Kunstaugen-Augenkunst

„The eye would never have seen the sun, if it wasn't of a sunny nature itself"
Plotin

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Kunstaugen-Augenkunst

"The most beautiful of a human being is its eye. It receives the spark of life, the light, and gives it back as a ray of gratitude. The sun created the human eye to admire itself and its beauty. The space gleams in our eyes and it dies away in our tears"
Carl Ludwig Schleich

Preface and introduction by Günter Schlüter, Lauscha

175 years of German eye prosthesis manufacture give cause to a special exhibition in the museum for the art of glass in Lauscha and are trigger for retrospection on the historical, medical and technical development of the eye prosthesis, the artificial eye. Both, exhibition and publication, do not claim to be scientifically complete, but are bound to be incomplete.
The complexity of the subject demands in the conceptual realization to dare the gap.

The manufacture of artificial eyes developed and was applied during and in manifold historical and technical stations. Even 5000 years ago sculptures and mummies were outfitted with artificial eyes. Discoveries from Mesopotamia and Egypt show a variety of eye manufacture and used materials. In ancient Rome specialised craftsmen fabricated and inserted artificial eyes in statues, the so-called "fabros oculariarios statuarum".
Results of the latest research show discoveries in the bronze age settlement Shahs-i-Sokhta at the

Afghan-Iran border. Archaeologists found a female skeleton with a hemispherical artificial eye made of some kind of bitumen (asphalt) its surface was probably covered in gold. But was this truly a prosthetic eye substitute? From which time on were artificial eyes used as prosthetic substitute in human beings, remains controversial.

Artificial eyes, in the sense of prostheses, used to be the topic of speculative contemplations regularly. Evidences of eyes from Italian manufacture (Geronimo Fabrizi, Venedig 1617) were never scientifically proven. Unchallenged however, are transmissions of the French surgeon Ambroise Paré (1510-1590) on artificial eyes in the form of metal forms made of gold or silver. Incompatibility and uncomfortable wearing of those prostheses led to the use of glass in the further development. After the mid-eighteenth century was Paris the centre of this development. Known French eye artists like Hazard-Mirault, Desjardin, Noel, Boissonneau and others brought the artificial glass eye in the following years on technical, medical and economical road to success. The pioneers of the prosthetic eye substitute worked in France.

The crucial impulse for the development of the "modern eye prosthetics" in Germany occurred 1832 through Heinrich Adelmann, professor in Würzburg. He won the glassblower Ludwig Müller-Uri from Lauscha to make artificial glass eyes. The "Parisian eyes" which Müller-Uri received from Adelmann became model for the development of an artificial eye which should meet all requirements. Exhaustive researches on usable material, optimising the shape of the eye, the manufacture of the iris and plenty of other technical details were required.

"For the eye sees not itself, but by reflection, by some other things" William Shakespeare.

Ludwig Müller-Uri, the sons Reinhold and Albin as his nephew Friedrich Adolf Müller-Uri developed the unprecedented artificial glass eye, they developed a product which meets up to this day the material, artistic and medical requirements. They established a basis for artificial eyes made of glass that deserve the denotation "eye art".

Kunstaugen-Augenkunst

„The eye
If the eye was not sunny, the sun could never behold it. Lieth not gods own power in us, how could the godly rapture us?"
Johann Wolfgang von Goethe, Zahme Xenien

by Norbert Zitzmann, Lauscha

Artifical eyes and "eye art" point both to "seeing", "not seeing" and "to be seen". That lets on about what we know about the multiple meanings of "aesthetics". That is the relationship between the beauty in hearing, judging in perception, the perceptive and the act of perception, in what intersection Aristotle thought the truth/reality to be. [1]

Addressed is both the peculiar on perfection directed relationship between cathartic illumination and purified illumination [2].
The elders still believed in an eye fire, which illuminated the to be seen in seeing, while one

[1] Aristoteles: De an III 2,425 b26// Sofern das Wahrzunehmende vom Wahrnehmungsakt unterschieden sein soll.

[2] Wie das Eine aus- und überströmt und so das zum Einen gewendete (Universum) entstehe, vollende sich die menschliche Seele durch Loslösen vom Materiellen (katharsis) und aufzusteigen zu ihrer wahren Natur, nämlich der Welt des reinen Geistes // Plotin: Enneaden, V, 2, 1 und VI, 9,9.

discovers something in seeing [3]. The eye as the godly organ of light was the premise for the illumination of the godly light in unsubstantial material and condition of the possibility of material light, which we are used to call "things" [4]. „*The eye would never have seen the sun, if it wasn't of a sunny nature itself; in the same way a soul couldn't see beauty, if it wasn't beautiful itself*" [5].

The Egyptians believed, that Ra [6] had put the flame goddess Tefnut as eye and diadem on his forehead, for that she chases evil and disperses order, truth and justice with her flaming light. "Aesthetics" stands here already for knowledge and beauty. The light of the sun was brought into relation with the continuous gaze of the creator upon his creation, sun and moon were fought to be gods eyes, men were the "eye creatures" [7]. Gods gaze saturated the world not only with his light, but also with meaning: " *Then with you is the living spring. And in your light we see the light*" [8], is the psalm poet praising.

[3] Konrad von Megenberg berichtet über den römischen Kaiser Titus, dessen Augenfeuer so stark gewesen sein soll, dass dieser im Dunkeln hätte sehen können.
[4] Plotin, Dionysius Areopagita // Bei den Ägyptern stellt die spontane Selbstenstehung des Sonnengottes im ersten Sonnenaufgang den Anfang der Welt dar.
[5] Plotin: Enneaden, I, 6,9 // Ach noch Meister Eckhart: *„Das Auge, in dem ich Gott sehe, das ist dasselbe Auge, darin mich Gott sieht; mein Auge und Gottes Auge, das ist ein Auge und ein Sehen und ein Erkennen und ein Lieben"* // Predigt 12 „Qui audit me" // Deutsche Predigten und Traktate // Quint S. 214.
[6] Sonnengott
[7] Belz 1987, S.94 ff. // Assmann 2004
[8] Lutherbibel 1545 // 26. Psalm Vers 10.

The sick eye was ascribed as the "evil eye" [9]. The Holy Thomas of Aquin warned of the poisonous gaze of old women who were in league with the devil. Their gaze was thought to pollute the air and blind mirrors, similar to what resulted from menstruating women[10]. The speculum in medieval times saw more than the beholder [11] and slowly, from the evil eye developed the fascination which, since Leonardo da Vincis autopsies, remains to this day with Gunther von Hagens "Körperwelten".

