when using such instruments, the pollen surface is scanned by the focused electron beam and the reflected electronic signal is collected and displayed on a screen. The signal can be recorded, stored, and then printed.

The Scanning Electron Microscope was exclusively used for our pollen micrographs in this article. The SEM has a large depth of field, which allows more of a specimen to be in focus at one time. The SEM also has much higher resolution so that closely spaced specimens can be magnified at much higher levels. In most applications, data are collected over a selected area of the surface of the sample and a two-dimensional image that displays the spatial variations in these properties is generated. Additional technical details can be found in the references.[12]

As colours are characteristics of the visible light, all pictures obtained from electron microscopes are of course black-and-white only. But pictures obtained from the SEM are frequently coloured to increase their attractiveness. In these cases, the colours are chosen arbitrarily following purely aesthetic aspects. Colouring such pictures may also be a kind of

9. Willem Punt (ed.), *The Northwest European Pollen Flora,* vol. 1, Amsterdam: Elsevier 1976, 145 pp. Vol. 2, 1980, 265 pp. Vol. 3, 1981, 138 pp. Vol. 4, 1984, 369 pp. Vol. 5, 1988, 154 pp. Vol. 6, 1991, 275 pp.
10. Peter Dale Moore, J.A. Webb, *An Illustrated Guide to Pollen Analysis*, London: Hodder and Stoughton, 1978. Peter Dale Moore, J.A. Webb, M. Collinson, *Pollen Analysis*, London: Blackwell 1991.
11. Palynology is the science of palynomorphs, a general term for all entities found in palynological samples. A dominating object of the palynomorph spectrum is the pollen grain; see "What is Pollen" within the text above.
12. Patrick Echlin, *Handbook of Sample Preparation for Scanning Electron Microscopy and X-Ray Microanalysis*, New York: Springer 2009. See also following Internet links: http://www.purdue.edu/rem/rs/sem.htm, http://web.utk.edu/~prack/MSE%20300/SEM.pdf http://serc.carleton.edu/research_education/geochemsheets/techniques/SEM.html (01/2012).

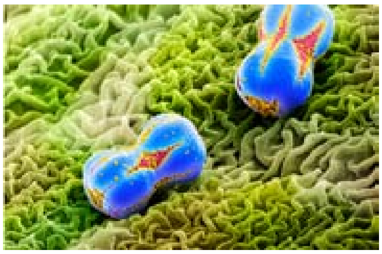


Figure 5
Martin Oeggerli,
Forgetmenot pollen on petal (crop),
artificially coloured,
Scanning Electron Microscope,
c. 7300 times. Micronaut.

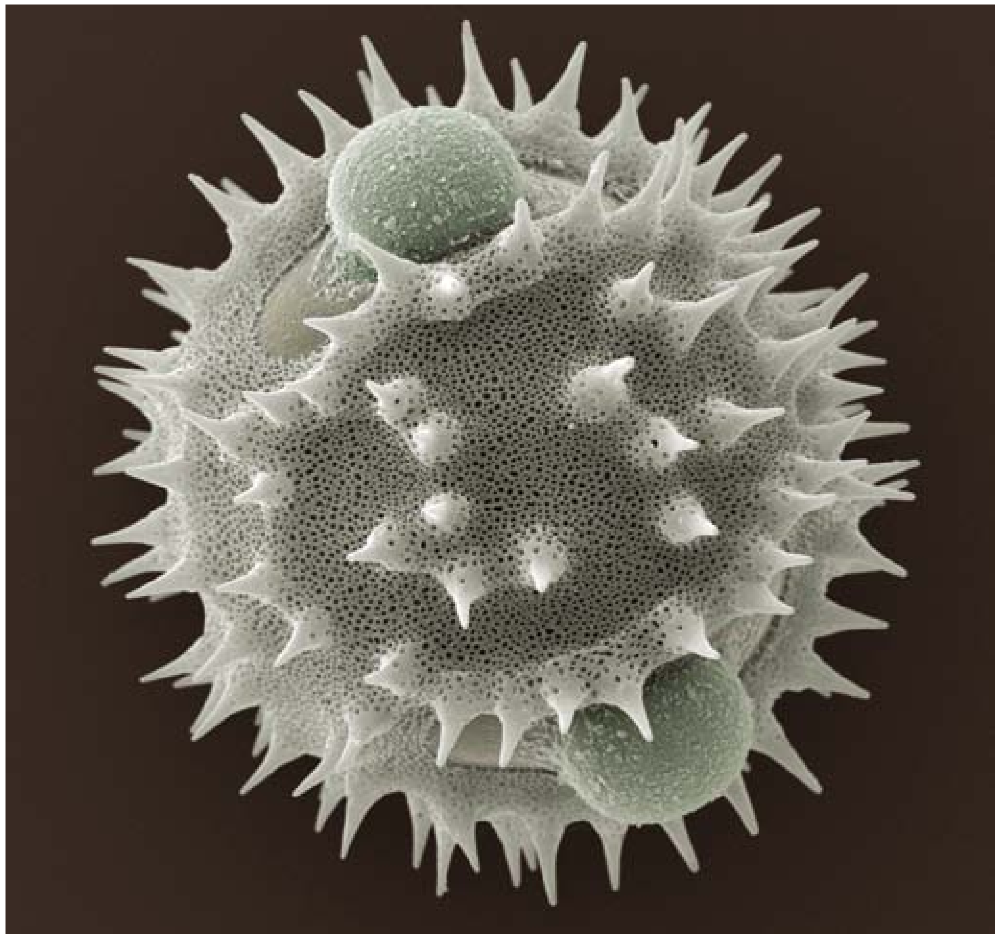
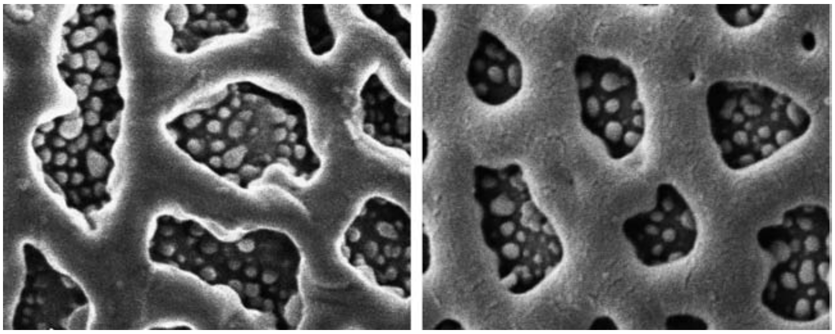


Figure 4
Heidemarie Halbritter, Pollen grain of Austrian viper's grass (*Scorzonera austriaca*, *Asteraceae*, artificially coloured), Scanning Electron Microscope, c. 1500 times. University of Vienna: Department of Structural and Functional Botany. Each grain has 3 apertures and a diameter of about 50 µm. The highly attractive pollen wall is ornamented with spines partially situated on ridges, and small perforations.

artwork, an artistic challenge for scientists as well as for artists. One of the champions of this genre is the Swiss scientist Martin Oeggerli who has already received several international awards for his coloured SEM pictures.[13] (Fig. 4, 5)

Pollen grains, these tiny and seemingly fragile objects, appear to be stable for ever under suitable circumstances (fossilization). In fact, the coat (the pollen wall) of these objects is formed by the most stable biopolymer known in nature, sporopollenin. Sporopollenin, as a stable cell wall polymer, is found in pollen grains as well as in fern and moss spores. It was "invented" hundreds of millions of years ago, most probably to give support and stability to Silurian or Devonian plant organisms colonizing the dry land (c. 400 million years ago). Sporopollenin is stable for hundreds of million years, has existed since the springtime of

13. Micronaut, the art of microscopy: http://www.micronaut.ch/. (01/2012).



live on the earth's surface, and is therefore found in fossils from that time. (Fig. 6)
Up to now, we have knowledge of approximately 250,000 angiosperm species. All of these species produce "their" pollen, and consequently c. 250,000 different, often highly diverse, pollen forms exist. Interestingly, pollen grains did not greatly change their features over millions of years – fossil pollen is often quite similar to recent specimens.

All too often, pollen grains are misinterpreted as "small allergenic monsters" causing hay fever in humans and the newspapers are sometimes full of lurid stories about "horrible pollen grain monsters".

But pollen cannot be reduced to its sole effect of triggering human allergic responses. Without pollen – no fruits, without pollen – no seeds, without pollen – virtually no plant foods... (Fig. 7)

Figure 6
Reinhard Zetter and Heidemarie Halbritter, *Detail of pollen wall*, Scanning Electron Microscope, c. 10000 times. University of Vienna: Department of Palaeontology and Department of Structural and Functional Botany. The material of the pollen wall is the most stable biopolymer known in nature, called sporopollenin. Left side: Pollen wall detail of an about 85 million years old pollen grain from the Late Cretaceous found in Gmünd (Lower Austria, South Bohemian basin). The pollen wall detail from a recent *Orthophytum* (Bromeliaceae) pollen (right) exhibits almost identical features.

Figure 7
Heidemarie Halbritter, Pollen grain of birch (*Betula*), Scanning Electron Microscope, c. 3500 times. University of Vienna: Department of Structural and Functional Botany. Birch is one of the most important allergenic plants in Central Europe causing human hey fever disease. Allergenic plants like the birch tree are wind pollinated and produce an enormous amount of pollen.

If you wish to learn more of the diversity and aesthetics of pollen grains, visit PalDat! PalDat is a palynological database designed by the Department of Structural and Functional Botany at the University of Vienna. The database was developed by Martina Weber and Ralf Buchner. The aim was to catalogue the large amount of palynological data from a variety of plant families accumulated by the department over many years. PalDat - a palynological database: providing descriptions, illustrations, identification, and information retrieval. The database is freely accessible under www.paldat.org (from 2000 onwards). The reader may enjoy the stunning diversity of pollen exemplified by the SEM micrographs shown in this article.

Making Science Visible: The 1937 PSA Photography Exhibition

Kelley Wilder

1937 was an exciting year for exhibitions of photography. In New York City, at the Modern Museum of Art (MoMA), Beaumont Newhall curated the exhibition *Photography 1839-1937* consisting of some 800 photographs – scientific, documentary, pictorialist, colour and straight – which subsequently became the centrepiece of the photographic history canon. In Rochester, five hundred kilometres upstate, C.B. Neblette, secretary of the Rochester Technical Section of the Photographic Society of America (PSA) curated the *First International Exhibit of Scientific Applied Photography* at the Rundel Library. The legacy of these two exhibitions could hardly be more different. Newhall's exhibition travelled to ten US cities, and its core formed the book that is now used as the standard textbook *The History of Photography from 1839 to the Present*.[1] Neblette's exhibition travelled to Los Angeles in 1938,[2] but quite likely went no further and many of the prints are currently languishing, without accession numbers or cataloguing information, in boxes in the collection of the George Eastman House.[3] Newhall's exhibition launched careers of well-known photographers such as Madame Yevonde. Although well-known scientific photographers, including Harold Edgerton and Max Poser, exhibited in Rochester, their reputations were not built on this exhibition. That these scientific photographs survive at all is a minor miracle; and that the exhibition could, in large, be resurrected is an intriguing possibility. This short essay will consider only two of the many prints, as they hold out the possibility that this exhibition can be read as a particular sort of archive of science.[4] Figure 1 will be the departure point for discussing visibility of two sorts – the ability to make different things visible via different methods of photography, and visibility of the limits of photographic research within the sciences. Figure 2, both the front and back, will be a discussion point for the visibility of the advances of science and the transfer of that knowledge to scientists via photographic exhibitions.

Before discussing Figure 1 in detail, it is important to consider the section of the exhibition it appeared in. All prints were made before February 1937 and, as we will see with Figure 2, some a great deal earlier. The exhibition received prints in ten sections: Colour Photography; Astronomy, Meteorology, and Aerial Photography; Photo Micrography; Radiography and Medical Photography; Documentary Photography; High Speed Photography; Stereoscopic Photography; Photography in Physics and Chemistry; Natural History; and Miscellaneous. Each exhibitor filled in a form for their entries that not only included the title or description, but also the process. The forms for Figures 1 and 2 have not yet been located, but they appear to have been shown in the medical photography, rather than the experimental colour, section. Many of the objects in this exhibition have a similar format as dictated by the Committee (16 x 20 inches or 40 x 50 cm). "Prints should be on white or cream mounts of these sizes and must not be framed." The most interesting directive for our purposes is that "[w]hen a series of

1. Beaumont Newhall, The History of Photography from 1839 to the Present, revised and enlarged New York: Museum of Modern Art 1982.
2. The exhibition was held at The Art Center School from January 2-10, 1938.
3. I am extremely grateful to Joe Struble for bringing these boxes to my attention.
4. See for instance Christine Y. Hahn, 'Exhibition as Archive: Beaumont Newhall, "Photography 1839–1937" and the Museum of Modern Art', in: *Visual Resources* 18, no. 2, 2002, 145–52.

Figure 1
Frank N. Ruslander, Detroit,
Color images of carcinoma courtesy of Dr. C.D. Brooks,
wash off relief process, ca. 1937.
Courtesy of George Eastman House, International Museum of Photography and Film, Rochester, NY.

prints illustrating one subject is to be shown, as many prints as convenient should be placed on one mount."[5]

Figure 1 shows a group of three images titled *Carcinoma of jejunum* made by Dr. C.D. Brooks using the wash-off relief process. The larger image in black and white is easily recognizable as an X-ray image of the affected area of the small intestine. The smaller monochromatic purple image to the right shows a histology slide of eccentric nuclei with prominent nucleoli. The third image, to the left and in 'full colour', is a photograph of the affected organ and tumour. Clusters of images like this are used today in pathology journals, and it is not difficult to locate an article with nearly the same mixture of images of the organ and the histology slides.[6] In 1939, the difficulty in diagnosing this very aggressive cancer was that identification

5. Exhibitor Form for Rochester Technical Section Photographic Society of America *First International Exhibit of Scientific and Applied Photography*. Collection George Eastman House, unnumbered.

6. Javier Salamanca, Manuel Nevado, Miguel Angel Martinez-Gonzales, Gustavo Perez-Espejo, and Fernando Pinedo, 'Undifferentiated Carcinoma of the Jejunum with Extensive Rhabdoid Features: Case Report and Review of the Literature', in: *APMIS* 116, 2008, 941–46.

techniques like the X-ray mandated that the tumour grow to a certain size before it could be detected.[7] Diagnostically then, X-ray photography, in spite of its overwhelming use in medicine, was not enough. The poster exhibits other possibilities for diagnosing the cancer via photographic techniques. It not only makes the limits of photographic processes visible, but the way in which different sorts of photography worked together to create a new sort of visualization of pathology.

Most interesting from a photographic point of view is the presence of an image of the affected organ taken by reflected light and printed in the colour wash-off relief process. Aside from being exciting in its photographic exhibitions, the decade of the 1930s was also a time of prodigious photographic innovation. Colour changed particularly quickly in this time, benefitting from intensive research into infra-red and layer technology at large research labs like Kodak and Agfa. At the beginning of the decade, colour was achieved trichromatically via three various colour processes (from black and white separation negatives) or by multi-colour screen plates like the Autochrome or the Agfa Color Plate. By the end of the decade Kodachrome had appeared; it was launched in 1936 just a year before this print was made. Wash-off relief was another product of the Kodak Research Labs and was made in much the same way as Technicolor. It became better known as dye transfer printing, used by the advertising industry and artists alike to create vivid and very stable colour prints from black and white separation negatives. What did pathologists stand to gain from this multifaceted form of depicting disease? The images gathered here show a bewildering array of visualization techniques that cover monochromatic depiction and full colour, microscopic and X-ray vision, as well as depiction by reflected and transmitted light. It is an overview of the possibilities of photographic diagnostics, but it also carries the implied message that one sort of photographic imaging is not enough.

In her thesis, *Regarding the Brain*, Sarah de Rijcke contemplates the use of multiple views of the brain using different processes (photographic and lithographic). She notes that Daston and Galison argue for the use of multiple images as a method for accomplishing detachment. The multiple images throw the burden of representation onto the audience instead of retaining it within the image.[8] De Rijcke counter-argues in line with Lynch that photographs can also have a 'directional' relationship with lithographs or line drawings or diagrams.[9] That is, the images work together to generate a semblance of reality and objectivity. It seems that, in the case of these three photographs of carcinoma, *both* notions are at work in order to make the cancer visible. Clearly, "macroscopic anatomy alone cannot rescue us here" if the carcinoma is so difficult to diagnose.[10] These images not only prepare the observer for the variety of possible

7. T.E. Jones and I.E. Harris, 'Primary Carcinoma of the Jejunum: Report of Case', in: *American Journal of Surgery* 43, no. 3, 1939, 769–72.
8. Lorraine Daston and Peter Galison, 'The Image of Objectivity', in: *Representations* 40, 1992, 81-128, 107.
9. Michael Lynch, 1991 as cited in Sarah de Rijcke, doctoral dissertation *Regarding the Brain: Practices of Objectivity in Cerebral Imaging 17th Century to the Present,* Groningen: Rijksuniversiteit Groningen 2010, 56.
10. Daston and Galison 1992 (reference 8), 106.

