# AN HISTORICAL EVALUATION OF PERSPECTIVE AIDS PARTICULARLY IN THE ANATOMICAL ILLUSTRATIONS OF B. S. ALBINUS (1697—1770)

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In the historical survey problems of the visual field are approached from a viewpoint unusual to the ophthalmologist. The normal field of vision of a designer or painter does not enable him to depict the scene from one point of view. He has to move his head necessarily from one side to the other to observe all objects of the scene. Thus the scene is viewed from different angles. This brings me to the problem that always played an important part in painting and particularly in anatomical illustration: the *perspective distortion.*

From early history artificial aids have been used in the solution of this problem. Especially after the introduction of the third dimension into painting by GIOTTO (1266–1337), great attention was paid to the problem of perspective transformation (cf. CHOULANT, 1852). Before this time medieval art was characterized by geometric diagrams of linear contours and flat colour planes (PANOFSKY, 1955).

The use of perspective aids brought about a dependence on technical possibilities and on optical rules. In the 15th century plano and convex mirrors became available. LEON BATTISTA ALBERTI (1404–1470) is considered as the inventor of the *camera obscura*. He also described the plano mirror as an artistic aid in his *"Elementi Della Pittura"* (HOOGEWERFF, 1921).

At the beginning of the 17th century many optical laws of EUCLIDES were shown to be wrong. JOHANNES KEPLER (1571–1630) argued that light rays that enter the pupil give rise to perception. He also stipulated that light rays are not emitted as straight lines from one point in the eye as in the Euclidean concept, but are refracted, particularly by the lens, to form an image on the retina. Thus, KEPLER's theory could explain the visual field: due to the curved shape of the retina the eye would have a visual field slightly larger than 180° (cf. KEPLER, 1604, 1611). Nevertheless, the influence of Euclidean optics persisted. This influence is illustrated in the works of MAROLOIS (1572–1627).

On the basis of Euclidean laws this influential Dutch mathematician calculated by geometrical analyses that the visual field of one eye could not exceed 90°, and was limited by the anatomy of the eye and orbit. He pointed out that only one quarter of the globe is exposed outside the orbit and light rays diverge from the centre of the globe. On this basis, he calculated that the greatest angle of vision would be 90° and images stretching over more than 90° would be perceived as distorted.

During this period, the concave lens was developed and in 1611 the mathematician FRANCESCO MAUROLICO of Messina developed theories of lenses. He analyzed laws of refraction and explained why convex lenses can correct presbyopia and concave lenses can correct myopia (ROSEN, 1956). The concave lens was not only applied as a correction for myopia, but also used as an artistic aid for painting.

The inventions of telescope and microscope followed. The *'perspectiva'* developed into a science, in which anamorphoses also held an own place as *'magica naturalis'*. Two-dimensional shapes were transformed to give a depth illusion to the picture, and simultaneously one discovered how to reverse this relation: a picture, stretched according to the same rules of perspective, assumes a grotesque shape.[1] By such projective transformation pictures are distorted to an extent that they are difficult to recognize. The distortion is *reconstructed* by viewing the picture on a slant or as a reflection in a suitable mirror.

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[1] The geometric technique of drawing slant pictures was explained in one of the first major treatises on anamorphotic art by JEAN FRANÇOIS NICERON (1638)

[2] In his publication on PETRUS CAMPER's dissertation, TEN DOESSCHATE (1962), describes the architectonical method as that of parallel perspective and the perspective method as that of central perspective.

[3] Reproductions and descriptions of these paintings can be found in PANOFSKY (1964).

Anamorphic paintings for cylindrical and conical mirrors were fashionable toys in the 17th and 18th centuries. The first known examples are in LEONARDO DA VINCI's notebooks. Another famous specimen is HANS HOLBEIN's painting *the Ambassadors* (1533; Fig. 1).

We shall now consider which optical aids were used for the perspective and architectonic methods of painting. The aim of the perspective method was to view and represent the object from one single point. In the architectonic method of painting each point of the object had to be depicted at an angle of 90 degrees.[2]

## Perspective method

To realize this representation different tools were used.

1. Artificial reduction of field of the depicted image, so that from one point of view the full object could be seen.

### *Convex mirrors*

JAN VAN EYCK used a convex mirror for this purpose. On his painting of *Giovanni Arnolfini and his wife* such a mirror can be seen in the centre of the painting (Fig. 2). The symmetry of the composition is exactly reproduced in the mirror, although the reflection is reversed and the space is depicted beyond the limits of the picture plane. We can consider this application of the convex mirror as a perspective aid.