The eye of the beholder and the beheld eye, two unequal brothers?

[9] Lat.: fascina
[10] Thomas von Acquin // Summa Theologica I., q. 117 // siehe auch von Megenberg 1861, 5, 25.
[11] Weshalb der Spiegel der Selbsterkenntnis diente.

In the twinkling of an eye…

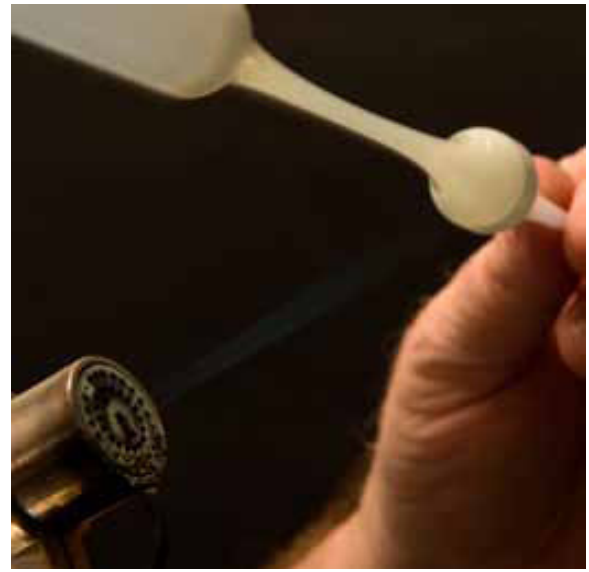
An Interview with Jan Müller-Uri (J), Wiesbaden and Andreas Müller-Uri (A), Lauscha

From the beginning, the museum for glass manufacture in Lauscha – a place of collection, preservation and presentation of the glass art and manufacture - shows glass objects from the domains of technique and medicine.
Therefore, the visitor gets a glimpse into the technique and development of the modern eye manufacture. The manual perfection, the control over the material glass and the medical knowledge needed for the fabrication tends to raise questions.
The interested reader and visitor should get to know some secrets of the glass manufacture in the following interview. Who is better suited to answer those questions than two master craftsmen, who continue a family tradition.

In the beginning allow me a question concerning the genealogy of the family Müller-Uri. In what relationship are you to each other?

J: To answer this question thoroughly we'd need to go through our family history, which goes back to the founder of Lauscha Christoph Müller (1545-1628). There lies our common origin, a family history of 13 generations. Prostheses were manufactured in 6 generations of the Müller-Uris. Beside the development in Lauscha, Friedrich Adolf Müller-Uri (a nephew of Ludwig Müller-Uri) founded the "Institute for artificial eyes" in Wiesbaden.

A: I would like to add, that the origin of the development in the Wiesbaden-line, as in the Lauscha-line lies with Ludwig Müller-Uri. Close contact is kept up until now.



An often raised questions among our visitors: What actually is an eye prosthesis?

A: An eye prosthesis is a substitute for an eye, a prosthesis which balances out the lost eye volume, in case the eye shrank or had to be removed. The front side of the eye prosthesis is matched to look similar to the remaining eye. The form of the backside is determined by the orbit, the eye socket. The eye prosthesis helps to regain the natural look. A well fitted and manufactured eye prosthesis is able to reduce physical and psychical adverse effects of the loss of an eye. So, an eye prosthesis is an artificial eye which, in its design, should not have any difference to a natural eye.

…and how long does an eye prosthesis last?

J: This answer cannot be answered generally. The eye is in constant use due to the lacrimal/tear fluid. From our daily experience we know that eyes last between six months and 3 years. In a small percentage of cases it lasts even longer, but never lifelong. The mean value is one to two years. Individual meanderings are always possible.

What has the bearer of an eye prosthesis to consider?

J: A precondition for wearing an eye prosthesis is cleanliness. When wearing a prosthesis one has to keep in mind to brush from the outside to the inside, for not brushing out the eye. Daily removal and cleaning is not needed. Due to sanitary reasons it is recommended to clean and remove secretion on the prosthesis at least weekly. There are patients who choose a longer interval. But it should be at least once a month. If the wearer is having an intact cornea it is advisable to remove the prosthesis nightly, to administrate enough oxygen.

What medical, anatomical or biological conditions demand the use of an eye prosthesis?

A: This has a lot of reasons. Inborn anomalies, accidents and illnesses like cancer, a high eye pressure or inflammations. All those are reasons for the removal of an eye and the use of a prosthesis.

There exist a lot of terms for the same occupation or are there any differences?

J: The different terms have their origin in local and temporal situations. The difference is only in the term but not the occupation and the product of an eye prosthesis. In the modern eye manufacture manual skills are just an as important requirement as founded knowledge in material technique, anatomy and psychology. High expertise in the manufacture of prostheses and a professional handling of the patients are requirements for professionalism and absolutely value-free concerning the term of occupation.

Concerning the apprenticeship: How does one learn how to manufacture eye prostheses, what is the development concerning the content and time?

A: The apprenticeship is a two stage vocational training. In the first stage the student learns all basic knowledge concerning the technical manufacture of glass. He learns how to work glass and the steps of the manufacture of an eye prosthesis. After three years this stage is terminated with an exam and the occupational title of "assistant".

In the second stage which also lasts for three years, the students qualifies for ocularist. The assistant is now in contact with the patients. From so-called "semi-finished" prostheses he learns to manufacture the required eyes for the particular patient. This is the hardest part of the training. We describe this stage as a "learning by doing" process, which is under constant control and supervision of an ocularist.

J: The work with the patient must not be carried out without completion of the first stage. Without the qualification as an "assistant", the completion of a prosthesis and customisation on a patient are not allowed. To add is also that both stages include the teaching of theory and praxis.

The described apprenticeship requires persistence. What other requirements are needed?

J: For this six-year-long apprenticeship patience and persistence are needed, as are discipline, willingness to learn and precision. The development of a "feeling of the glass" is for the manufacture and design of prostheses a further basic requirement, as is interest in association with human beings.

Concerning the eye prosthesis: Ludwig Müller-Uri, pioneer of the modern eye prosthesis manufacture, what is his works importance for the development?