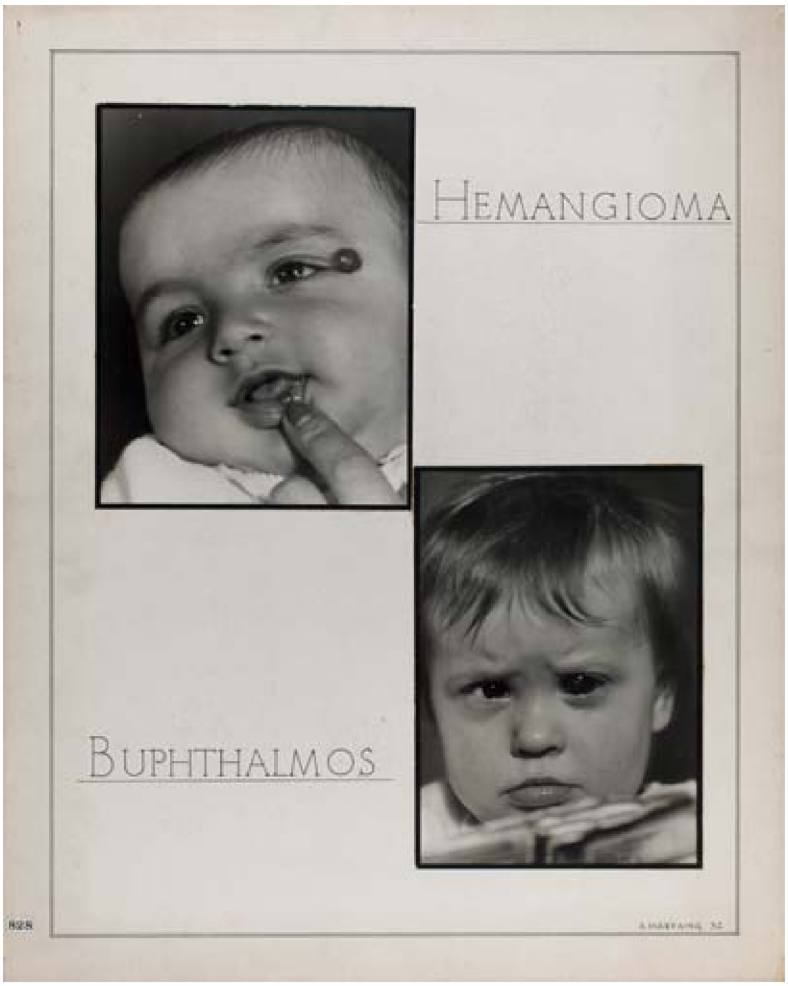


Figure 2a
Adolph Marfaing, Exhibit 828,
Hermangioma and Buphtholmos,
silver gelatin prints, ca.1936.
Courtesy of George Eastman House,
International Museum of Photography
and Film, Rochester, NY.

views, macroscopic and microscopic, that might occur, but the X-ray acts directly to bolster the new technology of full colour imaging. Scepticism about the value of full photographic colour's usefulness in the sciences has been largely taken for granted. For a time, however, in the heyday of colour innovation from 1907 to the 1970s, the possibilities of colour appeared endless. This image is only one of many in the exhibition that sought to train scientific eyes to the full spectrum of photographic imaging and, with it, photographic manipulation. Implicitly inscribed in the many 'innovations' was the message that photography was rapidly changing, much manipulated, and required special interpretation and constant reinvention. One would think then, that these sorts of images would have had very little circulation, being directed solely at other professional scientists. Many of the prints however appear to have achieved much wider distribution.

As an example, Figure 2a showing two children, one with Hemangioma, the other with Buphthalmos, by Adolph Marfaing, was one of several photographs that had been previously exhibited. On the back of the mount (Figure 2b) we find the orange stamp from the 1937 PSA Exhibition, the blue one of the 1938 Los Angeles Exhibition, and an oval gold stamp from the 1936 National Salon of the Oval Table Society of New York at the Vanderbilt Gallery of the American Fine Arts Society. The Oval Table Society was a powerful photographic Salon with strong links to the Royal Photographic Society in Britain, and similar exhibition practices. The presence of applied science imagery at these exhibitions should come as no surprise, as they had been an integral part of photographic exhibitions since the one held in the Crystal Palace in 1851. This revelation will appear unsurprising to photographic historians who are familiar with the lists of exhibitions in *The Photographic Journal* and other organs of the photographic societies, but to historians of science it poses a new avenue for understanding the dissemination of scientific knowledge beyond the periodical, atlas or archive context.

Figure 2b
Verso of Figure 2a,
exhibition mount,
showing exhibition stamps.
Courtesy of George Eastman House,
International Museum of Photography
and Film, Rochester, NY

While applied photography was always part of nineteenth-century national exhibitions, the circulation of applied science photographs in exhibitions in the twentieth century is still very much unknown. If Robert Koch's 1880s microphotographs of bacteria were integral to making the discipline of bacteriology visible, what were applied science images 'making visible' in the twentieth century?[11] Certainly, as Tucker and Daston and Galison have written about the nineteenth century, photographs were teaching students in certain fields of study.[12] The PSA exhibition photographs however, appear to show something more. They were made with experimental photographic materials like new films, new printing techniques and new cameras. There are examples of dye transfer, stroboscopic imagery, stereo movies, flexichrome, wash-off relief, experimental Kodachrome, and early Transmission Electron Microscope images to name a few. This was an exhibition about the cutting edge of photographic technology as well as the uses of photography in science. What the 1937 exhibit made visible was the much less tangible but critical passage of knowledge between photographic science and state-of-the-art science photography. More study on this exhibition is forthcoming and may give some insight into other aspects of the interaction between photographic research laboratories and science at large.

11. For more on Koch see Jennifer Tucker, 'The Social Photographic Eye', in: Corey Keller (ed.), *Brought to Light: Photography and the Invisible, 1840–1900*, New Haven and London: Yale University Press 2008, 37–49.

12. Tucker 2008 (reference 11), 41 and Lorraine Daston and Peter Galison, *Objectivity*, London: Zone Books, 2007.

Philip O. Gravelle and the Origins of Macrophotography in American Scientific Consulting and Corporate Advertising 1920-1935

Jennifer Tucker

An often overlooked but important site for the production of new meanings of photographs of material phenomena below the threshold of human vision during the twentieth century is commercial industry. During the early decades of the twentieth century, scores of U.S. manufacturing corporations began turning to consulting scientists and engineers for help detecting flaws in materials and for gaining knowledge about their behavior. One consulting industrial microscopist, Philip O. Gravelle, an internationally known authority on microscopic photography, who became especially instrumental in the transformation of the photography of extremely small objects into a manufacturing concern, is particularly interesting in this regard. A pioneer in the use of magnification, dyes in negatives and polarized light to make photographs of microscopic phenomena, he was also a prominent nature photographer and the first non-English scientist to win, in 1923, the prestigious Barnard medal, awarded by the London Photographic Society, the highest achievable honor in photomicrography. Although virtually overlooked in today's scholarship on the history of photography, he was a popular scientific celebrity during the 1920s and 1930s, when his photographs of subvisual phenomena graced hundreds of glossy corporate print advertisements and his photography was widely covered by the press. Gravelle's life and photographic productions serve as a reminder of the range of photography and its hybridity during the early decades of the twentieth century. This essay briefly describes the nature of Gravelle's work with photography of the invisible, discusses the nature of its public appeal, and presents specimens of his work, including color photographs that have never before been reproduced. It is argued that Gravelle's photomicrographs offer a valuable and hitherto unutilized lens through which to reconstruct the historical and cultural contexts that engendered new public meanings of "snapshots of the invisible" in the early twentieth century, an era of protean creativity and innovations with the scientific camera.[1]

"Industry's New Eye That Sees and Solves"[2]

"Have you ever examined the tongue of a fly"? Or "that the spines on strawberries are like big carpet tacks"? So wrote the popular writer Fritz Blocki in the opening lines of an article about Gravelle in *Popular Science Monthly* in October 1927.[3] Like similar articles that appeared in the illustrated popular press around this time, Blocki stressed several things about Gravelle: his interest in photography, dating back to his childhood; his success as a pioneer free-lance microscopist in industry; his practical contributions to society through his work for industry and crime laboratories; and his remarkable photographic revelations through the microscope. The article contained reproductions of several examples of his photographs of phenomena magnified up to two thousand times under the microscope: a spectacle that

1. On the history of the scientific camera and photography of the unseen there is a large literature including Lorraine Daston and Peter Galison, *Objectivity*, Cambridge: MIT Press 2007); Peter Geimer (ed.), *Ordnungen der Sichtharkeit: Fotographie in Wissenschaft, Kunst and Technologie,* Frankfurt am Main: Suhrkamp 2002; Corey Keller (ed.), *Brought to Light: Photography and the Invisible, 1840-1900*, New Haven: Yale University Press 2008; Helga Nowotny and Martina Weiss (eds.), *Shifting Boundaries of the Real: Making the Invisible Visible,* Zurich: Hochschulverlag 2000; Jennifer Tucker, *Nature Exposed: Photography as Eyewitness in Victorian Science,* Baltimore: Johns Hopkins Univ. Press 2006, among others. For the history of the "snapshot," see Douglas Nickel, *Snapshots: The Photography of Everyday Life*, San Francisco: San Francisco Museum of Modern Art 1998.
2. Henry Propper, 'Industry's New Eye That Sees and Solves', in: *The New York Herald Tribune* (May 25, 1924): 10-11.
3. Fritz Blocki, 'He Photographs the Invisible', in: *Popular Science Monthly* (Oct. 1927): 47-48.

Figure 1
'Philip Gravelle's home laboratory, with photographic and microscopic apparatus', c. 1935, gelatin black-and-white print, 12.1 x 17.8 cm, in: *Symmetry and Structural Design in Nature*, unpublished manuscript, c. 1940. The Gravelle-Foster Collection, Staten Island Museum History Archives and Library, New York.
To achieve standardized lighting, Gravelle worked with engineers at General Electric to produce a new kind of lamp made of ribbon filament tungsten.

revealed an "astonishing new world of tiny wonders" in the tiny foot of a spider; a group of microscopic pond organisms; the lateral grooves on a phonograph record; the edge of a shaving razor and beard fragments. Many of these were familiar to American consumers; a popular press account of his work reminded readers that, "Many of the pictures of magnified objects you have seen in the advertising sections of leading magazines have come from Gravelle's home laboratory."[4]

Gravelle's life and interests provide a window into the surprising and hitherto unexplored links that connected microscopic optics, photography, amateur nature study and the world of commercial advertisement and manufacturing interests in the 1920s and 1930s. Philip Octavious Gravelle was born in San Francisco, California, in 1877. A textile designer by profession, his interest in the chemical processes of textile manufacturer, together with his interest in photographic chemicals, led him to study chemistry at Pratt Institute and Columbia University. Around 1900, he moved to South Orange, New Jersey, where he resided for the rest of his life and where, like many inventors and amateur hobbyists of his time, he set up a home laboratory for his professional and amateur pursuits with microscope and camera. (Fig. 1) There, as free-lance industrial microscopist, he applied the microscope to industrial problems, to the solving of crimes. Early in this career he invented a technique that became widely adopted in the forensic investigation and identification of firearms used in crimes, using a comparison

4. Edwin Teale, 'Wins World-Wide Fame with Microscope Hobby', in: *Popular Science Monthly* (Dec. 1934): 24-26.

microscope which makes side by side comparisons of bullets: a technique he later adapted to the observation of three-dimensional specimens (a critical innovation that allowed for viewing a whole specimen, rather than individual cells, in the years prior to the invention of the scanning electron microscope in 1952).[5] In addition to his work for industry and crime labs, he quickly became established as a popular science writer and a nationally recognized nature photographer who wrote and gave talks for popular audiences locally. His photographs of marine creatures, minerals, and plants seen through the microscope and camera were borrowed and reproduced widely by other naturalists and popular science writers in places ranging from the Museum of Natural History in New York to the new glossy popular interest mass circulation magazines, *LOOK* and *Life*.[6]

Gravelle began working as a free-lance industrial microscopist at a time when photomicrography was being widely hailed as a boon to industrial manufacture. *The New York Herald Tribune* published an article on the value of photomicrography to industry in a 1924 article, "Industry's New Eye that Sees and Solves", in which it noted that "Industry has been given a new eye with which to look into itself." Since the beginning of the 'big business' era", the article continued, there had been a "marked tendency toward industrial introspection," with industry increasingly seeking "the aid of science in uncovering unknown and disturbing factors which impede its progress. "Industry was looking for a 'physician'," one who could diagnose causes. "Some idea of the variety of industrial problems presented to the photomicroscopist" could be gathered from the aid given by Gravelle, the microscope and photography to the phonograph industry and to the plaster of Paris manufacturer.[7] (Fig. 2) Microscopic photographs began to be used in industrial manufacture for the purpose of detecting and diagnosing flaws in materials and for learning knowledge about the behavior of materials that would provide a competitive advantage. From 1920 through the 1940s, Gravelle worked on a variety of different projects for over one hundred corporate brands, supplying photomicrographs to manufacturers of razor blades, textiles, phonographic records, paints, cosmetics, and newspapers, to name just a few.

Public perceptions of the importance of photomicrography for industry reflected the expansion of corporate-sponsored scientific research. Fritz Blocki for *Popular Science Monthly* wrote, "The science of photographing under the microscope has been practiced for some time in such fields as pathology, biology and botany; but now, largely through the efforts of Mr. Gravelle, its usefulness has extended to another purpose, that of furnishing an additional link between science and industry by solving mysteries and difficulties of manufacturing which could be solved in no other way."[8] Another journalist wrote that his "snapshots of the invisible" pro-

5. 'Life and Death Hinge Upon His Photos as South Orange Scientist Aids Police', blazed one headline from 1931. Press clippings, The Foster-Gravelle Collection. Staten Island Museum History Archives and Library (SIMHA).

6. A few of the slides he prepared for *Life* and *Look* may be found in The Foster-Gravelle Collection (SIMHA).

7. Propper 1924 (reference 2), 10-11.

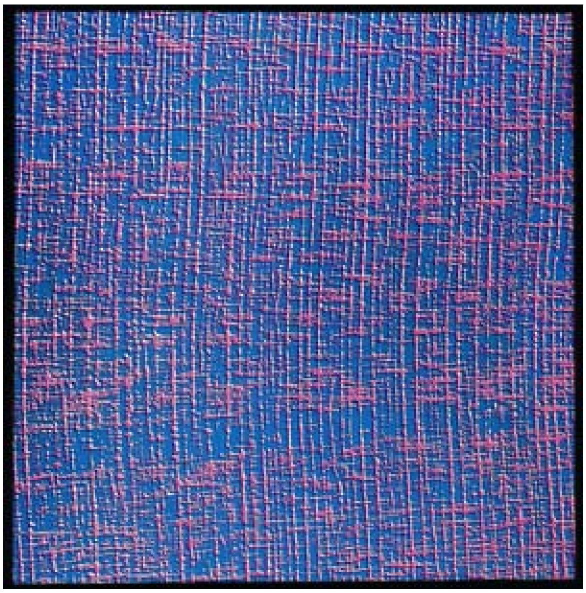


Figure 2
Woven textile pattern, c. 1920-1935, lantern slide negative obtained with a microscope and use of dyes on the negative, 8.3 x 10.2 cm, magnification 140. The Gravelle-Foster Collection, Staten Island Museum History Archives and Library, New York.

vided industry "with a new eye."[9] The role of illustrated newspaper and print media was important, both in bringing him into the public eye, and in promoting commercial products. In his laboratory, a Waterman's ad is shown hanging on the wall beside other scientific photographs. Over the course of his career, Gravelle produced magnified pictures of silk, tobacco, soap, yeast, coal, milk, metals, pencils, pens, razor blades, mayonnaise, cod liver oil, ink, cocoa, shoe polish, runs in stockings, women's facial creams, and a host of other commodities.

To show potential clients the range of his products, Gravelle produced a pamphlet, *Photomicrographs for Advertising and Industrial Use*, containing "Greatly reduced illustrations of Nationally Advertised Products showing the use of Gravelle Photomicrographs."[10] (Fig. 3) A list of users of "Gravelle Photomicrographs" in the pamphlet included not only the major New York City advertising agencies (George Batten Company, Frank Presbrey Company, and Lord and Thomas and Logan), but over forty laboratories and industrial organizations. Photomicrographs were placed in the ads in order to provide empirical support of the corporation's claims that the product was scientifically better than its competitors, and why the product was superior. American industry was producing thousands of consumer goods in the 1920s, and mass-appeal advertising (from radio to magazine print advertising) paralleled the mass production of goods.[11] While advertising generated modern anxieties about its ethical and social implications, it nevertheless became newly central in the 1920s, by one estimate rising from a total volume of $200 million in 1880 to nearly $3 billion in 1920.[12] Advertising agencies, who formerly bought advertising space in local newspapers and a few magazines, began working for the new national advertisers, placing advertisements in places most likely to attract buyer's attention, especially in the scores of new mass circulation magazines.

American commercial photography before about 1915, Elspeth Brown reminds us, was a medium whose faithful reporting of material fact and enthusiasm for endless detail failed to meet advertisers' growing demand for the abstraction or idealization necessary for "capitalist realism": "it provided realism but not art, rationality but not emotion." Brown shows how the change in this outlook can be dated from the work of Lejaren à Hiller, who, borrowing fine art aesthetics and techniques from pictorialist photography, "established the medium

8. Blocki 1927 (reference 3), 47.
9. Edwin Teale 1934 (reference 4), 24.
10. Gravelle's dossier included print ads for Colgate's shaving cream; Waterman's pens and pencils and inks; Peter's "DK" Cocoa; Tastyeast; Facial cream; Faber pencils; D and G. Sutures; lustrous white paint by Barreled Sunlight.
11. On American advertising and mass consumer society, see esp. Elspeth Brown, *The Corporate Eye: Photography and the Rationalization of American Commercial Culture, 1884-1929,* Baltimore: Johns Hopkins Univ. Press 2005; T.J. Jackson Lears, *Fables of Abundance: A Cultural History of Advertising in America*, New York: Basic Books 1995; David E. Nye, *Image Worlds; Corporate Identity at General Electric*, Cambridge: MIT Press 1985; Susan Strasser, *Satisfaction Guaranteed: The Making of the American Mass Market,* Smithsonian Books 2004.
12. On the modernization of American advertising to 1920, see esp. Pamela Walker Laird, *Advertising Progress: American Business and the Rise of Consumer Marketing,* Baltimore: Johns Hopkins Univ. Press 2001.

Figure 3
"Greatly reduced illustrations of Nationally Advertised Products showing the use of Gravelle Photomicrographs,"
printed promotional pamphlet, c. 1935.
The Foster-Gravelle Collection, Staten Island Museum History Archives and Library, New York.

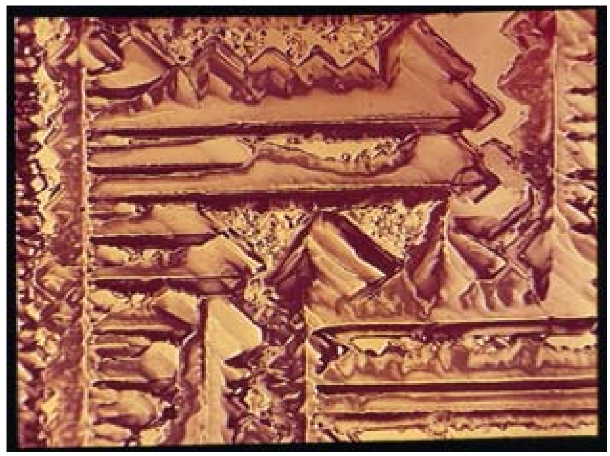
as suitable for the complex visual and narrative strategies required by the social tableaux advertising of the period."[13] What Gravelle's work for commercial advertisements during the 1920s and 1930s adds is yet another dimension, showing how photography's value as a medium of efficient rationality and revealer of visual truths hidden beneath the surface became, no less than pictorialism, a symbolic language associated with the cultured aesthetic connoted by the feature illustration. A typical magazine ad using Gravelle's photographs directed the viewer's eye to a photomicrograph of a commodity (e.g. the point of a lead pencil or night cream). One of the most famous was his photograph of shaved beard trimmings made with the use of polarized light. The text around the images characteristically stressed the connection between scientific investigation and product superiority that the advertiser encouraged. The mechanical recording of visual facts, rather than being replaced by pictorial or artistic photography, became joined with the new advertising appeals to the subjective realms of emotion and psychology.