In the painting the mirror is also a magical instrument with the symbolical meaning of divine perfection. Thus, the mirror may represent both a symbol of the eye, and the mirror of the soul. By its frame with ten miniature scenes from the Passion the 'spotless' mirror *(speculum sine macula)* is explicitly characterized as a religious object. It is a symbol of Marian purity. So we can consider the mirror as the divine eye of a divine soul, which has taken the object and the painter in his perfection.

A convex mirror was also used by other painters of the 15th century. In the left wing of the *Werl Altarpiece* (1438) the Master of Flémalle has depicted a circular convex mirror, reflecting the left wall with a window. In *'St. Eloy of Petrus Christus'* (1449) and in QUENTIN MASSYS' painting *'the money changer and his wife'* a convex mirror can be seen to reflect the world outside the window.[3] In these last paintings the reflections in the mirror do not represent the same composition of the picture as in the symmetrical picture of JAN VAN EYCK. For these painters the mirror was rather a magical instrument of perspective than a perspective aid.

The artistic function of the convex mirror became more important in the course of time. This is evident in some of the paintings of GERARD DOU (1613–1675) which represent only the mirrors' reflections (GOLDSCHNEIDER, 1967).

*Concave lenses*

At the end of the 16th century the concave lens became better known and appeared to be a better artistic aid than the convex mirror. The artist could view the object directly through the lens and the image was neither reversed nor obscured by the artist's own reflection.

A splendid example of this application is the painting of CAREL FABRICIUS *'View of Delft'* (Fig. 3). In reality the church in the centre of the picture dominates the surroundings and the pavement, as entrance to the city, appears rather flat. Viewed through the lens, the church recedes into the distance and is reduced in size. By slanting the lens slightly upwards, a curved appearance of the lower part of the field (the pavement) is created (WHEELLOCK, 1973).

2. Another method to control the perspective was to 'copy' the field of picture by means of a fixed *'foramen opticum'*.

*Camera obscura*

According to the description by GIOVANNI BATTISTA DELLA PORTA (1558), the *camera obscura* enjoyed popularity as a magical, scientific and artistic instrument. It was used in many studios for the painting of portraits. ROBERT HOOKE developed a portable camera for the painting of landscapes (1668). Until the 18th century the *camera obscura* was used in drawing academies in a more perfected form, as we can see in some designs of the physicist G.J. 'S GRAVESANDE (1711). The *camera obscura* was also used by the anatomist WILLIAM CHESELDEN (1688–1752) to achive precision in his anatomical illustrations. His beautiful illustrations of the bones (1733) are considered among the best productions of the 18th century (cf. MOEHSEN, 1771).

*Tracing apparatus*

LEONARDO DA VINCI, DÜRER and HOLBEIN worked with the aid of a so-called *'tracing apparatus'* (Fig. 4; cf. DÜRER, 1532). Through a peephole the painter observed the object with one eye and sketched it on a glass pane, sometimes covered with transparent paper.

For his anatomical studies LEONARDO DA VINCI made use of a frame divided into squares and placed between the eyes and the object. To fix the point of view he placed a little ball in the square. This little ball had to coincide with the fixated point of the object, as for instance a vertebra (DA VINCI, 1940). With such tracing apparatus the painter could achieve an exactness of perspective better than with any other aids.

Fig. 1: The Ambassadors (1533) by HANS HOLBEIN. – The stretched shape at the bottom of the painting can be visualized by closing one eye and slanting the page away from you, with the lower left corner of the page towards your eye and placed about 6 inches from it. – Another way to see the skull is to place the edge of a flat mirror about 3 inches from the lower left corner and to look into the mirror with both eyes, while topping it until the skull appears normal.

Fig. 2: JAN VAN EYCK: Giovanni Arnolfini and Jeanne Cenami (1434).

Fig. 3: CAREL FABRICIUS: View on Delft (1652)

Fig. 4: A. DÜRER: A tracing apparatus consisting of a glassplane and a peephole.

In the course of time many great mathematicians have made use of a tracing apparatus. In the science of the *'perspectiva'* it was improved to depict all things exactly according to perspective.[4]

The application of this kind of drawing apparatus originated from an aim at perfection, which was connected with the idea of an 'homo perfectus' of ideal proportions. LEONARDO DA VINCI considered as perfect those proportions, which are seen in nature. He arranged the proportions of the human body according to headlengths.