A: Ludwig Müller-Uri was the first who manufactured glass eyes in Germany with the French eye as prototype. In Germany he is the founder of the occupation ocularist. It is noteworthy that he didn't simply copy, but developed the French eye. His eyes were of high quality and were prized with national and international awards. Ludwig Müller-Uri laid the foundation for the development of the modern German eye manufacture in Lauscha, a success story of 175 years.

Two important terms in the eye manufacture are the "shell eye" and the "reform eye". What do they stand for and what are the differences in design and manufacture?

J: The "shell eye" is a one walled eye, which is formed from a blown bubble. The "reform eye" is double walled and therefore has more volume. Determined by the hollow space between front and backside, it has a thickness of at least 3mm.
In the beginning only one walled eyes were used, also in Germany. Leading doctors wished for that, but it was also a question of technical capability. It is said that Ludwig Müller-Uri already developed double walled eyes in 1832, but the break through was only around the turn of the century with the initiative of the Dutch doctor Prof. Snellen and the company F. Ad. Müller Söhne.

Nowadays both basic forms are obviously used. When and where are the utilised?

J: Even though the "reform eye" presents a development of the "shell eye" both are used. Which of the models is used is determined by the space in the patients' eye socket. At some time the "shell eye" was replaced by the "reform eye" for 2/3rd. With the development in ophthalmology and chirurgical possibilities to balance out the volume with implants, "shell eyes" are used more often again. The manufacture of both models is important to serve our patients.

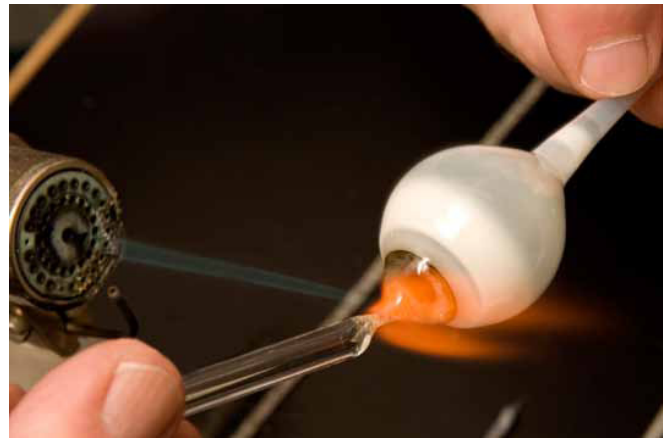
The main difference of the eyes is apart from size and form the colour and design of the iris. It is the iris which renders an eye unique. How do you succeed, despite of the variety of nature, to manufacture an artificial counterpart?

J: There exist two ways to manufacture an artificial counterpart. A for both the patient and ocularist

time-consuming practise is the manufacture of an eye which has all the characteristics of the healthy eye. The patient serves as a model for the ocularist.

We use another way. We choose from a range of pre-manufactured eyes, so-called "semi-finished" prostheses, the most suitable eye for the patient.

For that we have a collection of about 3000 colour pattern of the iris. This method is more effective. Both methods require good power of observation for a truthful and natural conversion. It's the entirety of design, rendering of the iris, pupil and volume of the sclera which decides whether the copy is a successful one.



Since the beginning of the manufacture of glass eyes for human beings, different kinds of glass were used. The best material was obviously found only with the usage of cryolith glass. What is the difference between this and other types of glass?

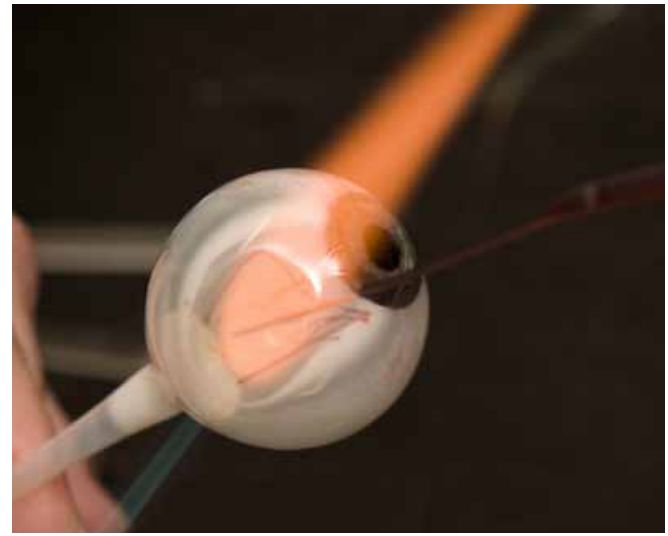
A: The French used lead glass which had the negative effect of discolouring, due to the tear fluid. After some time of wearing the sclera became grey or black. The glass was also unable to withstand the tear fluid and the surface of the prostheses became coarse. Ludwig Müller-Uri used "boneglass", which was extremely hard but didn't have a better resistance against tear fluid. He was looking for a substitute in the colour of the sclera which also sported a higher resistance against tear fluid. Beside that, the glass should be softer for a better manufacture. All of that was found in the cryolith glass.

The development brought forth two different techniques for designing an iris: drawn and melted. What is the difference between those techniques and is the drawn iris still in use nowadays?

A: Ludwig Müller-Uri assumed that the iris on the French products was drawn. So he drew it also with enamel. During a visit in Paris he discovered his error and started to melt the iris on top of the bubble with coloured glass bars. This technique was brought to perfection and is the normal method used today. It replaced the drawing of the iris in the process of the eye manufacture. There haven't been any indications for a drawn iris for some time now.

In this connection, the term "drawing stick" is often heard. What's its meaning in the eye prosthesis manufacture?