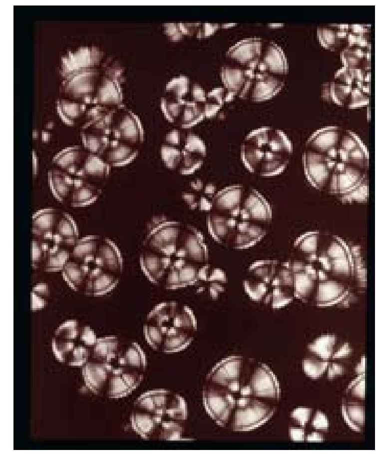
Gravelle's status as a scientist helped legitimize his use of photography in commercial illustration from 1920 to 1940. In commercial advertisements using Gravelle's photographs, scientific photographs became advertising currency. An ad for Faber lead pencils boasted, for example, that THESE AMAZING PHOTOGRAPHS TELL THEIR OWN STORY. The advertising text frequently encouraged viewers to place their trust in a commodity because of what the photomicrograph showed and to draw their own conclusions, after viewing the microscopic evidence for themselves, about the product's efficacy and manner of working: as one ad put it, "The Microscope Shows *Why* Peter's gives better results." The convention of the "before and after" photograph, with origins in nineteenth-century philanthropy and medicine, became central to commercial advertising: a photograph of the point of an "ordinary" surgical needle was juxtaposed with that of an improved "atraumatic" one. In other ad, a photomicrograph of yeast in an "ordinary" yeast cake was shown next to a brand name ("Tastyeast") yeast case "For purpose of comparison." Advertising appeals in these ads stressed not the heightening subjective powers and artistry of the photographs but their "unretouched" quality and lack of artistry adduced their power as visual proof. In many of these, a photograph of Gravelle himself appeared, peering through a microscope in a white laboratory coat. Perhaps to ward off any impression prospective that buyers might form as to the coldness of material recording scientific fact, advertisers emphasized the brand's personal connection to prospective buyers by means of a direct address to viewers: an ad for Waterman's pens reads, for example, "Waterman's *made this MICROSCOPE TEST for you.*"

13. Elspeth H. Brown, 'Rationalizing Consumption: Lejaren à Hiller and the Origins of American Advertising Photography, 1913-1924', in: *Enterprise and Society* 1, December 2000. 715-738; 718, 715.

Figure 4
Oriental, c. 1920-1935,
lantern slide negative of Potassium Chlorate obtained with microscope, polarized light, and dyes on negative, 8.3 x 10.2 cm, magnification 85. The Foster-Gravelle Collection, Staten Island Museum History Archives and Library, New York.

Figure 5
Quinate of Quinine, c. 1920-1935,
lantern slide negative obtained with microscope, dyes on negative and cover acid of fuchsine, 8.9 x 10.2 cm, magnification 125. The Foster-Gravelle Collection, Staten Island Museum History Archives and Library, New York.





"Symmetry and Structural Design in Nature"

Central to Gravelle's ability to act in the role of a "boundary agent" were his photomicrographic knowledge and skill and his access to means of producing so-called "snapshots of the invisible" using technical processes that included his new techniques of magnification and color photography, including his pioneering use of dyes on the negative. In their influential 1989 sociological essay, Susan Star and James Griesemer note the important and often overlooked role of individuals who facilitate communication across a cultural divide or boundary, translating information and mediating between different domains.[14] Their concept of "boundary objects" (and, by extension, what we could call "boundary agents") is a helpful theoretical frame for interpreting the work of a photomicrographer like Gravelle, who actively took up various roles in relation to different participants in the process of bringing nature photography, industry and commercial advertisers together, negotiating differing perspectives and concerns in the process.[15]

Surviving lantern slides of his photographs of crystals, viewed under a microscope and polarized light, and reproduced here for the first time in color, in appearance resembling fractal and Polaroid art that developed in later decades. (Figs. 4 and 5). He also made hundreds of slides of organic compounds such as adipic acid, which rarely occurs in nature but which from an industrial perspective was (and remains) the most important dicarboxylic acid, used mainly as a precursor for the production of nylon. (Fig. 6)
A surviving manuscript in the Gravelle Collection at Staten Island Historical Institute that Gravelle intended for publication, which he titled *Symmetry and Structural Design in Nature*, contains over three hundred photographs and accompanying text with captions which, in

14. Susan Star and James Griesemer, 'Institutional Ecology, "Translations", and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1939', in: *Social Studies of Science*, vol. 19 (Aug. 1989): 387-42.

15. "Trading zones" is a metaphor produced by Peter Galison that is often applied to describe collaborations between science and industry, when representatives of different cultures (e.g. physicists and engineers) are able to exchange goods, despite differences in language and culture. See Peter Galison, *Image & Logic: A Material Culture of Microphysics*, Chicago: Univ. of Chicago Press 1997.

Figure 6
K4416 Salicylaldoxime-Adipic Acid, 1920-1935, lantern slide negative obtained with microscope and submitted to *Life* magazine, 12.7 x 17.8 cm, magnification 75. The Foster-Gravelle Collection, Staten Island Museum History Archives and Library, New York.

combination with hundreds of his surviving slides, is the most complete surviving record of the range and unity of his life's work. Completed around 1954, it was never published, though Gravelle's friend Gordon Foster mailed it to Macmillan by registered mail in 1956, after Gravelle's death in 1955. It was around this same time, during the early to mid-1950s, that photographic expertise in scientific reporting was becoming increasingly popular due in large part to the well-known work of Hungarian émigré, Fritz Goro, the talented photographic expert in science reporting for *Life* magazine for twenty-seven years, whose *Life* magazine series, "The World We Live In," 1952-1954, in association with the science writer Lincoln Garret, tops the list of best-known popular science writing of the twentieth century.[16] Today, Gravelle's unpublished manuscript stands as a rare and forgotten example of what people then described as "Ultra-Microphotography" under scientifically exacting conditions in the years prior to the electron-scanning microscope. Gravelle provisionally titled his manuscript *Symmetry and Structural Design in Nature (Animal, Vegetable, Mineral).* It contained one hundred fifty pages of text and over three hundred photographic illustrations of objects selected from a "diminutive world of great diversity and form, living at the present time and from the past."

Written for a popular lay audience, Gravelle emphasized the general nature of the work and what he called its "esthetic approach," which he characterized, in language that evoked discourses of 1950's architectural modernism, as the visual display of the patterns of "Symmetry and Structural design" that Nature "devised."[17] Gravelle's clear passion for making photographical illustrations of subvisual phenomena through various arrangements of microscopes and cameras had roots in his hobby of nature photography. Alongside his consulting work he was a popular lecturer who gave hundreds of illustrated popular slide lectures about "nature viewed under the micro-

16. Stephen Jay Gould called Goro "the most influential photographer that science journalism (and science in general) has ever known." In: *On the Nature of Things: The Scientific Photography of Fritz Goro*, introduced by Stephen Jay Gould, New York: Aperture 1993, 7.

17. *Symmetry and Structural Design in Nature*, unpublished manuscript by Philip Gravelle. The Foster-Gravelle Collection 23: G-F Box 3/6 (SIMHA).

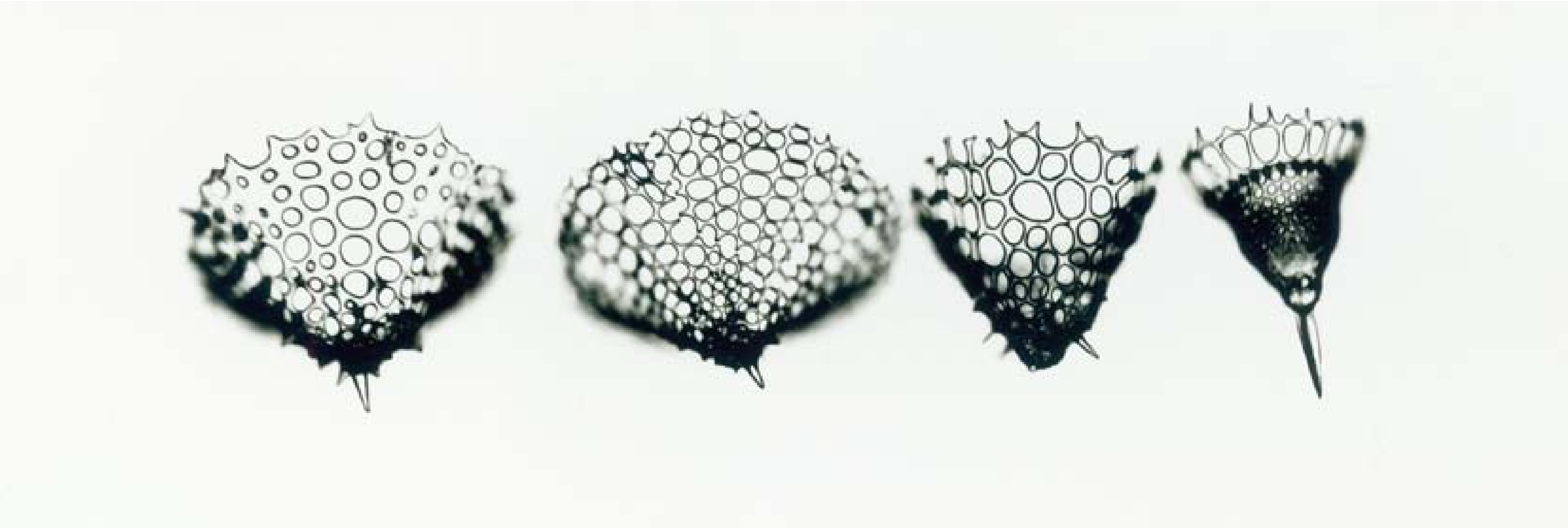


Figure 8
Radiolaria from Barbados, 1920-1935, black-and-white gelatin print using transmitted light and microscope, 4.4 x 12.1 cm, magnification 116, in *Symmetry and Structural Design in Nature*, unpublished manuscript, c. 1940. The Gravelle-Foster Collection, Staten Island Museum History Archives and Library, New York.

scope" to civic organizations, local microscopical societies, photography clubs, and gardening groups. In addition to his still photographs he also made teaching films about nature on subjects ranging from the life cycle of the rotifer to the circulation of the blood to the behavior of the amoeba and other microorganisms, culled from a pool in his garden. Called "physiological" films, one was made for the manufacturer of surgical sutures and depicted the "thrilling drama" enacted within the human body when the blood corpuscles battle to the death with germs of infection.[18]

The manuscript begins with a short historical introduction titled "The Need for Magnification." Then follow three illustrated parts: "Animal Life," "Vegetable Life," and "Mineral Life." Every illustration in the text was accompanied by a legend and text with the magnification and method of illumination given in the margins. The images Gravelle chose for the manuscript manifest the range of a diverse subject unified through a common focus on the simple terms of geometrical symmetry and the construction of both animal and vegetable structures. His photographs of marine invertebrate specimens using illumination by transmitted light, staining, and magnifications from twenty-five to two hundred fifty, displayed symmetry, bilaterism, and geometric forms. (Fig. 7) In Part II ("Vegetable Life") Gravelle included photographs of diatoms as found in nature and as arranged to "form pleasing designs," as in the following figures. (Fig. 8) Part III ("Minerals") contained photographic specimens of microscopic objects observed by incident light and different illumination techniques.

18. Described in Teale 1934 (reference 4), 25-26.

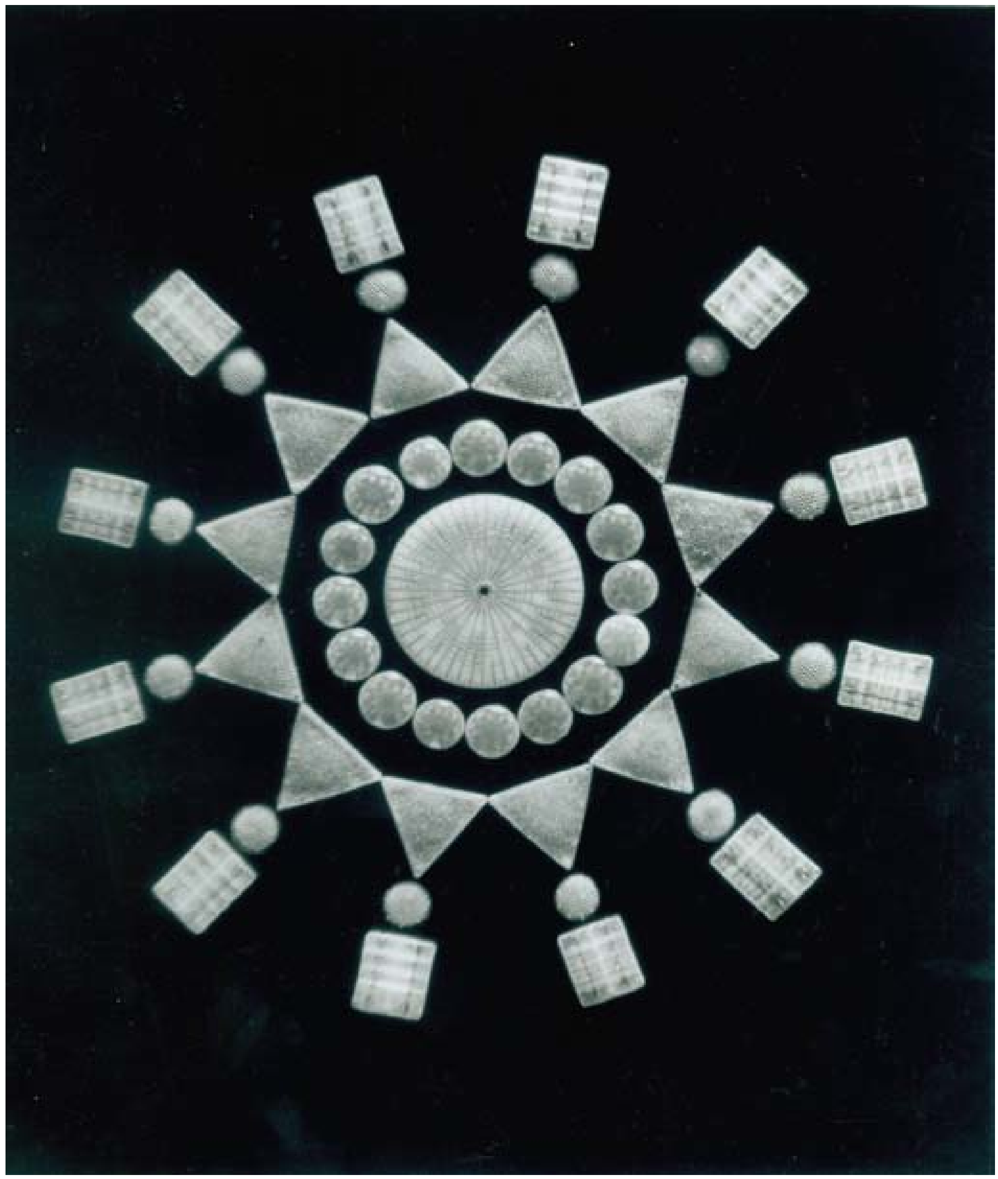


Figure 7
'An arrangement of Recent Marine diatoms and a Recent Fresh-water form, Terpisinöe musica around the outer edge of the preparation (c. 1891) by J.D. Möller', obtained with incident light, 19.2 x 22.2 cm, magnification 120, in *Symmetry and Structural Design in Nature*, unpublished manuscript, c. 1940. The Gravelle-Foster Collection, Staten Island Museum History Archives and Library, New York.

Preliminary historical assessment of this work suggests that in both his industrial work and his amateur nature studies, Gravelle had a core interest in the underlying symmetry and structural design in nature, areas that clearly carried over to his advertising work. A mass reproduced advertisement for Proctor and Gamble from the 1940s is especially interesting

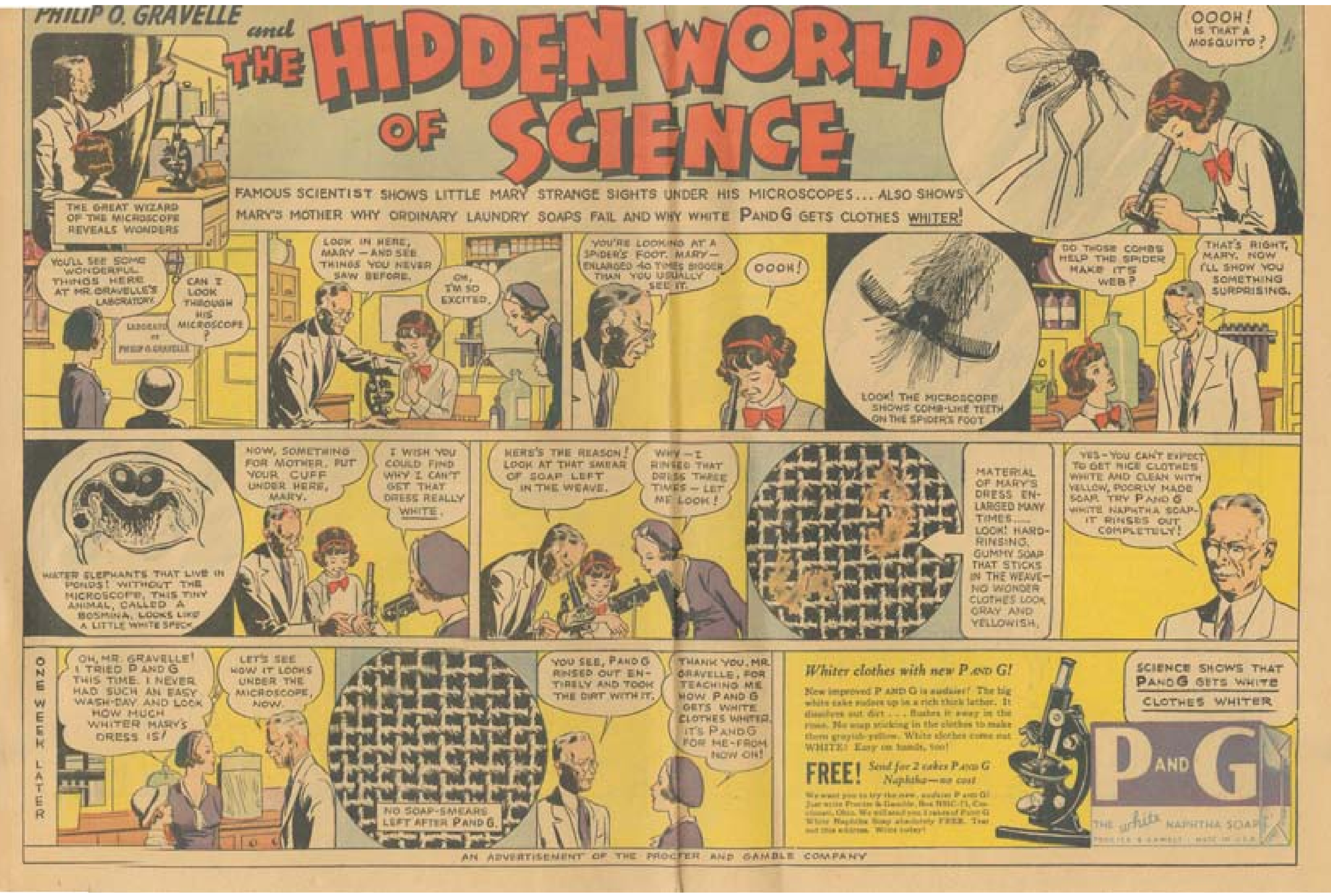


Figure 9
Hidden World of Science, c. 1945,
color cartoon advertisement
for Proctor and Gamble, 26 x 39.4 cm.
The Gravelle-Foster Collection,
Staten Island Museum History Archives
and Library, New York.

for the way it linked his photographs, his public image as a professional modern scientist and his celebrity within the amateur world of nature study in the service of promoting a mass consumer good. Titled *Philip O. Gravelle and The Hidden World of Science* (subheaded "Famous Scientist shows Little Mary Strange Sights under his Microscopes"), the color cartoon strip presented a series of vignettes in which what begins as a child's induction into the world of natural marvels seen through a microscope concludes in Mary's mother being shown by Gravelle how the microscope discloses new facts about how "ordinary Laundry Soaps fail and why white Proctor and Gamble gets clothes whiter." The ad includes drawings based on photographs representing magnified appearances of fabric, both before and after being washed with Proctor and Gamble soap. (Fig. 9)

As this essay has suggested, Gravelle's celebrated "photographs of the unseen" were produced not in contexts of "pure" science, but in the spaces of applied science and industry: domains of "photography of the invisible" and discourses of discovery that warrant much more historical attention. Laboratory observation was changing and new markets for scientific images opened with the dramatic rise in the early twentieth century of mass circulated illustrated picture magazines. While Gravelle fits into a longer historical tradition of photomicrography and scientific visuality that dates back to the 19^{th} century, therefore, his work also must be seen as representing novel practices in mid-twentieth century commercial science and art.