DÜRER (1532), who published 4 books about the proportions of the human body, also assumed the existence of ideal human proportions. These studies had great influence on the 18th century anatomist B.S. ALBINUS in his construction of a *'homo perfectus'* (PUNT, 1977).

## Architectonic or projective method

ALBINUS considered the perspective defects in anatomical illustrations especially as the result of the position of the eye point. He preferred to depict the human body in the same manner that architects used, i.e. by constructing with compasses and measuring scales. Each point of the object had to be depicted at an angle of 90 degrees to achieve a correct projection. ALBINUS strove for perfection, which was associated with the idea of the existence of ideal proportions and symmetry. In this respect symmetry was an expression of health.

Ideal proportions of bones and muscles were found by selection from parts of dead bodies of young men, who had died in full health. The finally selected *'Platonic'* skeleton showed typical proportions (Fig. 5): the bones were long in comparison to the head-trunk proportion: 54–46 %. The feet made a proportionally very small impression. Both characteristics corresponded with the ideal concept of a man in the Greek representation. The choice of the skeleton was well deliberated, as well as the position. The pelvis of the skeleton was placed upon an iron tripod and brought into the desired position with help of tackles. This practice was already applied in many art academies.[5]

To give vitality to the skeleton's position, ALBINUS used a living nude as a model. This man was also fixed with tackles. To avoid perspective defects, the skeleton was placed in one perpendicular plane. To transfer the skeleton in a projective manner, the designer of ALBINUS, JAN WANDELAAR, used 2 drawing

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[4] Many different types of tracing apparatuses have been described and illustrated by WOLFF (1734)

[5] Such a scene can be observed on the engraving of an art academy by C. CORT (1578) and on the frontispiece of the anatomy book by VAN DER GRACHT (1634).

phases. In the *first phase* he placed a wooden frame directly in front of the skeleton (Fig. 6). This frame was devided by strings into squares of 7.3 $cm^2$. The skeleton was then observed through a peephole from a distance of 40 Rheinland feet, i.e. approximately from infinity. Thus, all parts of the object were viewed at an angle of 90° without any perspective distortion. A similar pattern was put on the drawing paper, so that the artist could copy the object field by field in natural size.

In the *second phase*, detail had to be added to the contour picture of the first phase. In order to do this, the artist moved up to the object to a distance of 4 Rheinland feet. As a viewing aid a second frame with smaller sqaures of 7,3 $mm^2$ was placed directly in front of the artist. Each of these small squares, more than 70,000 in all, could be used for viewing the object. By simple mathematical methods, the correct perpendicular viewing position for each big square could be calculated. In this way all details could systematically be viewed from close distance and yet at right angles.

The next task was to *reduce* the picture. To this purpose the squares of 7.3 $cm^2$ were reduced similarly to squares of 2.15 $cm^2$. The result was a reduction of the skeleton from 167 cm to 48.7 cm. This drawing was finally etched (cf. ALBINUS, 1747).

According to the ideas of ALBINUS, the ideal skeleton formed the foundation of the *'homo perfectus'*. In agreement with the laws of nature, muscles and other organs were attached to the 'skeleton'. To construct the *'homo perfectus'* the skeleton was coded with the ideal origins and insertions of the muscles. The muscles were then selected from different dead bodies. They were placed at the same angle, as the corresponding parts of the skeleton and depicted architectonically. Finally they were adapted to the codes of the contour drawing of the skeleton by means of similar reduction (Fig. 5).

ALBINUS did not complete the construction of the *'homo perfectus'* with all organs. In the unfinished state, however, his attempts for this construction are preserved in manuscript. In these unfinished studies ALBINUS had tried to depict the internal organs in a mathematical relation to the skeleton (cf. ALBINUS, undated manuscript).

In all his studies ALBINUS calculated the ideal proportions by abstracting from many objects of various dead bodies. The selection of the ideal parts of the body was performed on the basis of these calculations. There is an analogy between this method and the story of PLINIUS about ZEUXIS, who composed an ideal woman from the most beautiful parts of many girls of his town.

A pupil of ALBINUS, S.T. SOEMMERRING (1797) achieved something similar and, stimulated by his master, constructed the female antipode of the *'homo perfectus'*.