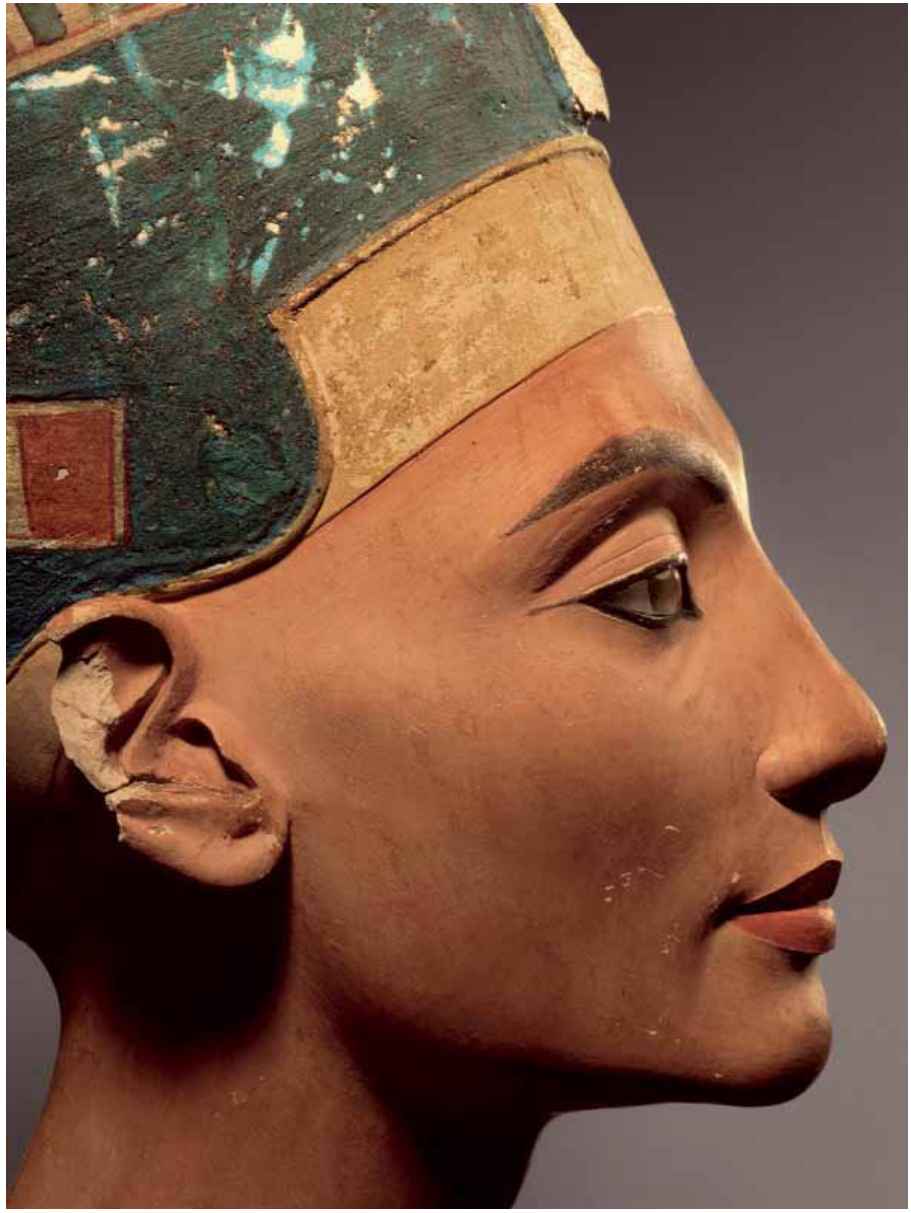
A: The "drawing stick" is an auxiliary means to design an iris, it is basis of the colour adjustment. "Drawing sticks" are manufactured in different colours by the ocularist or the assistant. In the fabrication we have nowadays, it is essential and determines the quality of the prosthesis and its effectivity. A good variety of "drawing sticks" is as essential as a good collection of "semi-finished" eyes.



In closing, a question concerning the future of eye prostheses: New materials (e.g. synthetic materials) are more and more used. What are the advantages of eye prostheses made of glass?

J: For a long time there were no alternatives to the glass eye developed by Ludwig Müller-Uri and his successors. Worldwide, synthetic eyes replace eyes made of glass for some years now. But the prosthesis made of glass is in Central Europe of higher importance. The main reason for the replacement seems to have its origins not in questions of quality, but the high expectations of fabrication.

Criterias in quality speak for the usage of glass. Noteworthy are the more wettable surface and therefore a better comfort of wearing. Its only disadvantage is the breakability, which can be met with careful handling of the eye prosthesis.



Nofretete, Queen of Egypt

The eye prosthesis in antiquity

by Theo Knauer, Berlin

The word "eye" is to be found more than 600 times in the bible, the word "seeing" even more than 1000 times. The beauty of the eye has been described and praised. The depiction of the eye is as old as the depiction of human beings. Nearly in all cultures, there are four ways to design eyes:

Lifeless eyeballs, without iris and pupil (for example in Mesopotamia after 4000 BC),

Eye of Zeyna (Ain Ghazal)

Painted eyes from after 3000BC in Egypt, after 700BC from Greece to Rome (Etruscans after 400BC),

Drilled or carved eyes, the speciality of the Romans after Hadrian (76-138AD),

Inlaid eyes in a variety of materials such as shells, stone, ivory, semi- and precious stones, metal or glass. Glass as the probably most interesting and most versatile material was used in Egypt around 3000BC, after that by the Romans, Greek, Chinese and in the Americas.

The oldest example for a human depiction are 25 statues from Ain Ghazal [1] , which fascinate especially because of their eyes. With their border strip of asphalt, they look like painted. One distinguishes circular from pastille-shaped irises. In Jericho/Israel a statue with a red and black painted head was found with eyes made from shells [2].

In museums worldwide we find men and women from Sumer (Iraq) with inlaid, often enlarged irises made of black chalk/lime stone. A lot of religious figures sport eyes made of lapis lazuli [3]. The eyes of a golden and alabaster Babylonian goddess are made of rubies [4].

Eye of Rahotep, about 2400 BC, Egypt Museum Cairo

[1] about 7200 BC // British Museum London

[2] 6000 BC // British Museum London
[3] Ebih-il , 2400 BC // Louvre Paris
[4] 300 BC Iraq Museum Baghdad

Herodotus (484-425BC), father of historiography, was right when he talked about Egypt containing a lot of wonders and creations. Pharaohs erected buildings which even surpass those of the modern world. The culture of ancient Egypt shows in paintings and sculpture. In the third millennium AD Egypt was a highly developed state on a cultural peak. Art, technique, astronomy, and mathematics flourished.

Eye as symbol of Horus

The eye was of great importance in Ancient Egypt and accompanied the Egyptians through their daily life and death. In the religious beliefs and the Egyptian mythology there is a special god-human relationship. The rendering of an eye is meant to ban evil. The eye of "udjat", a stylised form of an eye, is used as amulet. And the eye of Horus is the symbol of integrity, conqueror of death. Most of the time the right eye is depicted, the eye of the sun god Re, which establishes the relationship between right, good and the positive.