Moreover, although Gravelle was internationally known as a skilled photomicrographer, I have suggested here that it was his eye for modern forms of design, in structures of both living and non-living matter, that informed his photographic aesthetic, from his popular scientific writing and illustrated lectures on nature photography to his astute grasp of the demands of the new age in advertising. His life and work illustrate, among other things, how visual objects are able to bridge the boundaries erected between different scientific fields because they satisfy the needs of different social groups, despite that they frequently have been treated within academic disciplines as belonging to different "genres." It is hoped that this essay contributes not only to a reappraisal of Gravelle's importance in the history of macrophotography but also to new understandings of "photography of the invisible" in the advertising age.

Tricycles in the Desert Sand
Observations on the Phenomenon of *Computer Generated Images*

Heinz-Michael Jostmeier
Christoph Schaden

In the digital field, there is always only the chance of an image.
Wolfgang Hagen[1]

Today, a person attempting to deal with the tremendous number of digital images from a retrospective position will inevitably find himself facing a gap. This is because there is still a lack of any historicisation of digital photography that attempts to portray the lines of development of the digital image in its technical, socio-cultural and aesthetic contexts within the frame work of a *large narrative*.[2] At best, the majority of contemporary overviews of this subject put together a study on *Photography in the Digital Age*, to quote a popular book title.[3]

At first glance, this might seem to be surprising, especially when one considers that preliminary work from the photo-historical aspect has long been carried out and the development of the phenomenon itself now covers half a century. More than four decades have passed since Boyle and Smith of the Bell Laboratories (USA) came up with the epoch-making invention of the Charge-Coupled Device (CCD). Individual investigations – the research carried out by Herbert W. Franke is mentioned here as just one example – have reconstructed the gradual genesis of the first digital images in the 1960s in great detail.[4] And, last by not least, in 2008, the German Society for Photography (DGPh) honoured the electrical engineer from the USA Steven J. Sasson (Kodak, Rochester) for the handheld still camera he developed successfully in 1977 (fig.1). Significantly, he named his apparatus that, with a weight of 4.2 kilograms and resolution of 100x100 bits (!) (0.01 megapixels), now seems like a fossil, "The Camera of the Future".[5] The first image created using this camera is documented by a colour picture that shows the digital reproduction of an analogue portrait of a child on a screen in an experimental setup. Upon closer investigation, the programmatic comparison of the same motif opens up an entire catalogue of questions that appear to have remained unanswered to this day. This picture asks: What is analogue here, and what digital? Where is the original, where the reproduction? What is still photography, what photographic? What has remained the same? And what has just changed? (Fig. 2)

Figure 1
Sven Nieder, *Steven J. Sasson with camera*, C-Print, 2008.
© Sven Nieder.

1. Wolfgang, Hagen, 'Es gibt kein "digitales Bild". – eine medienepistemologische Anmerkung', in: Lorenz Engell, Joseph Vogl, Bernhard Siegert (eds.), *Licht und Leitung. Archiv für Mediengeschichte*, Weimar: Universitätsverlag 2002, 108.
2. From the technological perspective, see the contribution by Jens Schröter, 'Eine kurze Geschichte der digitalen Fotografie', in: "Verwandlungen durch Licht, Fotografieren in Museen & Archiven & Bibliotheken", *Rundbrief Fotografie*, special number 6, Dresden 2001, 249–258.
3. From the viewpoint of the photographic process, cf. Sylvia Wolf, *The Digital Eye. Photographic Art in the Electronic Age*, Munich, Berlin, London, New York: Prestel Publishing 2010, 23–53.
4. Herbert W. Franke, 'The Borderfields of Photography. Initial Steps of Science and Computer Art in the Sixties', in: Anna Auer, Alistair Crawford (eds.), *Helmut Gernsheim reconsidered. The Proceedings of the Mannheim Symposium.* Congress report, European Society for the History of Photography (ESHPh), Forum Internationale Photographie (FIP), Reiss-Engelhorn Museum, Mannheim, Passau: Klinger 2004, 57–61.
5. Christoph Schaden, '"It Needs More Work." Erste Gedanken zu einem ersten Bild', in: *The Camera of the Future*, Festschrift on the occasion of the presentation of the Culture Prize of the Deutsche Gesellschaft für Photographie (DGPh) to Steven J. Sasson, Cologne: White Press 2008, 29–33.

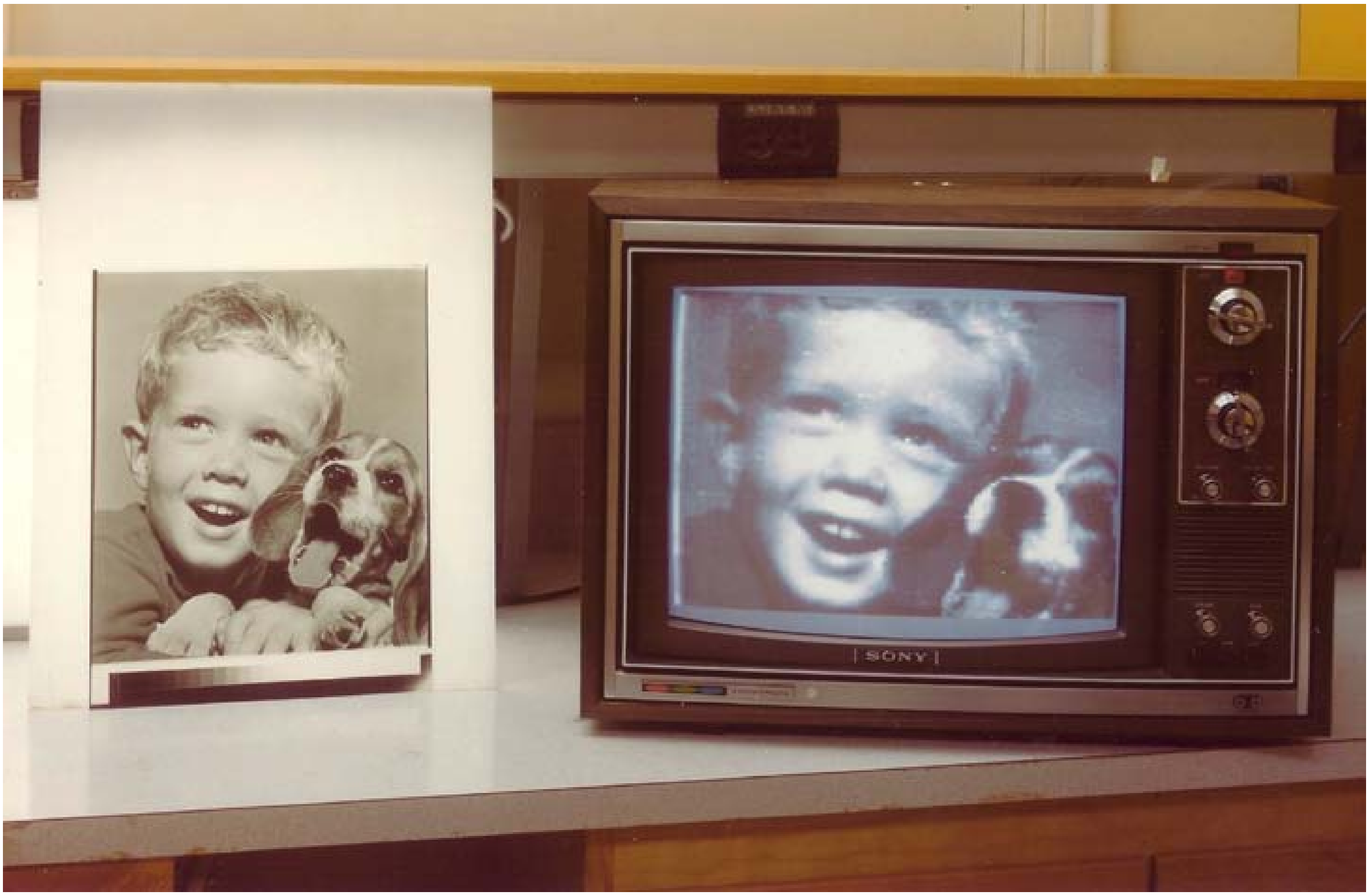


Figure 2
Steven J. Sasson,
Setting of the test arrangement,
in: *Technical Report*, 1977.
© Eastman Kodak Company,
Rochester.

Practical and technically perfect

From a cultural-historical viewpoint, the origins of digital photography have now received appropriate acknowledgment – albeit with a certain time delay. It might be assumed that, in this way, a solid foundation has been laid for embedding it in history. However, de facto, a *History of Digital Photography* is still missing. One could rightly argue about whether this is due to the questions raised by Steven J. Sasson that seem to have remained pertinent when considering the digital to this day. The fact that an overview, which – in the tradition of the 20th century – considers the formative production and effects of digital photography, is unachievable at the present time, is certainly due to the complex causal dynamics of the technology that has significantly changed the concept of the image itself.[6] A large proportion of the reflective contributions focus on an "analogue – digital" comparison, similar to Steven J. Sasson, in order to develop the tenable criteria necessary to enable the analysis of the causal phenomena of digital photography through direct comparison.[7] It is well known that, up until now, turning towards breaks and continuities mark the paradigm of *Photography after Photography* to quote the title of a seminal exhibition held in 1996.[8] Since then, theoretical debates on digital image technologies have mainly taken place under the dictum of a loss. Widespread buzzwords, such as "loss of indexicality", "loss of reality", "loss of photographic quality", "loss of photographic credibility" and so on, are based entirely on an understanding of photography centred on loss that remains analogue-centred in its terminology and categorisation.[9]

6. Cf. the methodologically innovative publication by Michael R. Peres (ed.), *Focal Encyclopedia of Photography. Digital Imaging, Theory and Applications, History and Science*, Amsterdam: Focal Press 2007.
7. With regard to the functional reception of the digital, see the detailed contribution by Rolf Sachsse, 'Zur Zukunft der Erinnerung', in: Irene Ziehe, Ulrich Hägel (eds.), *Digitale Fotografie. Kulturelle Praxen eines neuen Mediums*, Münster: Waxmann 2009, 13–22.
8. Hubertus von Amelunxen, Stefan Iglhaut, Florian Rötzer (eds.), *Fotografie nach der Fotografie*, Munich: Verlag der Kunst 1996.
9. As an example, cf. Tom Gunning, 'What's the Point of an Index? Or, Faking Photographs', in: Karen Beckman, Jean Ma (eds.), *Still Moving. Between Cinema and Photography*, Durham, London: Duke University Press 2008, 1–40. For a summary, also see: Bernd Stiegler, *Theoriegeschichte der Photographie*, Munich: Fink 2006, 403–422.

Figure 3
Audi TT, photograph, 2010.
© GSO University, Nuremberg.

Figure 4
Audi TT,
Computer Generated Image (CGI), 2010.
© GSO University, Nuremberg.

During a podium discussion dealing with the question of *Is photography disappearing as a result of digitalisation?* held at *Art Frankfurt* in 1996, the renowned journalist and photo connoisseur Wilfried Wiegand dared to make a different prognosis. The art historian informed that more computer-supported infringements on the image could be expected in future "practical and technically perfect retouching, collages and simulations."[10] At the time, Wiegand evaluated this development as posing a threat to the photographic identity but, as an art historian, he could not remain completely indifferent to the fascination of this newly-won freedom. He was well aware of intrusions being made into the image from other pictorial worlds.

Computer generated images

One can also confirm a shift in perception, away from the technical process towards an increasingly reference-oriented reference system, for the species of *computer generated images (CGI).* In the spectrum of digital imagery, their specific feature unquestionably lies in no longer being bound to an image. That initially makes them dubious as photographs. On the other hand, it must be argued that virtual *computer generated images* absolutely act as "photographein" – in the real sense of the word, to use John Herschel's fundamental term – as light drawings.[11] However, the difference is that in modern image technology, the factor of light is only used

10. Wilfried Wiegand, 'Verschwindet die Photographie aufgrund der Digitalisierung?', in: Peter Weiermair, *Aspekte und Perspektiven der Photographie, Dokumentation des Symposiums zur Art Frankfurt 1996*, Regensburg: Lindinger + Schmid 1996, 49.
11. Hans Michael Jostmeier, 'Das virtuelle Bild', in: *Digitales Bild_Bildung des Digitalen II*, Cologne and Nurnberg: DGPh/Ohm 2005, 93–105.

as a means of preservation in order to operate with a specific process of photometry. Based on spherical light metering, images are generated whose principal use lies in illuminating virtual (CAD) models. This results in the specific "photo-realistic" character of *computer generated images* with the consequence that, when looking at them, the reality of the scene and the object appear to be interchangeable. (Figs. 3 and 4)

One can understand that, from the point of view of analogue photography, digitally generated images radically undermine the viewer's expectations. Their method of creation – from the decisive moment, over the concept of the real, to the diktat of the authentic – no longer honours the fundamental constructs of the analogue image. Correspondingly, the patterns of the reception of *computer generated images* within the field of photography have so far also been characterised from a perspective of loss and the accusation that they are "unphotographic".

Image technology is not entirely uninvolved in this development; particularly as it was often guided by rather simple imitative tendencies in the images of the first generation compared with traditional photographs. At worst, there was even a lack reference in terms of style and motif. It is a simple matter to reveal the reasons for this negative development as it results from the specific methods of production. The creation of *computer generated images* has increasingly shifted towards conception and post-production areas that, in the commercial field, were originally exclusively performed by technically-competent operators many of whom had no creative competence. It is only in the second generation – where work by artists and freelance photographers can be observed – that one sees an increase in sensitisation and attentiveness to the traditional lines of the technical image. A decisive advantage for this generation arises from the fact that the image technology of the *CGI* process is becoming increasingly simple to handle. The factor of creativity and the aspect of functionality connected with it form the focus of their discussion and ultimately lead to the question: What are computer generated images capable of that other technical image media can not provide?

The more significant shift

Once again, the question about the specific characteristic of the young image species CGI – and therefore its unique qualitative features – can only be answered by taking a closer look at the history of its development. First of all, it is illuminating that the genesis of the photographic term *computer generated images* is derived from a cinematic impulse from the animation area. In her study *The Digital Turn: Animation in the Age of Digital Technologies*, Anne Crawford (London 2003) made a pertinent analysis of the success story of the use of *computer generated images* to create special effects in Hollywood films since the 1980s. Films such as *Tron* (Steven Lisberger, 1982), *Jurassic Park* (Steven Spielberg, 1993), *Lost World* (Steven Spielberg, 1997) and *Final Fantasy:*

The Spirits Within (Hironobu Sakaguchi, 2001) have all entered into our visual memory and must be mentioned as examples of this. According to Crawford, this cinematic film tradition, which was always linked to visual effects with the target of simulating reality, determines the collective perception of computer generated images to this day.

"The more significant shift from analog to digital arrived in the form of computer-generated imagery, or "CGI". With CGI, the keyframes in animation are produced through the manipulation of data within a computer program, and made visible through a combination of calculation-heavy procedures generally known as modeling, texture-mapping, compositing and, finally, rendering. In CGI, the convergence of computing and visual media has enabled truly unprecedented practices in production, distribution and reception, as well as shifts in the aesthetics of animation."[12]

This would appear to indicate that the global familiarisation with a cinematic aesthetic that has always remained firmly attached to the burden of creating a sense of (hyper) reality has now become superimposed on the reception of the still image today.[13] In his master thesis *CGI Animation: Pseudorealism, Perception and Possible Worlds*, which was published in 2003, David Surman, an artist living in Australia, studied the paradigms dominating the perspectives of the perception of *computer generated images*.[14] He compared relevant photographic parameters such as index, mimesis and realism in respect to the ontological and phenomenological essence of *CGIs*. Surman's conclusion is that computer-generated imagery has irreversibly shifted the creative horizon of the image. "Computer generated images have unbalanced how we the audience assess the credibility of cinematic representation they shift the position between the fantasy and reality."[15]

This would seem to suggest that a scaling of this kind reflects the reception criteria of still CGIs. Particularly in respect to the photographic process, the reference load towards the cinematic signifies a burden that can only be overcome constructively by applying synthetic visual strategies. To mention just one example: In his *Dark Lens* series, the French photographer Cédric Delsaux recently confronted the CGI dilemmata of media-relevant references in a virtuoso manner. In his pictures, he cited the famous arsenal of figures from the *Star Wars* trilogy by occasionally posing its science-fiction protagonists like photographic star cutouts.[16] In a second step, Delsaux calculatedly placed then in cityscapes that inevitably opened up additional photographic associative spaces. With his choice of motifs and style, Delsaux' pictures remind one of the hybrid large-formats we have become accustomed to in the work of Andreas Gursky and other contemporary photographic artists.[17]

12. Anne Crawford, 'The Digital Turn: Animation in the Age of Digital Technologies', in: Carol A. Stabile, Mark Harrison (eds.), *Prime Time Animation and American Culture*, London: Routledge 2003, 113.
13. Cf. Jürgen Schopper, 'Das Photo als virtueller Raum', in: *Digitales Bild_ Bildung des Digitalen, eine Veranstaltung der Deutschen Gesellschaft für Photographie e.V. (DGPh)*, Cologne and Design Faculty, Georg-Simon-Ohm University Nurnberg / Christian Gapp, Michael Ebert and Heinz-Michael Jostmeier, Cologne and Nurnberg: DGPh/Ohm 2003, 123–128.
14. David Surman, *CGI Animation – Pseudorealism. Perception and Possible Worlds*, Master's Thesis, autumn 2003. Accessible at: www.gamecareerguide.com (12 March2012).
15. Surman 2003 (reference 14), 4.
16. Further information at: www.cedricdelsaux.com (12 March2012).
17. This series of pictures received great recognition in the international photographic world – at *Paris Photo*, for example.