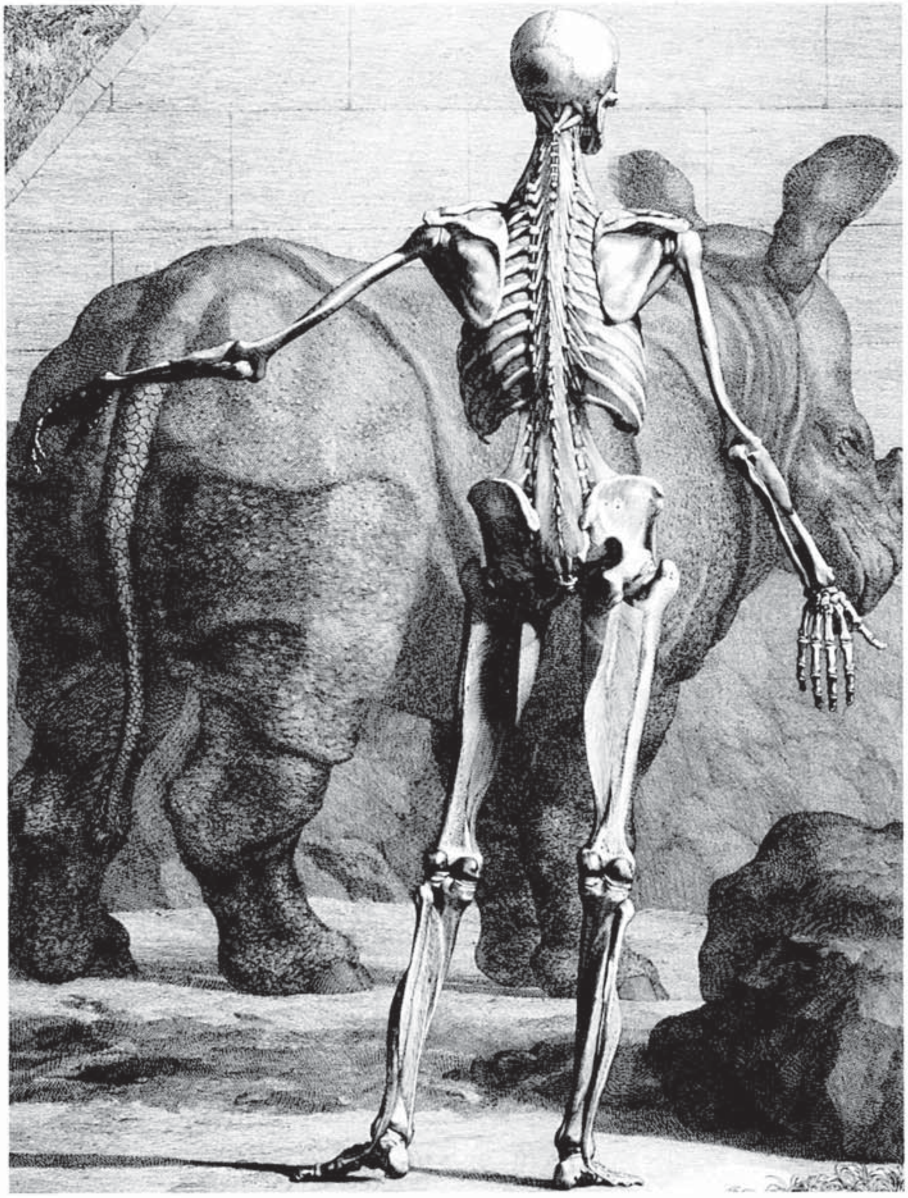

Fig. 5: B.S. ALBINUS: Tabulae sceleti et musculorum corporis humani, Tab. VIII. A finished state of the ideal skeleton, covered with some ideal muscles. – The *vanitas* symbolism which we find in many backgrounds of 16th and 17th century anatomical illustrations has disappeared. Instead, we see a rhinoceros as a symbol of vitality. (The cooperation of Mr. T. Stemerink is acknowledged, who took care of the reproduction).