Eye of queen Teje

In the Egyptian art the eye serves as the key for ensoulment. Art was built for the eternity, the afterlife.
In the pre-dynastic periods (3300-3032BC) small pearls were used as eyes. Inlaid eyes were used for sculptures, statues, on sarcophagi, on mummies, on masques etc.
Alfred Lucas (1867-1945), chemist and archaeologist, divided the inlaid eyes into six categories. In the oldest group (4.-13. dynasty, 2639-1600BC) the eyes were designed closely to nature: lids and eyebrows were made of black chalk, copper, silver or faience. The iris was made of a grey or brown mixture, the pupil a dark mixture (asphalt or resin) in a small cavity. The most important attribute of those inlaid eyes were the cornea made of rock crystal, which covered the iris and protected against wind and weather.
The eyes are arced in statues, masks and human-shaped coffins, while they are flat on case-shaped coffins. The caruncle is a painted red spot.

Eye of Nofretete, queen of Egypt

The five other categories vary in their material and design:
The lids: wood, bronze, glass and seldom gold.

inlaid eye of an Egyptian statue

The eyeball: Bone or glass.
The iris and pupil: black disc made from resin, chalk, obsidian or glass.

Simpler inlaid eyes hint at the different eye parts with different colours behind clear rock crystal (Nofretete). Lids aren't inlaid, but merely painted.
In statues inlaid eyes were used even before they were used in the mummification process in the 21st dynasty (1070-1044 BC) as a means to replace the natural ones.

Glass or artificial semi-precious stone is documented by Thutmosis III. (1479-1425 BC), even though the glazing of quartz and the fabrication of faience is known since predynastic times. In a sand core process, pearls, amulets and vessels were made, decorated with coloured glass strings. Copies of precious stones, colours, some kind of millefiori technique are Egyptian achievements, as is blue glass which was used, together with lapis lazuli, to depict eyes and crowns in statues and coffins of the pharaohs.
In the Ptolmean times (304 BC) and the Roman period (30 BC-14 AD) artists fabricated whole eyes in glass, including lids, sclera, iris and pupil.
The Egyptian art influenced the Greek visual art which led to the revelation of the ideal beauty. The climax was Polykleitos (450-410 BC) rules of art – the canon.
In the first and second millennia BC, Rome was influenced by

Egyptian eye

the Greek culture and its art. A lot of copies were fabricated, but also new inventions like portrait busts, reliefs etc. were "invented".

Roman time, about 50 AD, Egyptian Museum Berlin

In the Greek style, roman emperors were glorified and presented in an authority depicting manner.

Two techniques existed for the inlaid eyes of Greek and Roman statues:

The eyeballs are either cast with bronze as the statue itself (with inserted iris and pupil), or left open and later inserted in the form of marble or ivory.

This technique was already in use in Ancient Egypt (in 1976-1794BC) on the basic surface of gold. Filler (semi-precious stones, faience and later glass) were inserted into dents. After the fourth century BC glass was directly melted into the cells ("cloisons").

In Hellenistic times statues made of bronze or marble were decorated with eyes in the described way. This process was rather complicated and demanded a lot of knowledge. This is why special artisans, the fabri ocularіarii, were needed.

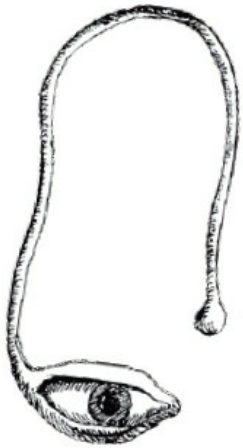
"Eye ob Brutus", Palazzo die Conservatori, Rome

Ambroise Paré (1510 – 1590)

The French eye prosthesis

by Wolfgang Trester, Cologne

Since when were eye prostheses used and what is known about the history of their origin?
The loss of a human eye through illness, accident or an act of violence leads to a disfiguration and disruption of the facial features. Therefore it is not surprising, that one looks for possibilities to cover this disfiguration. For centuries, eye prostheses and epitheses were used for that.



Eclblepharon of Ambroise Paré

Techniques and methods were developed for the manufacture of prostheses, new materials found and tested, but the eye prosthesis was never invented. The prosthesis' origin lies in the necessity to cover flaws or to regain the natural look.

It is speculated about whether even before the publication of Ambroise Paré (1510-1590) eye prostheses were used as substitutes for eyes. In the ending of the 19th century eye specialists argued about whether the Talmud (400 BC) speaks of the manufacture and fitting of an eye and teeth prosthesis. 1906 Ludwig Kotelmann from Hamburg wrote about this passage in the Talmud which lead to a controversy which was also joined by Julius Hirschberg (1843-1925) in his work about the history of the ophthalmology 1911.

But Ambroise Paré is seen as the man who demonstrably spoke about eye prostheses and portrayed them also graphically.

John Thomas Woolhouse (1666-1734) who worked in Paris as surgeon, mentioned artificial eyes from Abyssinia (then a synonym for Africa). In the ancient world, someone from this region was thought of making a lot of riches with the manufacture of golden eye prostheses. However, this historical tradition could never be proven scientifically.

There is only one answer about the usage of eye prostheses in the ancient world: "We do not know".

In the year 2007 a group of Iranian-Italian archaeologists discovered a female skull in the border region between

Afghanistan and Iran. The anatomy pointed to a person of oriental origin. The scientist Lorenzo Costantini from the Instituto Nationale in Rome assumes the remains to be from a priestess. He describes the eye as one made of bitumen (asphalt). Bitumen is found in Mesopotamia in its natural form and the material is seen as compatible with the human body. Remains of gold paint were discovered on its surface. The eye had two holes for fastening. The front side is convex and the back side is even, which emphasises its use as prosthesis. This eye was used more than 4500 years ago and seems to be the oldest known eye prosthesis. A sensation – did the history of eye prostheses start even before Paré?

Ambroise Paré was born in 1510 in Bourg-Hersent near Laval (France) and worked later as a barber. At that time, barbers often practised surgical tasks. In the 12th century, medicine and surgery separated. Medicine became an academic occupation, while surgery was practised by barbers or the like who didn't have a medical education.