Necessity of authorisation

In the *computer generated image* segment, eclectic processes have now come to form an effective strategy for innovative imagery opening up new freedoms at the moment of becoming liberated from the reproduction. From a historical perspective, this development is increasingly affecting the still picture because the technical deficiencies of the CGI process, which could only be used for moving pictures in the early stages, have largely been eliminated. However, due to the relatively slow pace of its optimisation, the – still very complicated – process continues to find its main application in the applied areas of advertising, especially for the automobile branch. This is no mere coincidence seeing that the technology was further developed with financial support from the international automobile industry. Therefore, application-related CGI images mainly address the factor of mobility with the consequence that targeting vehicles has now fostered an independent genre that, in a distorted way, has advanced to become a synonym for CGI technology in the way it is perceived by the outside world.

It appears that a fundamental reorientation is necessary for the new generation of *computer generated images.* To achieve this, it is beneficial that the technological tools have become more accessible in recent years and the use and operation of the technical instruments has been greatly simplified. In addition, the investment costs have also been considerably

Figure 5
Ragnar Herberth, not titled,
Computer Generated Image (CGI), 2010.
© GSO University, Nuremberg.

reduced. This has all led to *computer generated images* becoming increasingly liberated from the demands of the industry and being applied more and more in the areas of virtual set design, architecture and art. In connection with this, the factor of image quality is steadily increasing in importance. What does this imply for its reception? First of all, there can be no doubt that the demand for the authorisation of the image that has to face up to its ethical responsibility in media communication is one of the prime concerns. If the eye is no longer capable of differentiating between a computer-generated and digital photograph, it becomes essential to be able to reveal the implicit intellectual and practical strategies of its creator when analysing the image. As a result of the gradual increase in accessibility to *computer generated images*, which have so far primarily been used for commercial purposes, for artistic intentions, the dilemma of the conventions of perception assume major importance. This reveals itself in the conflict with contemporary documentary concepts. To what extent can computer generated images be considered “real” with a view towards internal and external realities? What can be articulated in them and made visible that is beyond the scope of digital images? Which subjects can computer generated images address? Which pictorial traditions do they have recourse to? And, not least important: What is their sense, their genuine task?

Renaissance of the montage

It seems to suggest itself that such functional criteria will have to be developed and formulated in the future. One possible path for the species of *computer generated images* could lie in the demand to create autonomous images of concepts and, using the tools of digital photography, compositing and elements of *CGI*, transforming them into autonomous concepts of images. The moment of the imaginary seems to be genuinely close to the representation procedures of *CGI*; not least because the formative force is usually based on the implementation of montage techniques.[18]

Since 2006, the CGI section of the Design Faculty of the Georg Simon Ohm University of Applied Science in Nuremberg, where the two authors teach, has mainly devoted itself to presenting technical concepts and application-oriented motive development. Without exception, the students’ works in the field of image design listed here follow the principle of the montage in order to investigate experimental solutions for various genres and media that satisfy the individual profile of the technology as well as taking various visual traditions into consideration.[19]

For example, in his pictorial work, Ragnar Herberth deals with a surrealistic painting by Salvador Dalí (fig. 5). He placed a sports car in the middle of a dreamscape that, in its few elements, explicitly quotes the vocabulary of motifs (crutch, geomorphic sculpture, desert) used by the Catalan genius. The referral to the Spanish painter is in no way coincidental. It is reported that Dalí, who – as is well-known – was greatly inspired by the writings of Sigmund Freud, wanted his surrealistic pictures to be understood as dream-photographs painted by hand.[20] On the other hand, Benjamin Hatscher’s work moves in the direction of a

18. Stephan Günzel, 'Die Geste des Manipulierens. Zum Gebrauch statischer und beweglicher Digitalbilder', in: Stefanie Diekmann, Winfried Gerling, *Freeze Frames. Zum Verhältnis von Fotografie und Film*, Bielefeld: Transcript 2010, 114–129.
19. Additional works carried out in the study module of the Design Faculty can be found at: http://cgi.ohmdesign.de (12 March 202).
20. Cf. Holger van den Boom, 'Die Spur der Realität im digitalen Fotoatelier', in: Norbert Bolz, Ulrich Rüffer (eds.), *Das grosse stille Bild*, Munich: Fink 1996, 104.

Figure 6
Benjamin Hatscher, not titled,
Computer Generated Image (CGI), 2011.
© GSO University, Nuremberg.

Figure 7
Thomas Brodowski and Florian Einfalt,
Stereotypes,
Computer Generated Image (CGI), 2010.
© GSO University, Nuremberg.

Figure 8
Thomas Brodowski and Florian Einfalt,
Desert Change,
Computer Generated Image (CGI), 2011.
© GSO University, Nuremberg.

scenographic setting (fig 6). Appropriately, he defines his resulting picture as a Wagnerian stage that consciously confronts the normative principles of the Gesamtkunstwerk with the desired pathos and stylistic simplicity. This opens up a possible field for *CGI* in the area of virtual set design where the technique would be capable of making preliminary formulations of aesthetic solutions in virtual space.

The extent to which photographic cross- and back-references can be reflected in CGIs is impressively illustrated in the works created to date by Thomas Brodowski and Florian Einfalt.[21] Not without a touch of irony, their five-part series *Stereotypes* refers to a tradition that was previously mainly formulated by photographic artists interested in staging in the analogue age of the 1980s (fig. 7). Following in the theatrical footsteps of the *Fotografia Buffa* as implemented by Rommert Boomstra, Bernard Faucon and Sandy Skoglund, the two students gleefully interpret virulent contemporary identity concepts in keeping with the popular slogan: "I am many".[22] Their most recent series of desert pictures (fig. 8), which assembles various relicts in a hostile landscape, reveals yet another reference to photographic traditions.[23] These were also not simply chosen without a reference. The motif of the tricycle will immediately remind photographic connoisseurs of a central work in the oeuvre of the colour photographer William Eggleston from the USA that was used as the motif on the cover

21. Werner Bartsch, Hamburg kindly provided the digital images.
22. Fotografia Buffa, *Staged Photography in the Netherlands*, Groningen: Groningen Museum 1986.
23. The series of pictures was created in cooperation with the Staudinger + Franke photographic agency, Vienna who provided the background images of the desert.

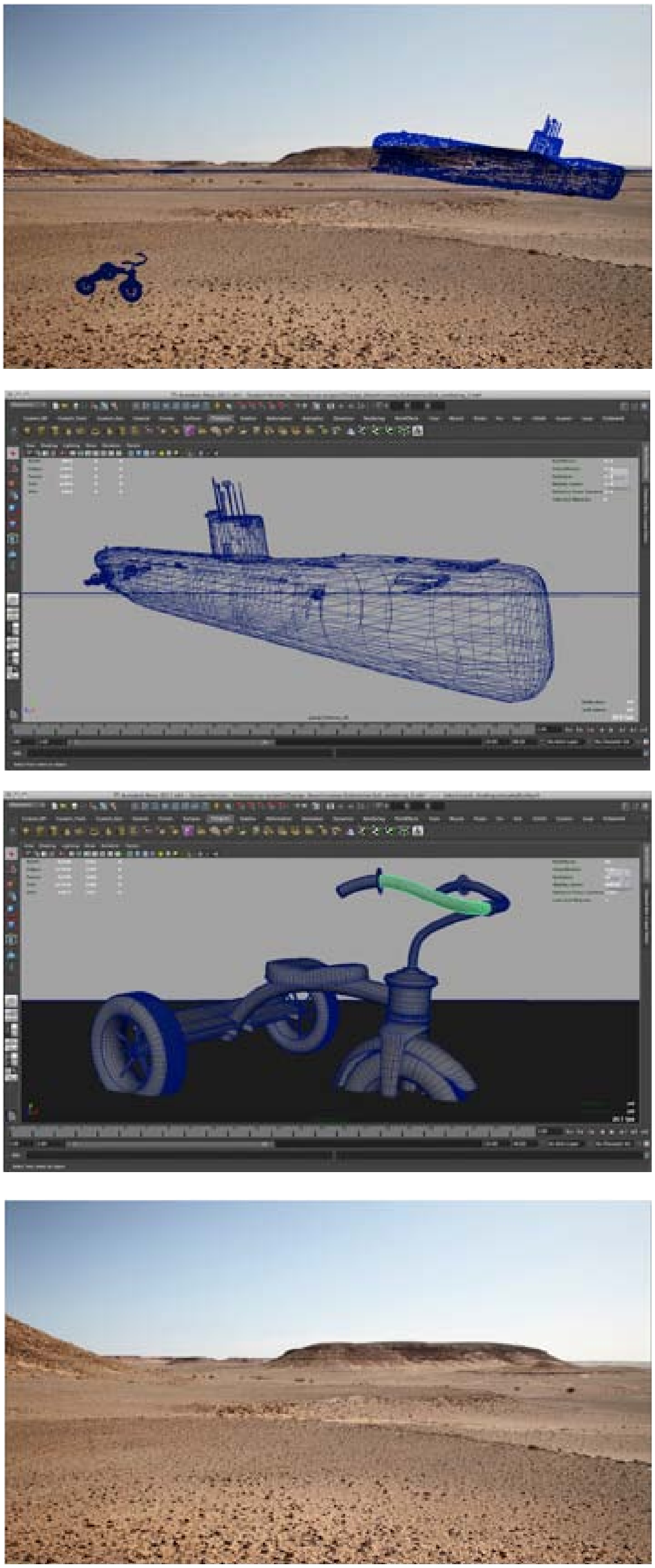


Figure 8 a-d
Thomas Brodowski and Florian Einfalt,
Sketches for *Desert Change*,
see figure 8.

of the famous MoMA catalogue “William Eggleston’s Guide”. However, it is significant that, in contrast to the prototype, the motif of the tricycle was generated entirely on the computer (figs. 8a-d). The fact that the resulting image cannot be misinterpreted as a mere reminiscence is stressed by the absurd motival element of a stranded submarine in the background. Here, everything attempts to fit in optically but nothing does motivically. Without exception, all of the visible compartments appear fabricated and positioned in an absurd manner in an apparently surreal scenery. At once, the entity of the picture is questioned, nothing makes sense, not even the visual perception.

In harmony with the first digital picture by Steven J. Sassen, the *computer generated image* once again poses a catalogue of questions that still need to be answered. Is it even a photograph? Or is it a photographic representation that could be labelled “pseudo-realism”? Can it still be described in the categories of original and copy, of analogue and digital? And, last but not least: What does this technical image expect of us, what do we expect of it?

Voyager between the Art Worlds
Allan Porter in Interview with Anna Auer

Allan Porter, born on 29 April 1934 in Philadelphia, is a multi-talented artist who was educated as a painter, photographer, stage designer, tapestry artist and typographer. In 1964, he left New York and initially worked as a layout artist in Basel and then Lucerne where he fulfilled his life's work: Under his guidance – as editor-in-chief, author and layout artist rolled into one – *camera* developed into one of the most important photographic journals of the 1960s and 1970s.

Figure 1
Birthday of Allan Porter, self-portrait.
Luzern 29 April 2008.

Allan Porter (fig. 1) promoted artistic photography unconnected to any commercial interests. The thematic numbers of *camera* were conceived to satisfy the highest aesthetic demands on graphic design and be independent in the way the subject matter was explored. With keen instinct, new tendencies were grasped, young photographic talents discovered and presented to the public for the first time. The history of photography – at the time, a still too little researched area – was provided with a platform to present important photographic protagonists (Eugène Atget, Robert Demachy, Heinrich Kühn, Josef Sudek etc.). *camera* wrote photo history and made an important contribution to the establishment of American photographic positions in Europe.

Anna Auer – herself a photo pioneer in those days with her gallery *Die Brücke* in Vienna[1] – was invited to visit Allan Porter in his home in Lucerne for an exchange of views. The result is a kaleidoscope of ideas on photography and the way they were integrated into *camera* from Porter's point of view. Here, numerous encounters with photographers, artists and authors are recalled and many previously unknown facts brought to light.

The following interview is a shortened version; the original has been published at: www.donau-uni.ac.at/eshph.

Departure for the World of Art

Anna Auer: In your own words, illustrated stories and comics fired your imagination while you were still a child and prompted you to start drawing. What did your family and others around you think about that?

Allan Porter: I grew up in a very liberal family; I was born in Philadelphia on 29 April 1934. The family of my mother, Molly Lambert Porter, came from Holland and Scotland. My father, Samuel Porter, was the son of Russian-Jewish immigrants who originally came from Kiev.

1. Anna Auer, *Die Wiener Galerie Die Brücke. Ihr Internationaler Weg zur Sammlung Fotografis*, Passau: Dietmar Klinger, 1999.

A.A.: Were you raised in the Jewish religious tradition?
A.P.: I was actually sent to the Yeshiva before my bar mitzvah but we were not strictly religious Jews and we were also partly formed by our Christian surroundings.

A.A.: Where did you get your first job?
A.P.: First of all, I tried to find work as a graphic artist in New York over the art director of *Harper's Bazaar* Alexey Brodovitch (1898–1971) who I had met before. Unfortunately, without success. I only learned how a magazine was made during my time with the literary travel journal *Holiday* in Philadelphia between 1957 and 1958.

Figure 2
camera 03/1969.
Cover: Robert Frank.

A.A.: Did you come into contact with photographers then?
A.P.: Oh, yes. A lot of photographers worked for *Holiday*: Anselm Adams, Brett Weston, Henri Cartier-Bresson, David Attie and the then young Bruce Davidson. Of course, there were also quite a few writers there such as Jack Kerouac and Truman Capote (his real name was Truman Streckfuss). I was then given the job of designing the August 1958 number by myself and chose landscape pictures by Anselm Adams (1902–1984) and Brett Weston (1911–1993). The issue was titled: *Natural America*. It did not include a single picture of a person and was an enormous success: Many American schools, in particular, bought it to be used in class.

A.A.: Does that explain why "nature" is a subject that *camera* repeatedly focused on?
A.P.: That's right! There were five or six issues in which ecology played an important role. That also comes from the fact that, while I was still a student in the 1950s, I bought the book *The Sea Around* (Oxford University Press, 1951) by the biologist Rachel Carson. In it, I read about the effects pesticides have on our environment and that is why this topic has always been one of my major concerns.

A.A.: Are there any influences that were particular significant in forming your artistic development?
A.P.: Of course there are. György Kepes (1906–2001). He once gave a lecture at the Philadelphia Museum School of Art where he was introduced to us as a friend of László Moholy-Nagy. I was so stimulated by his talk that I went out and immediately bought a copy of his book *Language of Vision*.[2]

A.A.: Were you aware of Marshall McLuhan's work at the time? His writings are being rediscovered on the occasion of his 100th birthday this year.
A.P.: Oh yes, I bought and read in 1962 and 1964 *The Gutenberg Galaxis* and *Understanding Media*.

2. György Kepes, *Language of Vision*, Chicago: Paul Theobald, 1944.

McLuhan impressed me most. He was strong and forthcoming in his ideas and ideals and influenced my generation tremendously.

A.A.: Any other influences?
A.P.: The Beat Generation. After I moved to New York, in 1958, I got to know many artists, musicians and poets: Allen Ginsberg, Jack Kerouac, the poet and painter Lawrence Ferlinghetti, Everett LeRoy Jones. And Andy Warhol, Bob Dylan and Charles Bukowski too, the essayist Edward Dahlberg and many others; not to forget William S. Burroughs, the author of the novel *Naked Lunch*.[3] Of course, I also met Robert Frank (*1924) (fig. 2) who lived not far away from me in Greenwich Village and was working as a reporter and fashion photographer for *Harper's Bazaar* under Alexey Brodovitch at the time.

A.A.: And then there's that wonderful book *The Americans* by Robert Frank.
A.P.: You should know that after Frank had received his Guggenheim Grant in 1955, he and his family drove all over America. He selected 83 of the thousands of photographs he had taken for the book. The first edition was published in Paris by Robert Delpire in 1958; Jack Kerouac wrote the foreword. In 1976, the Swiss Foundation for Photography devoted its first exhibition in the Kunsthaus in Zurich to him and a monograph of his work was published to coincide with it.[4]

A.A.: You discovered tapestry art while you were doing your military service in Germany (1955–1957) and had great success with it in New York in the 1960s! Why didn't you continue with this?
A.P.: It was the first medium that made it possible for me to use all of my talents but I was still looking for something that could fit in with my visual and literary inclinations even more.