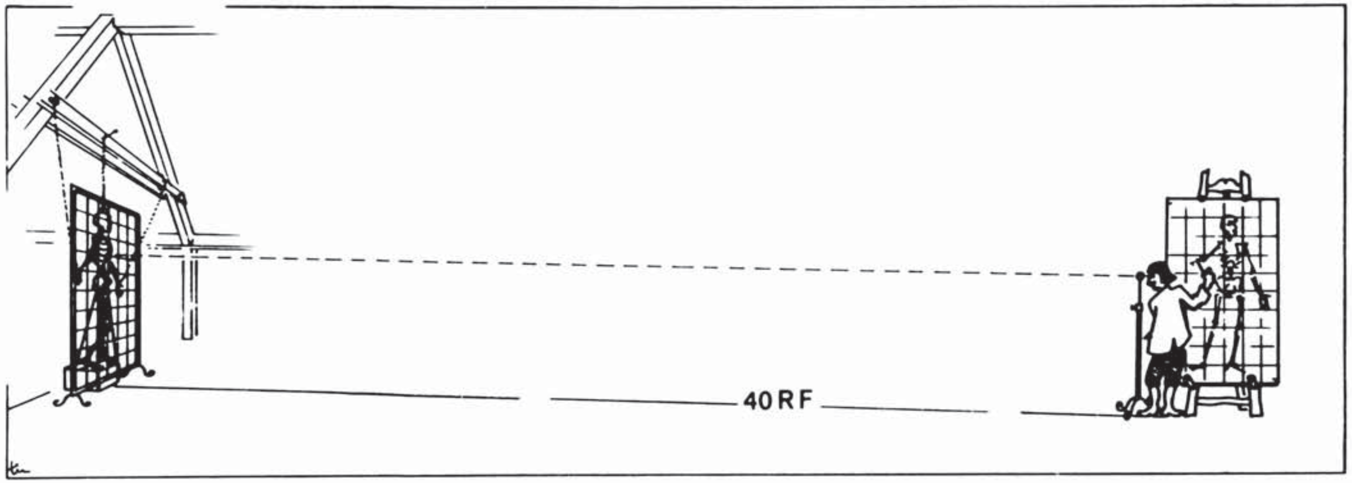


Fig. 6: Diagrammatic representation of the first drawing phase of ALBINUS. Projective reproduction of the contours of the skeleton at a distance of 40 rheinland feet. (Drawn by Mr. Y. Tinkelenberg, Dpt of Anatomy, Leiden).

In this survey I have tried to demonstrate that perspective aids were useful tools in the achievement of perfection. This was, in a way, induced by JAN VAN EYCK's idea of divine perfection and by the idea of ideal human proportions of DA VINCI and DÜRER. This ideal brought ALBINUS to the construction of an ideal man on the basis of anthropoligical studies.

## Summary

An historical evaluation is given of optical aids in painting. Tools are discussed which have been used in the so-called perspective and architectonical methods of painting.

In the perspective method the object is represented from one single point. This has been attained by two methods: (1) by artificial reduction of the field of scene so that from one point of view the full object could be seen (e.g. convex mirror or concave lens), (2) by 'copying' the object through a fixed 'foramen opticum' (e.g. camera obscura, tracing apparatus).

In the architectonical method each point of the object is depicted at an angle of 90 degrees. For this purpose the anatomist B.S. Albinus used a quadrilage system (a frame divided by cords into squares) in two drawing phases. During the first phase the object (a skeleton) was observed through a frame with 7.3 $cm^2$ squares approximately from infinity (i.e. 40 Rheinland feet). A similar pattern of squares was put on the drawing paper so that the artist could copy the object field by field. In the second phase, detail was added to this contour picture from a closer viewing distance (4 Rheinland feet). To ensure a perpendicular viewing position for every part of the object, a second similar frame with 7.3 $mm^2$ squares was placed directly in front of the artist as a viewing aid. All perspective aids were used to achieve perfection.

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## PUNT, H. – L'historique des aides optiques, specialement dans les illustrations anatomiques de B.S. Albinus (1697–1770)

### Resumé

L'auteur donne l'historique des aides optiques en peinture. Il décrit, entre autres, les moyens qui ont été utilisés pour la méthode dite perspective et celle dite architectonique en peinture.

Dans la méthode perspective l'objet est représenté à partir d'un seul point. Ceci peut être obtenu par deux moyens: (1) Réduction artificielle du champ, de sorte que l'objet tout entier peut être vu d'un seul point de vue (par exemple un miroir

convexe ou une lentille concave). (2) Copie de l'objet à travers un "foramen opticum" fixe (par exemple "camera obscura", appareil de décalque).