Different eye-shape (Hazard-Mirault, 1818)

Painting of a French enamelled eye-prosthesis

The time of Caterina de' Medici (1519-1589) saw a lot of wars in Europe. French forces also went to Italy. Paré became a barber in the military and learned surgery on those campaigns. He was aware of the shortcomings of surgery which he wanted to improve. Despite not being able to join a medical faculty in France – he didn't speak any Latin – he introduced several improvements. Through notes from Paré we also learn about the first artificial eyes. Unsurprisingly, this development occurred to the times of Caterina de' Medici, who brought her country's culture to Paris. Ambroise Paré himself went to Italy on a military campaign. He was held in high esteem at the court in Paris and became "Chirurgien du Roi" in 1552. In this position he served Heinrich II., Karl IX. and Heinrich III. In 1554 he even became "maître en chirurgie" at the medical faculty in Paris. In France he is nowadays seen as the father of surgery.

Paré's credit in the ophthalmology is appreciated, as he provides us with the first verifiable documents about artificial eyes. Those prostheses were dressings/bandages, eye patches, Ecblephari and Hypoblephari . The Hypoblephari were hulls made of metal (silver and gold). The sclera and iris were painted on the hull with enamel.

In 1718 Lorenz Heister (1683-1758) published in Nürnberg his writing "Institutiones chirurgicae". Often translated, this work was continually published until 1797. In his work on surgery, Heister describes his knowledge on artificial eyes. He writes that blacksmiths produce prostheses made of gold, silver or copper which were then painted by artists. He also describes the secretion which occurs while wearing those prostheses and remarks that glass prostheses are much better tolerated by the human body than metal. He mentions the disadvantage of their breakability. Unfortunately he doesn't give any names of the producers of those glass eyes.
The prostheses made of metal were obviously fabricated in three stages: A goldsmith provided the metal compound, an artist painted the sclera and the iris. After that the prosthesis had to be enamelled. According to several authors, enamelled eyes were used until the beginning of the 19th century, while published materials favoured the prostheses made of glass.

Philipp Adam Haug describes in his dissertation in 1749 that eyes made of glass were blown by ocularists. So he must have known about the fabricators but didn't name them. Haug preferred the prostheses made of glass and recommends to all patients to get reserves, because of the breakability of glass. It is to assume that all eye prostheses were fabricated in France to that time.

French glass prosthesis, made by Hazard-Mirault 1790

1818, François Hazard-Mirault published his book on eye prostheses " Traite practique de l'oeil artificiel". He opens with a regretful note that eye prostheses have been written about in the past, but that only one person – Haug - described the process of manufacture. He also describes how a glass prosthesis is fabricated.

Hazard-Mirault had his knowledge from his uncle, who already fabricated eye prostheses in the 18th century in Paris. After Hazard-Mirault, Rho,M. Auzon Carré, Gaucher, Desjardin and Auguste Boissonneau provided patients with artificial eyes.

French prosthesis: enameled copper

Auguste Boissonneau became the founder of the modern ocularistic, which has never been appreciated in Germany. He introduced the term "ocularist" which is up until now internationally used and recognised. Boissonneau minded a lot about the patients care: He travelled to his patients and favoured the individual fitting of the prostheses. He had medical knowledge and considered anatomical and pathological conditions when fabricating a prosthesis for a certain patient. In this, he differed clearly from other manufacturers.

The basic of the French eye manufacture were glass plates, from which smaller pieces were cut. Those were molten, blown into bubbles or molten into glass sticks. Those sticks were mixed and used for designing the iris. The disadvantage of those eyes was the use of lead glass/crystal, which changed colour when in constant contact with tear fluid.

Boissonneau declared the German eyes as rip-offs of the French eyes. In 1870 he tried to stop the German manufacturers with a court ruling. According to him, all German eyes were illegal copies of French eye prostheses.

This wasn't the case, as Ludwig Müller-Uri (1811-1888), a glassblower from Lauscha who got some "Parisian eyes" from Paris as a copy, didn't have all the information about the production process. Ludwig Müller-Uri therefore had to find his own way and didn't get any further information on his trip to Paris. So he developed his own manufacture process with other materials.

Collection of french eye prostheses, 1900

Friedrich Philipp Ritterich (1782-1866) mentions that he helped improving Müller-Uri's eyes, which were then as good as, if not even better than the Parisian eyes.
Outside of France, others manufactured eye prostheses as well in the second half of the 19th century: Paul Greiner/Hamburg, Blaschka/Dresden, Jerak/Prag, Cédergrén/Schweden, Pache/Birmingham, Grey and Herford/London and Davis/Northern America.

The development of eye prostheses came from France. French ocularists had a great influence on the development of the eye prosthetics which reached a state of stagnation. The eyes were rather costly and the material inaccurate, which lead to the supremacy of the German eyes.

French eyes made of glass aren't fabricated anymore. In France, only prostheses made of synthetics are produced which is a regretful situation and neglect of tradition.

175 years of German eye prostheses

by Theo Knauer, Berlin & Günter Schlüter, Lauscha

In the year 1597, the two gaffers Greiner and Müller didn't know that with their founding of a glass factory in Lauscha, this region would become the most important place for glass and become famous 250 years later. It started with green-tinged "forest glass", crown glass, flasks and drinking vessels. Beakers were fabricated, which hid the defects of the "forest glass" behind enamel. This finishing originated in Venice and spread in the middle of the 16th century all over Europe, while having its peak in Thuringia between 1600 and 1770. The glass factories in Thuringia were counted among the best in Germany. The basic material was a fast melting sediment of quartz, melter and colours in the form of metal oxides. The bonding agent turpentine makes the material able to be painted. The painted works were heated in an oven on 500 to 600 degrees Celsius, so that the paint connects with the grounding.

old glass factory Lauscha, 1597-1905

After 1720 translucent glass was used for coffee and tea cups and vases. The colouration based on the Chinese porcelain, but also used native themes of fauna and flora. The colours were more beautiful on the translucent glass, than on the colourless or green-tinged glass.

1760 the foundation for a new manufacture was laid, the fabrication of lamps. This technique bases on the converting of glass tubes and sticks for home work. It started with pearls and figurines, after that glass devices for chemistry and medicine and especially after 1849 Christmas tree decoration.