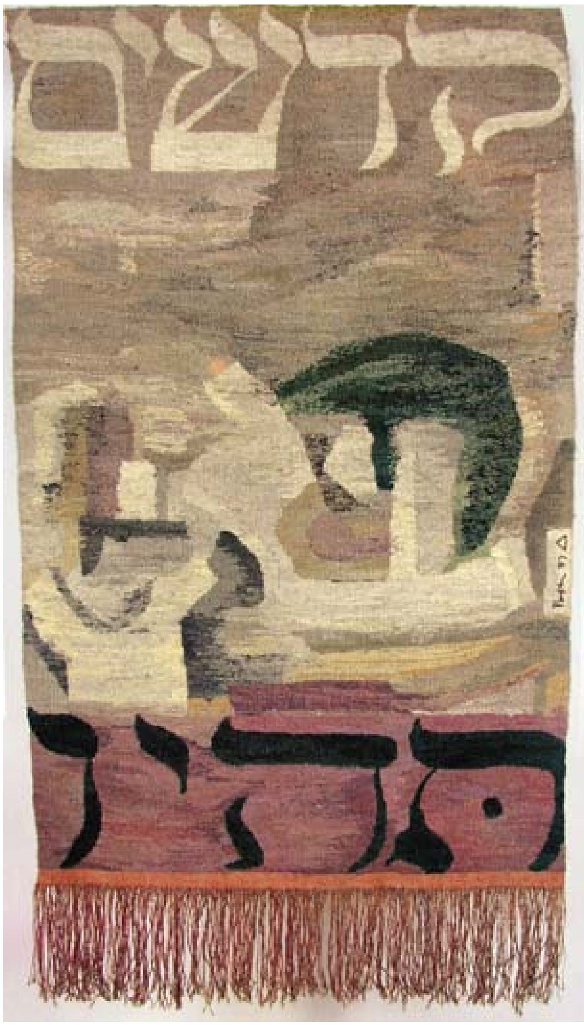


Figure 3
Kedosheem Teheyoo 07.
Tapestry made by Allan Porter, 1957.

A.A.: How did things continue after you returned to the USA from Germany?
A.P.: I did oil painting, photographed and continued to weave tapestry (fig. 3). I also designed the interior of the Buckminster Fuller Dome at the American National Exhibition showing a version of Edward Steichen's (1879-1973) *Family of Man* as a large multimedia show in Moscow in 1959. Three years later, in 1962, I was responsible as art director for the organization of the exhibition pavilion at the Century 21

3. *Naked Lunch*, film by David Cronenberg, 1991. Cameraman was Peter Suschitzky, son of photographer and cameraman Wolf Suschitzky. (William Seward Burrough, *The Nacked Lunch*, Paris: Olympia Press, 1959; New York: Grove Press, 1962).

4. Willy Rotzler, *Robert Frank. Werkverzeichnis*, exhibition catalogue Kunsthaus Zurich, 29 February 1976–25 April 1976, Zurich: Kunsthaus, 1976.

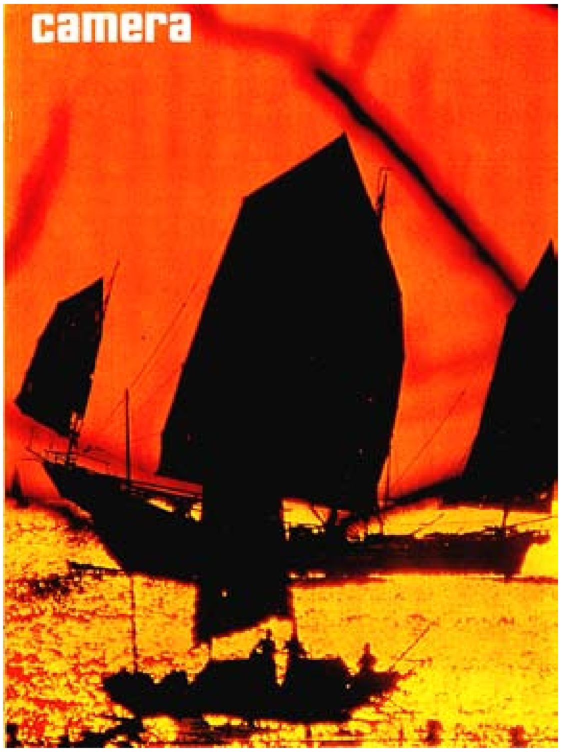


Figure 4
camera 01/1966.
Cover: Pete Turner.

Expositions in Seattle.

A.A.: What were the reasons that made you decide to move from America to Switzerland in 1964?

A.P.: It was because I no longer wanted to live in the USA after the murder of John F. Kennedy (1963). That's why I accepted the offer to work as a layout artist with the Jean Reinwald advertizing agency in Basel before changing to the C.J. Bucher publishing house in Lucerne in 1965.

Allan Porter's camera (1965–1981) – on the beginning and the end

A.A.: How did you come to take over editing *camera* for C.J. Bucher in Lucerne?

A.P.: In the mid-sixties, I was taking part in a press conference in honor of Robert Capa in New York when Horst H. Baumann (*1934) approached me and asked whether I would like to take over the production of his book *Die neuen Matadore (The New Matadors)* for Bucher. When that book was finished, Alice Bucher asked me to create the layout for a new format for *camera.* I accepted immediately. She was so pleased with my exposé that she hired me already in October 1965; I then became editor in January 1966 [5] (fig. 4).

A.A.: You already used two different types of paper in the October 1965 edition; matt for the text and glossy for the pictures. Why?

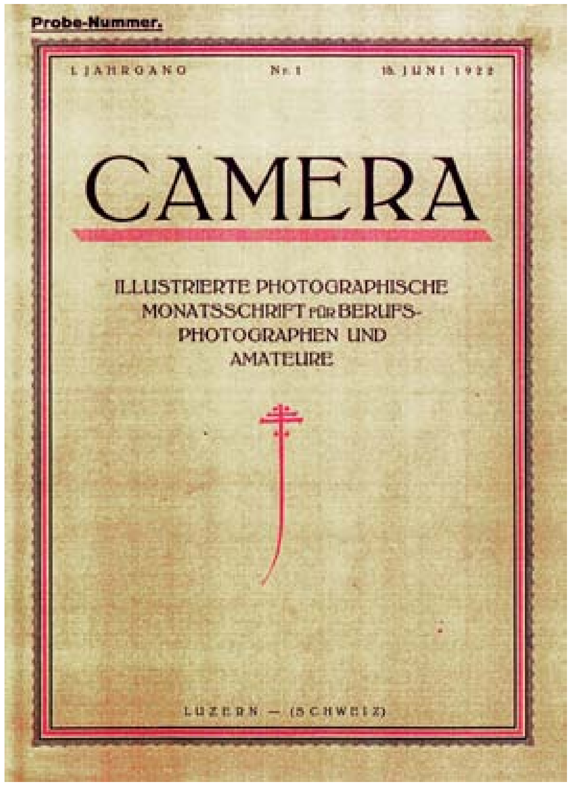
A.P.: I told myself that if I separated the text (single editions in three languages; English, French and German) from the pages with the illustrations and only ran the picture pages through the printing press once, that would be an enormous cost saving. I stuck with this concept until the very end.

A.A.: Your texts were not simply editorial contributions in the classic sense. They were an experimental mix of various kinds of texts (essays, poetry and technical reports). What was this textual "mélange" combined with the various movements in photography based on?

A.P.: I studied art, graphic art and painting under Franz Kline (1910–1962) at the Philadelphia Museum School of Art. Along with Jackson Pollok, Willem de Kooning and Mark Rothko, he was one of the initiators of the dissolution of the concrete – of abstract expressionism. At the time, Kline advised me to investigate other media such as lithography, the aquatint etching technique and, above all, photography. In addition, I had been interested in literature and poetry since my youth.

A.A.: In the book written about you *Ein Amerikaner in Luzern* (2007), we learn that Charles Josef Bucher (1873–1950) and his friend Adolf Herz (1862–1947), a Viennese engineer, who had migrated to Switzerland, founded *camera* in 1922 (fig. 5). And, that Herz produced the journal

5. Allan Porter already worked in the editorial team from October 1965 and designed the December 1965 issue as a so called "guest editor in chief". He is mentioned as editor in the imprint from January 1966 on and, starting in April 1971, as editor in chief of *camera*, in: Nadine Olonetzky, *Ein Amerikaner in Luzern, Allan Porter und "camera" – eine Biografie*, Lucerne: Pro Libro, 2007, 44f and 59f. See also: Nikolaus Flüeler, "Zur Geschichte einer Zeitschrift", in: *Die Photozeitschrift Camera 1922-1981*, Schweizerische Stiftung für die Photographie, Zurich: Kunsthaus, 1991.



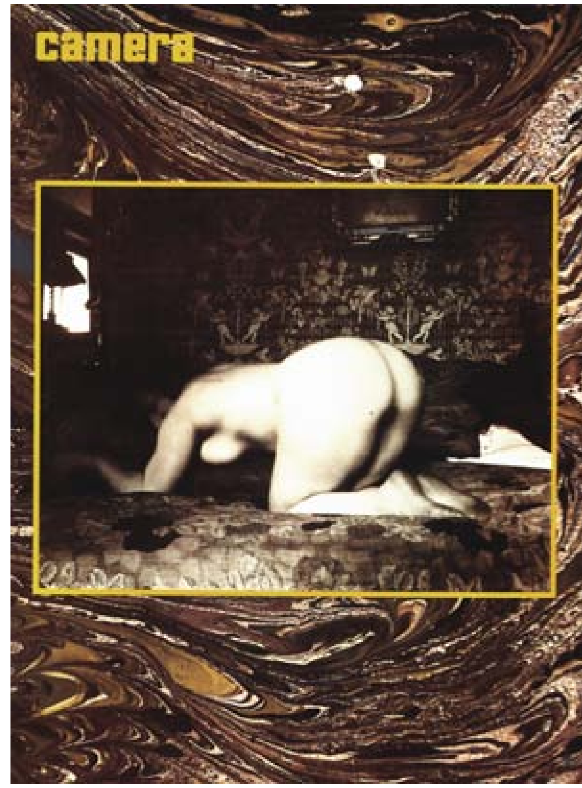


Figure 5
camera 01/1922.
Cover: Adolf Herz.

Figure 6
camera 12/1981.
Cover: Eugène Atget.

single-handedly for twenty-five years from 1922 to 1947; he wrote all the texts and even made the reproductions himself.[6] It is interesting that Herz lived in New York from 1905 to 1913! He must have come into contact with Alfred Stieglitz and Edward Steichen! Why is there no real information on Adolf Herz?
A.P.: That is all connected with the closing down of the C.J. Bucher Company when – as Alice Bucher told me later – parts of the *camera* archives, including correspondence with many photographers, were quite simply thrown away.

A.A.: How thoughtless! I found Adolf Herz mentioned as an amateur photographer in the *Lexikon zur Fotografie in Österreich*.[7] I am surprised that, during his era, contemporary movements such as New Realism were only sporadically included in *camera*!
A.P.: That's exactly how it was.

A.A.: When did *camera* cease to exist?
A.P.: It became apparent that something was looming on the horizon in 1968 when the printers moved to Adligenswil while the preparatory editorial activities stayed in Lucerne. This put a strain on the company's returns and led to Alice Bucher selling the firm to Ringier & Co. AG in 1973. In 1981, all publishing activities were integrated into Ringier's Munich office. Today, C.J. Bucher belongs to the Gera Nova/Bruckmann publishing group and has ceased to have any significance as an individual entity.

A.A.: You provocatively "armed" the cover of the last number (12/1981) with a photograph of the backside of a female nude by Eugène Atget. What were you aiming at?

6. Olonetzky 2007 (reference 5), 38.
7. Timm Starl, *Lexikon zur Fotografie in Österreich 1839–1945*, Vienna: Album, Verlag für Photographie, 2005, 194.

A.P.: I wanted to make a statement about how I felt about this farewell. I mainly put together historical photographs for my personal résumé (fig. 6).

The topics in camera – the artistic parade ground

A.A.: You say that the December 1967 number was the most important you ever produced. Why is this?

A.P.: That's right. I was concerned with the photographic depiction of architecture. Photography produces the wrong impression if one is not fully aware of the proportions. That is what I wanted to bring up in this volume and added sketches of the ground plans of the buildings shown on tracing paper to the pictures.

A.A.: There are two especially notable sentences in your introduction to one of the numbers dealing with printing techniques (6/1969): "The new is not really as important per se as coming to terms with it intellectually. And, the future of photography lies precisely in this 'adjustment and its adaption'".[8] What did you mean by that?

A.P.: As one example, I brought a reportage by Dean Brown that he had shot from a television screen, and pictures by Duane Michals (fig. 17) that dealt with the problem of picture sequence and serial pictures.

A.A.: You also showed your own photogravures in that number; they reminded me of Dadaism in the way they played with letters and numbers.

A.P.: However, they were "not (borrowed) interpretations" of photographs but consciously conceived combinations of images and writing that I had created using copperplate techniques (fig. 7).

A.A.: That number looked forward to the age of electronics!

A.P.: It did! In it, I showed photographs that dealt with the mass media of television and multimedia production, such as the method for looking at sound films developed by Harvey Lloyd in 1962: the "CBS-Cinemacenter- Multiscreen- Film for Mixed Media" that led to the presentation form for looking at enormous pictures.

A.A.: The **real** issue at the *photokina* in Cologne and at the *Rencontres Internationales de la Photographie* in Arles (1972).

A.P.: Oh yes! I organized seven exhibitions for the picture shows at the *photokina*; and I gave lectures on Josef Koudelka, André Kertész, Josef Sudek and other photographers in Arles.

8. *camera* 6/1969, 13.

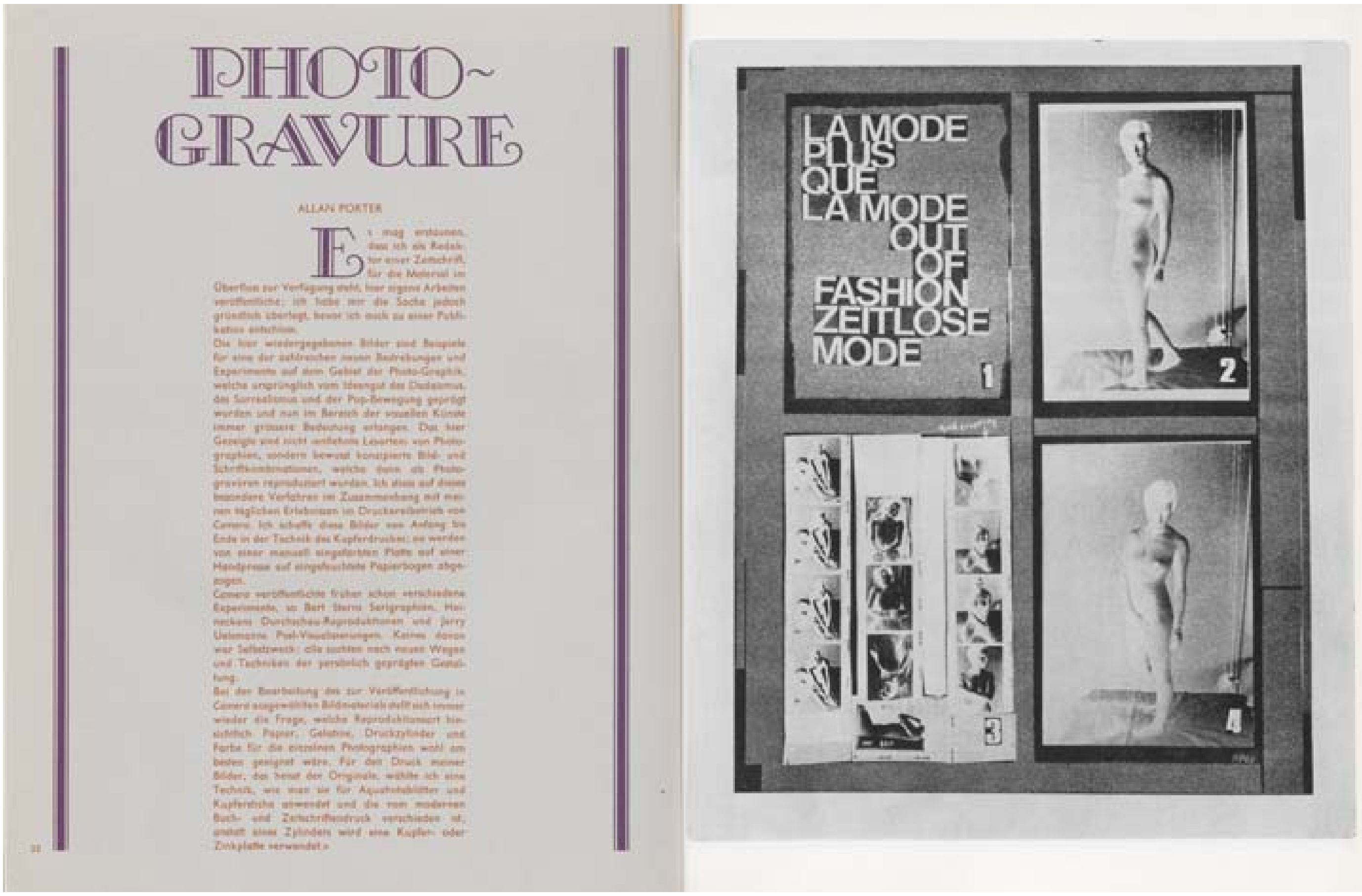


Figure 7
camera 07/1969, pages 32-33.
Photogravures: Allan Porter.

A.A.: Why did the Polaroid process appeal to you so much?
A.P.: After visiting Edwin Herbert Land (1909–1991) in Cambridge, Massachusetts, I published *camera* 10/1974 as a special Polaroid number (fig. 8). I had already photographed all of the pictures for *camera* 4/1966 on PN 55 and organized several exhibitions for Polaroid. When one of these was shown in the Musée de l'Élysée, I told its director at the time, Jean Favrod, that the entire exhibition should not be sent back to the USA and a part of it kept Lausanne.
A.A.: That's really interesting! There was a Polaroid exhibition in the WestLicht Gallery in Vienna in June 2011 where they showed parts of the 4400 works they had purchased from the Musée de l'Élysée.[9]
A.P.: Yes, I know that. But they didn't invite me to the opening even though the majority of these pictures were originally selected by me.

A.A.: As with virtually all of the volumes of *camera,* the number dealing with Heinrich Kühn (6/1977) is notable for its exquisitely beautiful design. How did you get hold of these pictures?
A.P.: I had learned about Kühn's oeuvre from *Camera Work* by Alfred Stieglitz. And, I had a girlfriend in Innsbruck in 1974. Her tennis partner was Dr. Diether Schönitzer, Heinrich Kühn's grandson who invited me to Birgitz and showed me the pictures by Kühn. Lotte Schönitzer[10] told me the whole family story. I took some pictures to make reproductions for *camera* and showed them to Harry Lunn (1933–1998).

9. Gregor Auenhammer, *Perfekt unperfekt*, Vienna: Standard, 13.08.2011, Album A 10; Archim Heine, Rebekka Reuter, Ulrike Willingman, *From Polaroid to Impossible. Masterpieces of Instant Photography, The WestLicht Collection,* Ostfilden: Hatje Cantz, 2011, exhibition catalogue 17 June–21 August 2011. For months, A.D. Coleman commented on the search for prospective buyers and the Polaroid auction at Sotheby's in New York on his blogs at www.noreply+feedproxy@google.com: 4 May 2010 *Polaroid Collection, Postmortem/Debriefing/Q&A*; 27 June 2010 *The Hammer Comes Down, Part 1*; 29 June 2010 *The Hammer Comes Down, Part 2*,. The ESHPh published excerpts in *The International Letter, Spring,* Vienna 2010, 23–24; *The International Letter, Autumn*, Vienna 2010, 17 – 19. www.donau-uni.ac.at/eshph.
10. Mother of Diether Schönitzer and youngest daughter of Heinrich Kühn.