Dans la méthode architectonique chaque point d'objet est dépeint à un angle de 90 degrés. Dans ce but l'anatomiste B.S. Albinus utilisait un système quadrillé (un cadre divisé en carrés par des cordes). Dans un premier temps l'objet (un squelette) était observé à peu prés à l'infini (à une distance de 40 pieds "rheinland"). En face du squelette il plaçait un cadre avec des carrés de 7,3 cm. Sur le papier à dessin les mêmes carrés étaient reproduits, de sorte que le peintre pouvait copier les champs correspondants. Dans un deuxième temps il dépeignait les détails à une distance de 4 pieds "rheinland" et utilisait pour la visée les carrés de 7,3 mm d'un deuxième quadrillage. Chaque visée devait être calculée perpendiculairement par rapport au grand carré de 7,3 cm.

**PUNT, H. – Historia de las ayudas ópticas specialmente en las ilustraciones anatómicas de B.S. Albinus (1697–1770)**

**Resumen**

El autor cita la histórica de las ayudas ópticas que se emplean en pintura. Describe entre otros, los medios que han sido utilizados para los métodos llamados de "perspectiva" y de "arquitectónica" en pintura.

En el método de perspectiva el objeto está representado a partir de un solo punto. Este puede ser obtenido de dos maneras: (1) Reducción artificial del campo, de forma que el objeto solo pueda ser visto de un punto determinado (por ejemplo un espejo convexo o una lente concava). (2) Copia del objeto a través de un "foramen opticum" fijo (por ejemplo "cámara oscura", aparato de calco).

En el método arquitectónico cada punto del objeto está pintado en un angulo de 90 grados. Con ese fin el anatomista B.S. Albinus utilizaba un sistema cuadricular (un cuadro dividido en cuadrados por medio de una cuerda). En primer lugar el objeto (un esqueleto) era observado casi hasta el infinito (a una distancia de 40 pies "rheinland"). Delante del esqueleto ponía un cuadro con cuadrados de 7,3 cm. Sobre el papel de dibujo estaban reproducidos los mismos cuadrados, de manera que el pintor podía copiar los campos correspondientes. En segundo lugar, pintaba los detalles a una distancia de 4 pies "rheinland" y utilizaba para el enfoque los cuadrados de 7,3 mm de otro cuadricular. Cada enfoque debia ser calculado perpendicularmente con relación al gran cuadrado de 7,3 cm.

**PUNT, H. – Die Geschichte der perspektivischen Hilfen, besonders bei den anatomischen Abbildungen von B.S. Albinus (1697–1770)**


**Zusammenfassung**

Der Autor gibt einen Überblick über die Verwendung optischer Hilfen in der Malerei. Es wird eine Reihe von solchen Hilfsmitteln vorgestellt, die bei den „perspektivischen" und „architektonischen" Verfahren der Projektion in der Malerei Verwendung fanden.

Bei der perspektivischen Malerei wird das Objekt von einem Blickpunkt aus dargestellt. Dies wurde auf zwei Wegen erreicht: 1. durch künstliche Verkleinerung des Gesichtsfeldes, was einen vollen Überblick über die gesamte Bildfläche gestattete (z.B. durch Wölbspiegel oder Zerstreuungslinsen), 2. durch „Kopieren" des Objekts durch eine festes „foramen opticum" (z.B. mit der „camera obscura" oder einem „Visierapparat").

Bei der architektonischen Methode wird jeder Objektpunkt unter einem Winkel von 90° betrachtet. Zu diesem Zweck bediente sich der Anatom B.S. Albinus eines Rahmens, der durch Schnüre in Quadrate von 7,3 $cm^2$ aufgeteilt war und der direkt vor dem zu zeichnenden Objekt aufgestellt wurde. In der ersten Phase der Abbildung betrachtete der Zeichner das Objekt aus einer Entfernung von 40 rheinischen Fu, d.h. etwa aus dem Unendlichen. Er übertrug die Umrisse des Objekts im Maßstab 1:1 auf ein Papier, das durch Linien in Quadrate gleicher Größe aufgeteilt war. In der zweiten Phase der Zeichnung wurden aus einem geringeren Arbeitsabstand von 4 rheinischen Fuß die Details ausgearbeitet. Um dabei jeweils eine zum Objekt senkrechte Beobachtungsrichtung zu gewährleisten, wurde hierbei ein zweiter in Quadrate von 7,3 $mm^2$ aufgeteilter Rahmen als Visierhilfe direkt vor dem Zeichner aufgestellt. Alle diese perspektivischen Hilfsmittel dienten dem Ziel, eine vollkommene Abbildung zu erreichen.



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