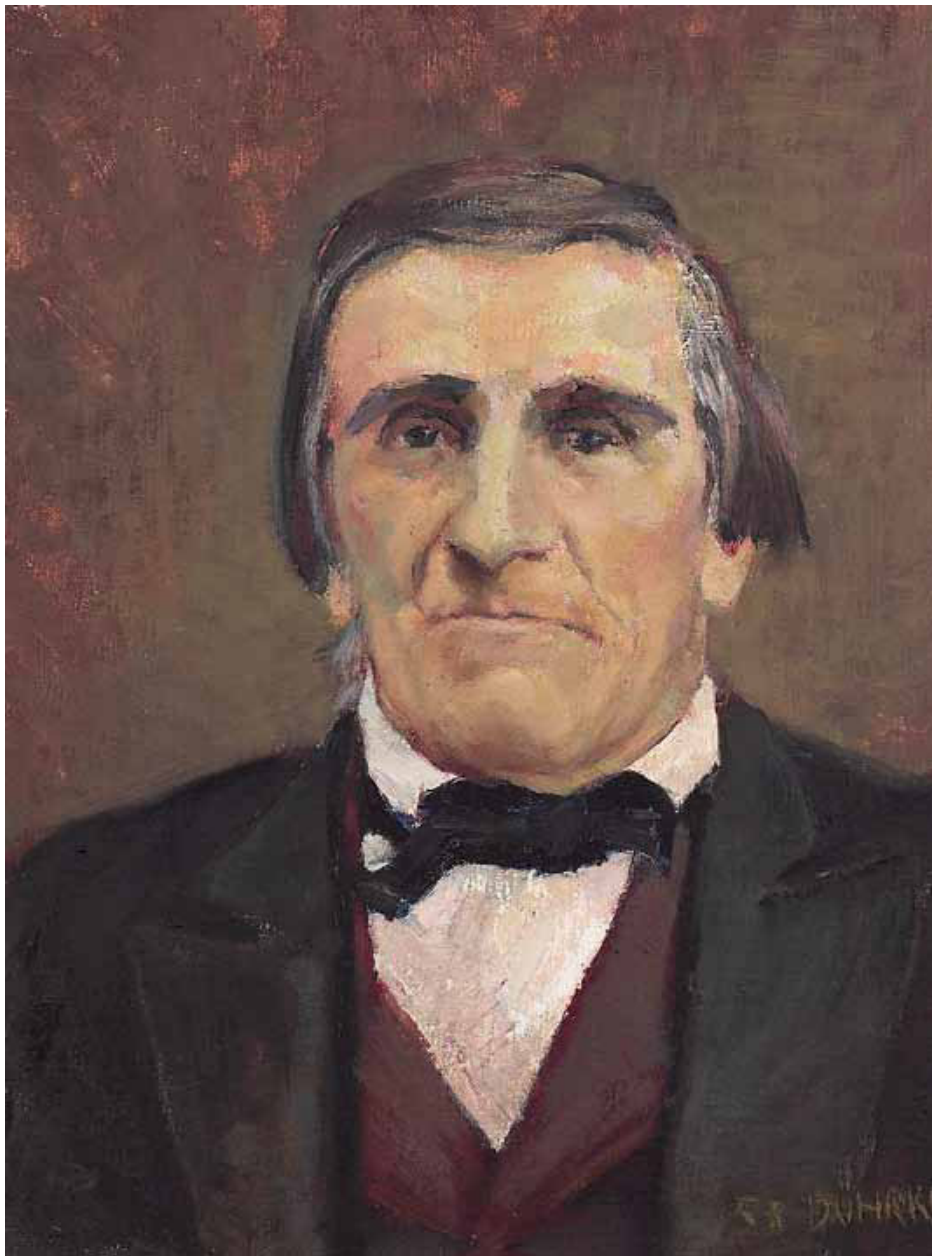
Glassblower at work, 1700

Starting from the middle to the end of the 18th century, glass eyes for toys and puppets were fabricated. The irises of those eyes were a single black point or a blue or brown circle with black point.

"The end of a coloured glass stick was molten, pushed to create a broad point and after that pushed into the middle of a black glass drop as pupil. Then the end of a thicker and colourless glass stick was molten, put onto the iris, the first stick melted off and replaced by a wire. Grabbing the wire and melting off the other colourless stick, some glass was left on the iris to represent the cornea of the eye. The still hot cornea was pressed against a slab, to form a curve."[1]

Those eyes were used in the toy factory in the nearby Sonneberg.

[1] Lehmann 1925 // S.94



German eye specialists were thinking for a long time about producing their own eye prostheses like the Parisian eyes. The medic Prof. Heinrich Adelmann got interested in those eyes, probably through his children's toys. The renowned ophthalmologist had already ordered eye prostheses from Paris for his patients. He contacted glassblowers in Lauscha, amongst others Ludwig Müller-Uri (1811-1888) and laid the foundation for the German eye prosthesis manufacture.

Ludwig Müller-Uri was born on the 4th of September 1811 in Lauscha as the son of a glassblower. He worked in the glass factory even during his school years and became sheet glass fabricator in Marienthal. Back in Lauscha he fabricated glass eyes for puppets and animals. With the interaction between the glassblowers and the ophthalmologist of that time, the development of the eye prosthesis manufacture took its course:

Ludwig Müller-Uri, 1811 - 1888

Müller-Uri thought the iris of the French eyes to be painted with enamel, what proved to be wrong later. After some trial and error, he developed a new technique of enamel colouring:

A part of a glass tube was molten off and blown into a sphere. In the middle of this sphere a drop of coloured glass was pressed, as a basis and laid aside. Then the top of a crystal glass stick was heated, pressed flat. Into this flat area, a pupil of black glass was placed and the iris painted with enamel. This stamp was then pressed and molten on the sphere and its basis. (Lehmann 1923 // S.45)

After that, the eye hull had to be designed from the spherical glass.

Working equipment and…

… painting devices (first technique)

While the French used lead glass, Müller-Uri used "boneglass". The white colour used for the artificial eye apple was made up of the normal glass basics such as sand, soda and potash, with grinded bones of animals.
In the beginning, Müller-Uri let his father-in-law Karl Greiner-Vetterle abrade the used parts of the glass spheres. But this left the edges of the eye prostheses sharp and in need of being heated again (for removing the sharpness). Due to the brittleness of that sort of glass, a lot of eyes broke. Another technique was more

successful: Blowing a small hole into the sphere and cutting off the hull from the sphere. The edges were left smooth.

In 1853 provided Müller-Uri his first patient with an eye prosthesis and after some more years, his eyes superseded the French eyes in quality, beauty and colouring. His prostheses were awarded in exhibitions in Berlin (1844) and München (1855). The ophthalmologist Dr. Ritterich from Leipzig prided Müller-Uris eyes and saw them as more successful than the French or Venetian eyes.