Figure 8
camera 10/1974.
Cover: Warren Krupsaw,
Polaroid, Typ 58.
Austrian National Library,
Picture Archives and Graphic Department.

A.A.: How interesting! Harry Lunn sent us a letter in the fall of 1974 and said that he would like to visit Lotte Schönitzer. All three of us – Harry Lunn, Werner Mraz and myself – then traveled to Birgitz in February 1975. I remember that Harry Lunn soon took out his checkbook and made purchases for a considerable amount of dollars. He also never made it a secret that he had been a member of the CIA until 1967. In 1971, he completely changed the focus of his gallery towards photography and became one of the most successful photo dealers in the 1970s and 1980s. There is proof that there were connections between the Austrian art and literature scene and the CIA in the late 1950s.[11]

A.P.: You should realize that, during the Cold War, the CIA established a large network of cultural programs with the goal of countering Communism; this included introducing pop art and American abstract expressionist paintings to European museums.[12]

A.A.: You devoted a *camera* to the culture prize winners of the Deutsche Gesellschaft für Photographie (DGPh) just as you did for the recipients of Guggenheim Grants in the 4/1966 edition.

A.P.: Yes. In the October 1966 number, I published excerpts from the congratulatory speeches along with photographs by the winners of the DGPh cultural prizes. But, I would like to briefly go back to *camera* 4/1966: I must tell you that when Minor White saw my Guggenheim number he told me that he wanted to make his next editions of *Aperture* exactly the same!

A.A.: But didn't Minor White start publishing his *Aperture* magazine in 1952?

A.P.: Yes, but the early numbers had a smaller format and this made people feel that *Aperture* was merely a catalogue and not actually a journal! That is why Minor White changed its appearance.[13]

Encounters: *camera* and *Die Brücke*

A.A.: *camera* appeared twelve times a year and was an important source of inspiration for museums, galleries and photographers – and also for my gallery activities. I was able to encourage 400 people to subscribe to *camera* in the photographic bookshop[14] that was attached to my gallery.

A.P.: I know; that really surprised us! And we then listed your photo gallery *Die Brücke* as our Austrian representative for the first time in *camera* 12/1972 (fig. 9).

A.A.: The number of American photographers in *camera* is not the only conspicuous thing; you were also one of the first photo editors to place color photography on the same level as black-and-white and published works by Eliot Porter, William Egglestone and Stephen Shore[15] (fig. 10).

11. Gerhard Habarta, *Frühe Verhältnisse. Kunst in Wien nach '45*, Vienna: Der Apfel, 1996. 208, 209, 210.
12. Frances Stonor Saunders, *Who Paid the Piper. The CIA and the Cultural Cold War,* London: Granta Books, 1999/2000. The book received the Gladstone History Book Prize of the Royal Historical Society (author's comment).
13. Minor White (1908–1976), American photographer, founded the magazine *Aperture* in 1952 together with Anselm Adams, Barbara Morgan, Nancy und Beaumont Newhall, editing it until 1975. The format of camera: 29 x 22,3 cm.
14. Auer 1999 (reference 1), 41–42.
15. Christoph Schaden, *New Color – Colour Photography in the USA*, lecture held on 28 October 2011 at the conference: *Auf der Suche nach natürlichen Farben. 150 Jahre Farbphotographie (On Search for Natural Colours. 150 Years Colour Photography)* organized by the German Society for Photography (DGPh) and the Industry and Film Museum Wolfen (IFM), former Agfa Film factory Wolfen (28 – 29 October 2011).

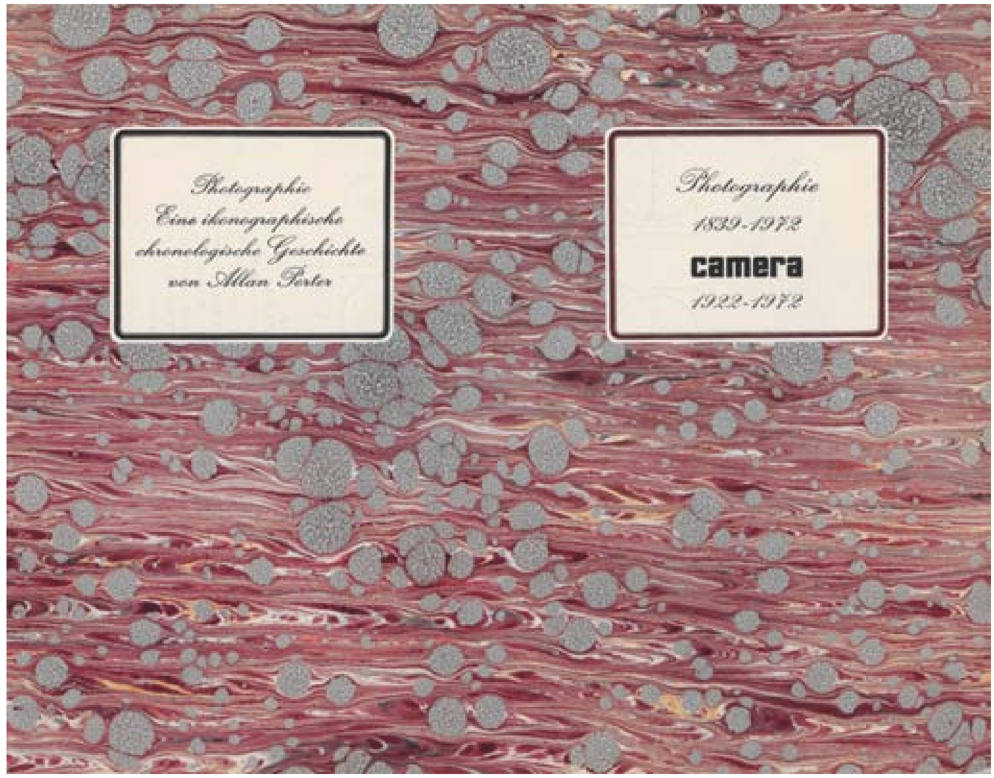


Figure 9
camera 12/1972.
Special edition of 50th Jubilee of camera.

A.P.: That's right. You must realize that these young American photographers were still completely unknown in Europe and *camera* offered them their first platform to appear before the public (fig. 11).

A.A.: We first met in Vienna in December 1972. The occasion was the 50th anniversary of *camera*[16] (fig. 12) when we showed your traveling exhibition *Sequence* in *Die Brücke*.[17] The impact this exhibition had on the work of European photographers could still be felt years later.
A.P.: I feel the same way. My exhibition was also shown in the *Photographer's Gallery* in London. Colin Osman (1929–2004) was so enthusiastic that he immediately started a similar journal in London; he was very successful with his *Creative Camera* in 1968. In addition to pictures from international photo history, he also introduced many young English photographers just I had done with young Americans in *camera*.

A.A.: Do you know the book *Dialogue with Photography*?[18] I modeled my own interview book *Fotografie in Gespräch*[19] on it.
A.P.: You have to know that I was responsible for most of the correspondence with the photographers for *Dialogue with Photography*. I had already published some of the interviews in *camera* before the book came out. Thomas Cooper is an outstanding photographer – he comes from the Minor White School – and Paul Hill taught at Trent Polytechnic in Nottingham.

A.A.: The first comprehensive retrospective of the work of Alfred Stieglitz[20] was organized by the Metropolitan Museum in New York; the curator was Weston Naef. It was never intended to leave the USA but I was able to show a smaller version of it in the Viennese Secession.[21] It caused quite a stir in the media.

16. *camera* 12/1972. Anniversary edition: 'Photography. An iconographic chronological history by Allan Porter. Photography 1839-1972. camera 1922-1972.'
17. *camera* 10/1972, exhibition catalogue 10 December 1972–8 February 1973.
18. Paul Hill, Thomas Cooper, *Dialogue with Photography*, New York: Farrar/Straus/Giroux, 1979.
19. Anna Auer, *Fotografie im Gespräch*, Passau: Dietmar Klinger, 2001.
20. Weston J. Naef, *Fifty Pioneers of Modern Photography. The Collection of Alfred Stieglitz*, New York: The Viking Press, 1978.
21. *Die New Yorker Photo-Secession zu Gast in der Wiener Secession* (6–20 December 1979).

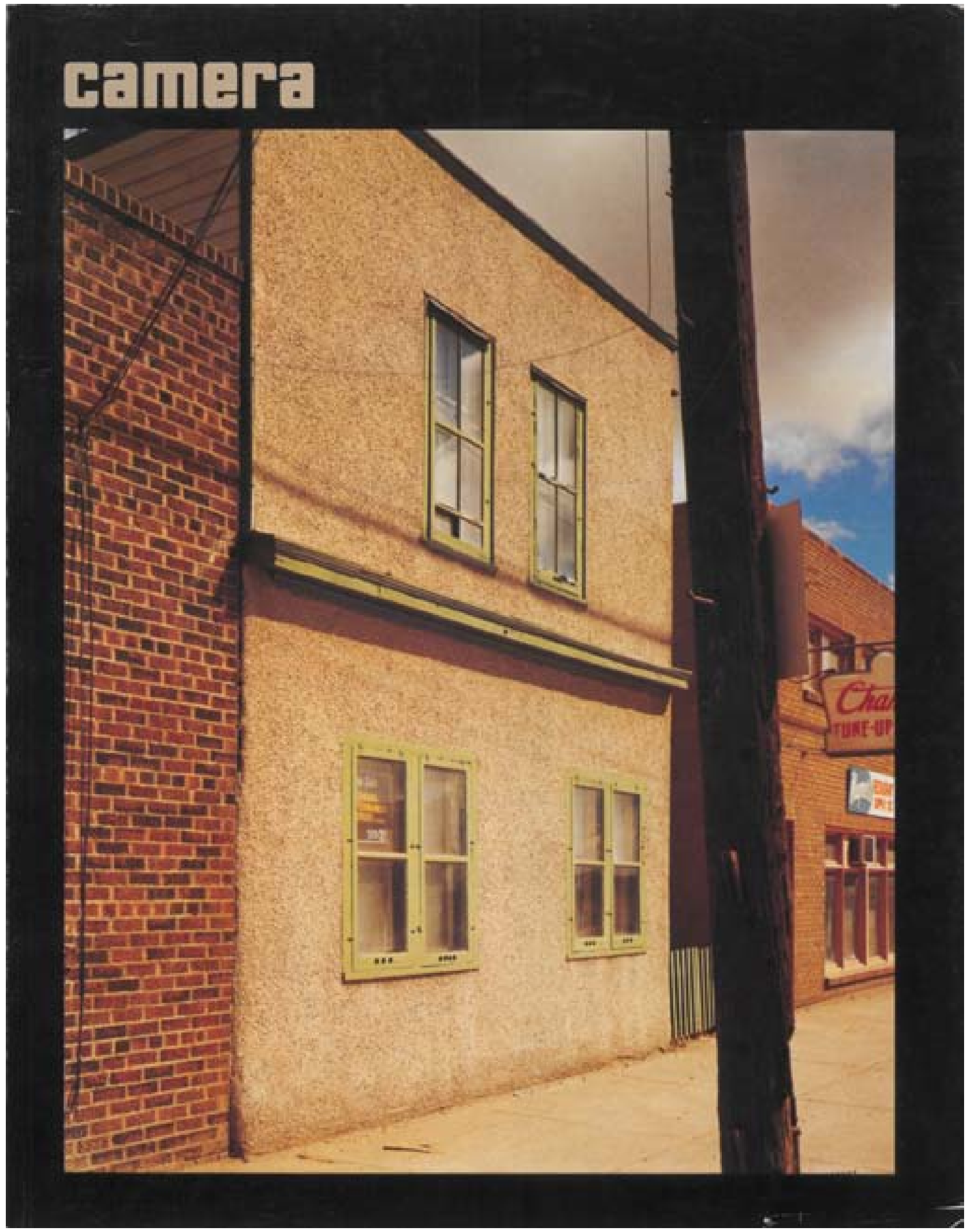


Figure 10
camera 01/1977.
Cover: Stephen Shore
Typ ‘C’ Print.

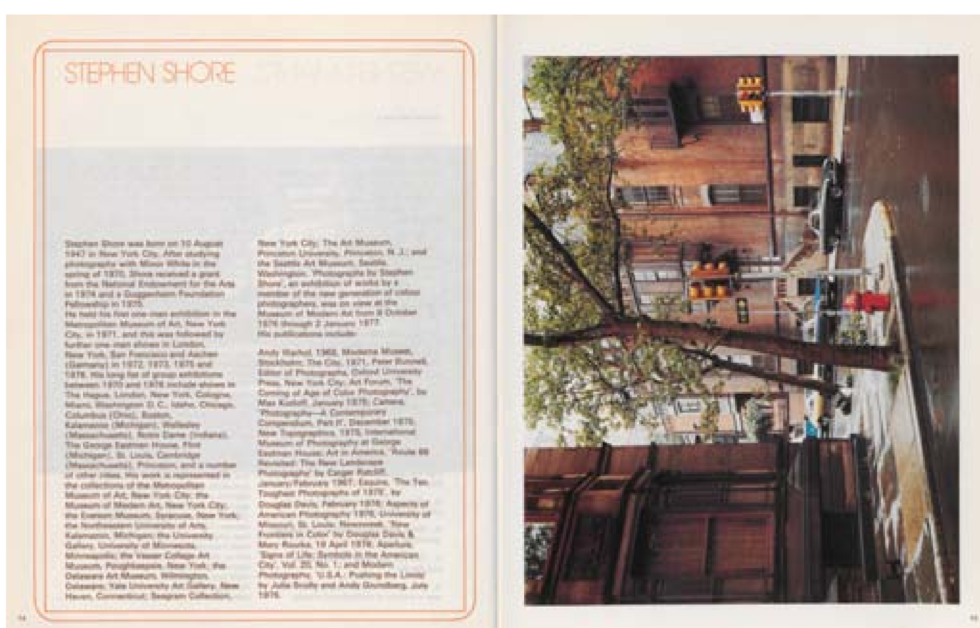
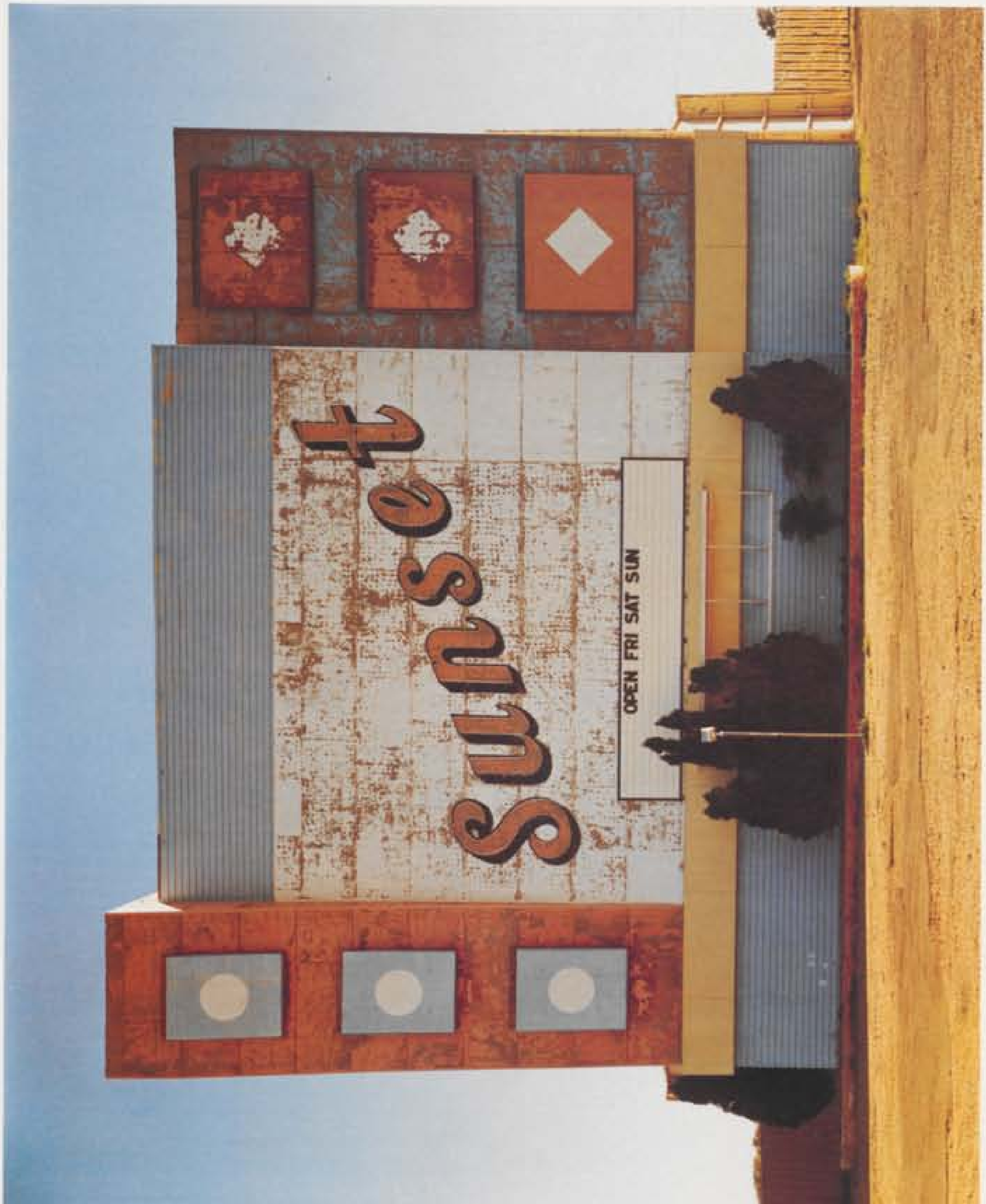


Figure 11
camera 01/1977, pages 14-15.
Photographer: Stephen Shore.


The Falls
The Falls


Sunset
OPEN FRI SAT SUN

<<
Figure 12
camera 01/1977, pages 18-19.
Photographer: Stephen Shore.

Figure 13
camera 02/1976.
Cover: Karl Blossfeldt.

A.P.: Weston is an interesting person who knows a great deal about the history of photography. Later, he went to Los Angeles where he founded the photographic department of the J. Paul Getty Museum in 1984 (figs. 13 and 14). And, I'm sure you know that Weston made the wonderful book about Pictorialism *The truthful lens.*[22]

A.A.: In 1992, Weston invited me to California for a three-month study period at the J. Paul Getty Museum in Malibu where I was able to continue with my research into Austrian photography in the emigration. The result was the exhibition *Übersee* shown in the Kunsthalle in Vienna in 1998.[23]

A.P.: I heard about it; it must have been a very impressive presentation.