But Müller-Uri was disappointed about the quality of the surface of his eyes. After some wearing, the glass became rough due to the tear fluid and other secretion. Müller-Uri was looking for new material in Paris, where Boissoneau and Noel tried to discover his secret of fabricating the iris. But Müller-Uri didn't give in and also declined the invitation to work in Paris. In Spring 1850 he returned to Lauscha.

The Parisian eye manufacturers were as secretive as he, but he discovered accidentally a coloured glass stick on the work table of one of his French colleagues. Back in Lauscha he tried to design the iris completely with glass, not with enamel as before. The coloured glass sticks were molten onto the glass basis.
The search for replacing the white glass he was using and needed to be replaced due to the roughening up of its surface, continued. Müller-Uri learned on his trip to Paris that their glass was even less usable, as it contained lead. After some weeks, the eyes seemed to be unusable.

„Iris colouring sticks" (new technique) and a „painted" iris (old technique)

The mutual effort of Friedrich-Adolf Müller-Uri, Septimius Greiner-Kleiner, August Greiner-Wirth and Christian Müller-Pathle led to the discovery of cryolith glass in 1868. The new material was tested and its advantages noted: Its small weight and the resistance against abrasion.

Another invention for the manufacture of glass prostheses happened in 1885. The gas burner was invented in 1867 and in the same year gasworks were established in Lauscha. It was now possible to design a washed-out limbo: The darker edge between iris and sclera. Another difficulty in the first years of production was the depiction of blood vessels. Deep red glass was unavailable in Lauscha, so Müller-Uri had to use pale red glass which was pulled into thin glass sticks. After some tests Müller-Uri developed sticks of ruby glass which was perfect for "painting" the red blood vessels. In the eighties of the 19th century, Müller-Uri and his productions gained a lot of international reputation. He was honoured on exhibitions in Vienna (1873), Philadelphia (1876), Sydney (1880) and Melbourne (1881).
Lauscha superseded Paris in the manufacture of eye prostheses. The eyes from Lauscha were seen in technique and material as the bests worldwide.

International Exhibition Philadelphia 1876

After his death in 1888, Müller-Uri's sons and other relatives continued the eye manufacture. Before 1900 several factories were established in Germany. His son Reinhold stayed in Lauscha. The other son Albin went to Leipzig in 1912, whose sons Ludwig ,Otto and Werner went to Jena and Berlin. The nephew Friedrich Adolf Müller-Uri founded his own company in 1860 in Wiesbaden. In Lauscha itself existed 54 companies in 1923.
One differentiated between two forms of manufacture and distribution: The selection and the specimen (the fabrication of individual eyes for patients). Also to be noted is that there was a big difference between human eye prostheses and those for animals or toys.

The volume of output in the year 1919 was about 100'000 human eye prostheses. 75% of it went abroad, after 1923 even over 90% (USA, Eastern Europe, Scandinavia, France and Great Britain).

Most ocularists received their training after World War I in Wiesbaden, Berlin and Leipzig. Other foundation places were Geneva (Ernst Greiner in 1900), Stuttgart (Ad. Müller-Welt) and Berlin (Richard Greiner in 1913). And after 1923 the cities of Breslau, Jena, Coburg, Essen, Hamburg, Dresden and München. Ocularists abroad were mostly descendants of people from Lauscha: England (10), USA (7), Paris (7), Lyon (4), Vienna (3), Budapest, Prague, Geneva, Stockholm, Rome, Venice and Cairo (in each case 1). In the German speaking parts of Europe are nowadays about 30 companies active.

The double-barrelled names stem from the fact, that a lot of people had the same name in the small village of Lauscha. To distinguish the people from each other, a second name was added, based on certain characteristics or skills. The glassblower Johann Andreas Müller (1770) chased away some youths. In the lawsuit afterwards the sovereign compared his brave deed with the people in Uri, Schwyz and Unterwalden (Switzerland). Müller and his descendants therefore received the second name "Uri".

back side of a double walled „reform eye"

In the first fifty years of eye manufacture, the prostheses were designed with thin shell, similar to the French products. In the daily practice, double walled prostheses were more useful. These eye forms were distributed after 1872 by Friedrich Adolf Müller-Uri. Those eyes were called Snellen-eyes or "reform eye". The backside of the "reform eye" was adapted to the eye socket. Rounded frames are more comfortable and easier to insert or take out. At some point the "reform eye" nearly displaced the one walled prostheses, but nowadays the latter is used more often once again. Only special glasses are used for the production of eye prostheses nowadays, glasses which are especially produced for the eye manufacture. Different sorts of glasses are used, which need to have the same melting temperature for fusing together easily.

The prostheses of cryolith glass of today, have a hard and smooth surface and were tested for biocompatibility. In normal usage, the glass doesn't irritate the skin of the eye socket. The coloured glasses used for the iris and the pupil don't come into contact with the skin, as they are molten between the cryolith (white eye ball) and the

crystal glass (artificial cornea). The smooth surface doesn't hinder the eye movement. The fire polished surface allows for medical and hygienically immaculate cleaning.

Around 1950 propaganda started to claim that synthetic materials were able to substitute everything. Nowadays we know that this is only a question of aesthetics: Even though we have plastic, we continue eating from porcelain plates and drink from glasses made of real glass. And premium quality cosmetic is sold in glass flasks and pots. Naturally the biocompatibility is of high importance for eye prostheses. The mechanically polished surface of a plastic eye is soft and easily damaged. Even hardly recognisable scratches lead to an irritation of the eye socket. Synthetic materials (PMMA) can only be imperfectly cleaned and the surface is water resistant. The tear fluid spreads therefore unequally on the prosthesis and the patient needs to use artificial sliding means. The prostheses have to be polished twice a year and allergic reactions are possible.

The eye prosthesis manufacture in Germany is of high quality. Natural eyes can be replaced by double or single walled eye prostheses and the patient regains a cosmetic balance. The eye should be replaced after two years.
The only drawback of a glass eye is its breakability, which can easily be counteracted with care in handling the prosthesis.

Cryolith glass is more than usable for glass eyes: It is biocompatible, hypoallergenic, fire polished and therefore hard and smooth. The artificial eye is due to its hollowness light, has a wettable surface, chemical endurance and natural shine.