A.A.: The photographic department of the Getty Museum was officially founded in 1984 but I am sure there must have been a lot of lengthy preparations before that.

A.P.: Oh yes, it was like this: Weston was still working for the Metropolitan Museum and so had to stay in the background; Daniel Wolf, a New York art dealer, was commissioned with making the acquisitions. His father was on the board of J. Paul Getty's major American oil company and naturally knew about the plans to found a photo collection at the Getty Museum. He was instrumental in having his son with the Getty Museum before it even opened. Vincent Vallarino, a talented young photographer who worked in my archives for two months, assisted Daniel Wolf in obtaining the pictures. Vincent knew Minor White, Paul Caponigro and all of these people and was able to open many important doors for Daniel Wolf.

The Swiss Foundation for Photography

A.A.: When was the Swiss Foundation for Photography founded?

A.P.: The idea goes back to 1965. The aim was to preserve the estates of Swiss photographers for posterity. In October/November 1970, an exhibition entitled *The Concerned Photographer* was held in the Centre Le Corbusier in Zurich[24] during which the notion of founding the Swiss Foundation for Photography and linking it with the *International Fund for Concerned Photography* established in New York by Cornell Capa was launched.

22. Lucien Goldschmidt, Weston J. Naef, *The truthful lens: a survey of the photographically illustrated book, 1844–1914*, New York: Grolier Club, 1980, based on an exhibition held at the Grolier Club, December 1974.

23. Anna Auer, *Übersee. Flucht und Emigration österreichischer Fotografen 1920–1940 (Exodus from Austria. Emigration of Austrian photographers 1920–1940)*, exhibition catalogue Kunsthalle Vienna, Vienna: Kunsthalle 1997.

24. *camera* 4/1981, 20.

Figure 14
camera 10/1975.
Cover: Imogen Cunningham.

A.A.: Doesn't the charter state that there was to be cooperation with the *ICP* (International Center of Photography) in New York with the aim of reciprocal orientation and documentation as well as organizing and presenting joint exhibitions?[25]

A.P.: Exactly! But, I soon told the members of the Foundation's management council that I would drop out if the Foundation was only a branch of the ICP and not an independent Swiss foundation. While the Foundation was being established in 1971, I spoke to Cornell about changing the name from *The Concerned Photographer* to *International Center of Photography (ICP).*

A.A.: But doesn't *The Concerned Photographer* go back to an idea of Cornell Capa (1918–2008) who founded the ICP together with Micha Bar-Am in 1974?

A.P.: This is how it happened: In the mid-1960s, I visited Cornell in his small two-room apartment in New York. At the time, he told me that he intended to change the *International Fund for Concerned Photography* that he had established in 1966 to honor the photographers Robert Capa, Werner Bischof, David Seymour and Dan Weiner, who had all died in the 1950s, into an institute named *Concerned Photography*. I suggested making a special number of *camera* available to him – free of charge – for his planned exhibition in New York in which he would be able to present his project. I produced 50,000 copies of this number in the J.C. Bucher Verlag in May 1969. We used the same volume as the catalogue for the Zurich exhibition *The Concerned Photographer*, which I mentioned before.

A.A.: When did the Foundation start its work?

A.P.: After the annex to the Kunsthaus in Zurich had been completed, the Foundation took over its premises in February 1976 with the exhibition *Robert Frank*. Originally, it was planned that the Foundation be headquartered in Lucerne.

A.A.: Why Lucerne?

A.B.: The Swiss government gave us one million Swiss francs for this. Originally, Alice Bucher also wanted to contribute one million francs but withdrew her offer because she was already considering selling her publishing house. Now, the Foundation is located in the Fotomuseum Winterthur.[26]

25. Olonetzky 2007 (reference 5), 54.
26. Olonetzky 2007 (reference 5), 54 and 56.

Figure 15
camera 12/1977.
Cover: Lisette Model.

A.A.: How do you manage to always be so well informed about everything?
A.P.: It's really quite simple: Whenever I travelled to New York, I went to the MoMA and visited Grace M. Mayer (1901–1996) there; she was the sister of Louis B. Mayer, the head of Metro Goldwyn Mayer. She started at the MoMa in 1949 and collaborated closely with Edward Steichen, the former director of the museum's photo department. Of course, another person I always visited was Lisette Model. That's how I kept up to date.

A.A.: How did you get to know Lisette Model (1901–1983)?
A.P.: I met Lisette for the first time in New York in 1965 shortly before I had taken over the editorship of *camera*. We met in the apartment of Harvey Lloyd who knew Lisette wanted to meet me and the future editor of *camera*. We talked for hours about photography and our mutual friend Brodovitch.

A.A.: Didn't Lisette Model receive a Guggenheim Grant in 1965?
A.P.: Yes, and that's why I met Lisette for an interview in New York; I wanted to list all of those who had received a grant from the John Guggenheim Memorial Foundation in the April 1966 number. But Lisette was against our interview being published.

A.A.: Did the interview with Lisette Model ever come into print?
A.P.: I met Lisette a few times again in New York in May 1977 to prepare a sixteen page portfolio of her work for future publication in *camera*. In September, Lisette came to Lucerne for a month with her pictures and we created "her" number (*camera* 12/1977) together. She had a lot of great ideas (fig. 15). By the way: today, the Lisette Model archives are in Canada.[27]
A.A.: Now I'd like to discuss one of the icons of American photography in the 1970s: Diane Arbus (1923–1971), one of Lisette Model's students. You gave a very touching account of the last time you saw her in *camera* [28] (fig. 16).
A.P.: Yes. We had a very special kind of relationship. The first time we worked together was in 1960 when I was art director of *Seventeen Magazine* and she and her husband Allan were

27. The estate of Lisette Model is stored in the National Gallery of Canada, Ottawa, file no: LM.AR2 F1.
28. *camera* 11/1972, 4, 21, 22.

Figure 16
camera 11/1972.
Cover: Diane Arbus.

active in the fashion photography area. I visited her in her apartment in Greenwich Village West in the early 1970s. When I left, I saw a small black cloud hovering over her house. It seemed to me to be an omen of death. In summer 1971, while I was preparing *camera's* "The Woman and Photography" number (2/1972), the telephone rang and my secretary told me that Diane had just committed suicide.

A.A.: Intuition? Don't things like that sometimes happen to people who are involved with art?
A.P.: Possibly. I have always let intuition lead my life and was lucky enough to often find myself at the right place at the right time!

A.A.: With *camera* in Lucerne?
A.P.: Maybe.

The future of photography

A.A.: How do you see the future of photography in our digital age? Today, a picture is digitalized and an exact "clone" produced; that means a copy with a constant quality.
A.P.: Each and every form of information is affected by digitalization today: newspapers, books, music and images. I feel that video art will gradually disappear from the museums and galleries. All of these things will only show up on the internet in the form of blogs. Photography has long become part of the internet. Today, you can click on almost any museum on the web, from George Eastman House (GEH) in Rochester, over the MoMa in New York to the SEFOMA in San Francisco. No problem at all! The point is that now photography, just like literature, is being defined differently.

A.A.: What do you mean by that?
A.P.: There are two kinds of photographs: 'discoveries' and 'inventions'. Today, a discovery is often turned into an invention because all images are digitally processed (...). The original will become less important. Digital prints will become as permanent, if not more so, than old analog prints. Sunlight changes the chemistry of a print. The colors of a digital print are

inorganic meaning that they will last much longer. And: Today, we are living in a facsimile millennium! The content of an image will always be important regardless of whether it was produced by a digital or analog medium.

A.A.: What are you doing to keep busy at the moment?

A.P.: I am currently working on twelve books at once and writing a cultural history of the media from cave paintings to today's computer images entitled *Media Milestones*.

A.A.: When will it be finished?

A.P.: I can't say that at the moment.

A.A.: Many thanks for this interesting discussion!

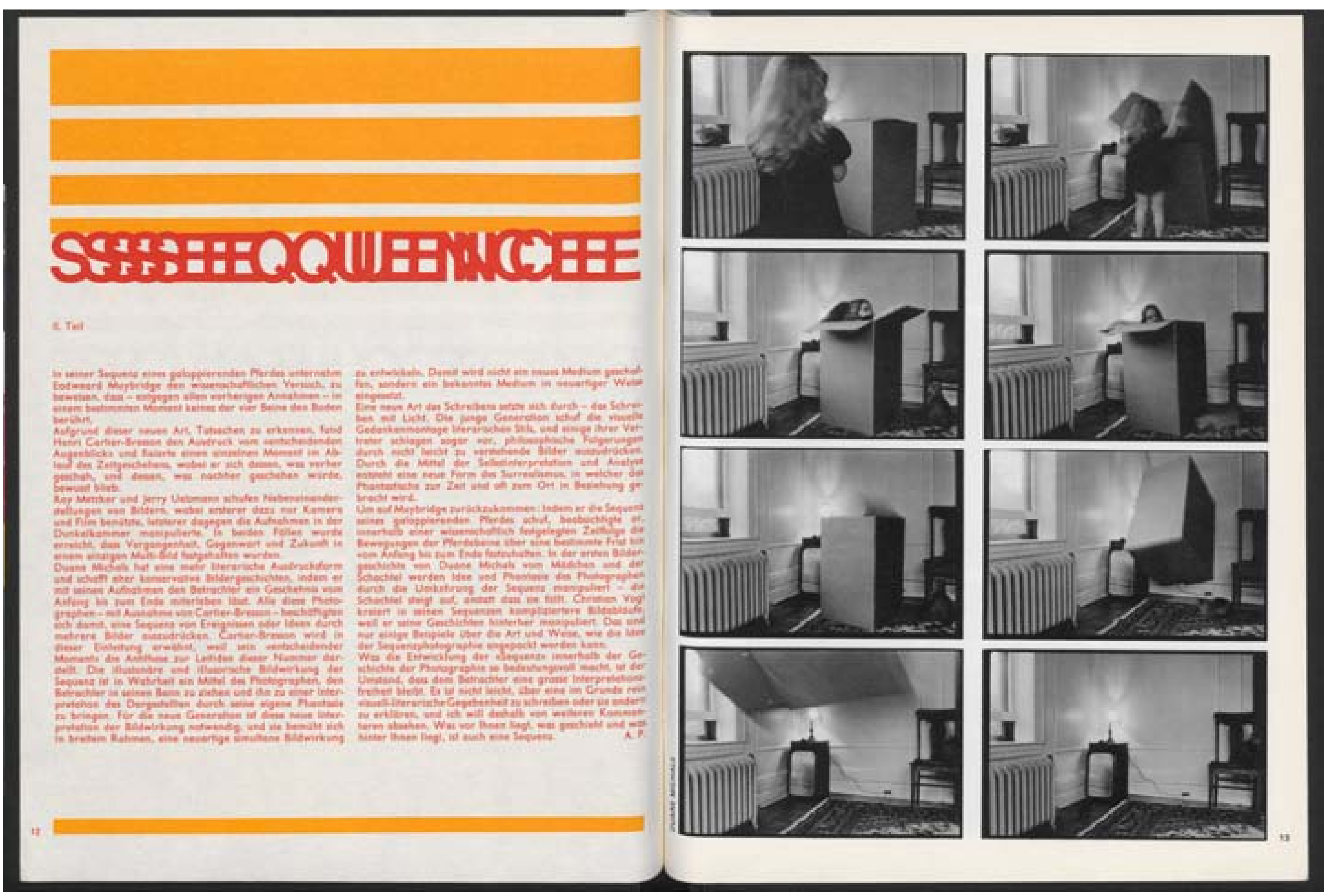


Figure 17
camera 10/1972, pages 12-13.
Photographer: Duane Michals.
Austrian National Library,
Picture Archives and Graphic Department.

Biographies

Anna Auer, Vienna, Austria
Born 1937 in Klagenfurt (Austria); member of the ESHPh Advisory board since 2011; studied at the University of Dramatic Art Mozarteum in Salzburg; founder of first Photo Gallery on the European Continent *Die Bruecke*, in Vienna (1970–1978); 1976 to 1986 founding director – together with Ivo Stanek (managing director) – of the private photographic collection *Fotografis* of the Austrian Laenderbank (now UniCredit Bank Austria AG); 1976–1981 numerous symposia about the history of photography; 1992 grant from the J. Paul Getty Museum, Los Angeles, leading to the exhibition *Exodus from Austria – Emigration of Austrian Photographers 1920–1940*, Kunsthalle Wien 1998; ESHPh President 2001–2010; co-editor of PhotoResearcher 2004–2010; awarded the title of professor in 2008.

Ulla Fischer-Westhauser, Traiskirchen, Austria
Born 1955 in Vienna, Austria; ESHPh Vice President since 2010, historian and anglicist. 1997–2003 free-lance academic assistant and curator at the Department of Pictures of the Austrian National Library; 2003–2010 curator for photography at *Westlicht. Schauplatz für Fotografie*, Vienna; numerous exhibitions and publications on the history of photography, history of economics and Habsburg topics; most recent publication: 'Die Ausstellungspraxis der Photographischen Gesellschaft im Spannungsfeld von Kunst und Industrie' in: Michael Ponstingl (ed.), *Die Explosion der Bilderwelt. Die Photographische Gesellschaft in Wien 1861–1945*, Vienna: Brandstätter 2011; in preparation: exhibition on Empress Elisabeth and the construction of idealized family images (as part of the newly arranged permanent exhibition of the Photomuseum Bad Ischl, Austria).

Heidemarie Halbritter, Vienna, Austria
Born 1955 in Vienna; studies in music (violin diploma 1982), biology (PhD in botany 1988) and medicine (graduation 2001); since 1988, member of the Department of Structural and Functional Botany, University of Vienna, research focus on morphology and diversity of pollen; improvement of preparation techniques for pollen in scanning electron microscopy; numerous publications on palynological topics, main supplier of pictures for the world's largest palynological database PalDat: www.paldat.org.

Michael Hesse, Vienna, Austria
Born 1943 in Vienna; study of biology at the University of Vienna, Austria, PhD 1968; 1992–2004 Head of the Institute of Botany at the University of Vienna; 2005–2008 Head of the Department of Palynology and Structural Botany at the University of Vienna; scientific research and academic teaching: Electron Microscopy in Palynology and Pollen Development; more than 190 publications in national and many international journals.

Heinz-Michael Jostmeier, Nuremberg, Germany
Studied visual communications/photography at the Folkwang School Essen, then worked as manager of a public relations agency; since 1996 Professor for Media Design and Computer Generated Imaging at the Faculty for Design of the Georg Simon Ohm University Nuremberg; appointed member of the German Photographic Academy (DFA) and the German Society for Photography (DGPh); 2002 and 2004 organizer of the DGPh symposia *Das Digitale Bild _ Bildung des Digitalen;* since 2006, realization of CGI projects for the visualization of vehicles in cooperation with BMW AG, Munich, AUDI AG, Ingolstadt und VW AG Wolfsburg; since 2006, in charge of the first CGI module at a German university.

Nadja Lenz, Cologne, Germany
Born 1976 in Neubrandenburg, Germany. Studies in communication design at Burg Giebichenstein in Halle/Saale and the Berlin University of the Arts (UdK); Senior Art Director at a public relations agency in Frankfurt. She is currently working on a thesis on latency and cryptography in photography at the Department for Art History Cologne (Prof. Dr. Herta Wolf). Nadja Lenz publishes in *Camera Austria* and *Rundbrief Fotografie*.

Carmen Pérez González, Cologne, Germany
Studied astrophysics, photography, and art history; thesis *A Comparative Visual Analysis of Nineteenth-Century Iranian Portrait Photography and Persian Painting* (awarded the ICAS Best PhD Thesis Prize 2011); numerous publications on Asian photography in academic journals; currently working at the Museum of East Asian Art in Cologne, curating the exhibition (and catalogue) *From Istanbul to Yokohama: The Camera Meets Asia, 1839–1900.* In preparation: *Local Portraiture: Through the Lens of the 19th Century Iranian Photographers*, Leiden University Press, March 2012.

Christoph Schaden, Cologne and Nuremberg, Germany
Studies in art history, psychology and contemporary German literature; since 1997/98, partner of the publishing house Schaden Verlag and of the bookshop Schaden.com; 2004–2010 member of the board of the German Society for Photography (DGPh); since 2005, freelance work on photography and art; numerous publications on photography. In 2010 he became Professor for Image Science at the Georg Simon Ohm University of Applied Sciences Nuremberg, Faculty of Design; currently working on research into the reception of the US-American New Color Photography in Germany.

Katharina Steidl, Vienna, Austria
Studies in art history in Vienna and Saragossa, Spain; Junior Fellow at the International Research Center for Cultural Studies and the Institute for Human Sciences, both in Vienna; research work at eikones, Basel, and the Max Planck Institute for Art History, Florence; currently visiting scholar at the Center for Literary and Cultural Research Berlin, Germany, working on a thesis on 19th century cameraless photography in natural sciences, amateur art and occultism. In preparation: 'Impressed by nature's hand. Zur Funktion der Taktilität im Fotogramm', in: Uwe Fleckner, Iris Wenderholm, Hendrik Ziegler (eds.), *Das magische Bild. Techniken der Verzauberung vom Mittelalter bis zur Gegenwart*, Berlin: Akademie Verlag.

Jennifer Tucker, Middletown CT, USA
Associate Professor of History at Wesleyan University; specialized in the historical study of British society, science and visual culture; author of *Nature Exposed: Photography as Eyewitness in Victorian Science*, The Johns Hopkins University Press 2006; she edited a special issue of *History and Theory* (vol. 48, 2009) on 'Photography and Historical Interpretation' and serves as Image Editor of *History and Technology*; currently completing a book about the role of photography and graphic display in the celebrated 19th-century British trials of the Tichborne "Impostor".

Kelley Wilder, Leicester, United Kingdom
Born in Canandaigua near Rochester NY; doctoral dissertation *Language and the Invention of Photography* at Oxford University; from 2005–2008 research on 'observation and photography in the work of Henri Becquerel' at the Max Planck Institute for the History of Science; author of *Photography and Science*, and, since 2008, Senior Research Fellow and Leader of the MA Programme in Photographic History and Practice at the Photographic History Research Centre (PHRC), De Montfort University, Leicester, United Kingdom. Most recent publications: 'Visualizing Radiation: The Photographs of Henri Becquerel', in Lorraine Daston and Elizabeth Lunbeck (eds.), *Histories of Scientific Observation,* Chicago: Chicago University Press, 2011 and 'Die fotografische Methode: Beobachtung, Experiment und Visualisierung', in *Fotogeschichte* 122, 2011.