LATE MEDIEVAL OPTICS AND EARLY RENAISSANCE PAINTING

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According to Gombrich in his famous 1964 paper on "Light, Form and Texture in Fifteenth Century Painting", "during the first decades of the fifteenth century, the two schools of painting (the Italian one in the South and the Flemish one in the North) ... divided the kingdom of appearances between them" (p. 20 in the version reprinted in *The Heritage of Appeles*, 1974). The Italian school excelled in the rendering of volume and space while the Flemish school specialised in the rendering of texture and reflections. By the second half of the fifteenth century, the two orientations had mutually assimilated each others achievements and the techniques of both groups became part of the standard procedures of painters from both North and South.

Gombrich traces the Italian tradition back to a revival of classical rules for modelling, taken up again and augmented by Giotto. However, Van Eyck's fascination with highlights and mirrors should be considered a spontaneous innovation. Being farther away, the North did not have the close confrontation with the remnants of classical culture and the suggestive examples that the Italians faced. Remaining out of the grip of the classical approach, there was more room for original exploration and experimentation.

In Gombrich's asymmetrical approach, almost no attention is paid to the possible influence of science. Late medieval science however provided descriptions and explanations for a wide range of optical phenomena, including a theory of vision, various sorts of mirrors and various effects of refraction, together with some astronomical issues. The societal importance of this optical doctrine that evolved primarily in the second half of the 13th century can be inferred from the references made to it in major literary productions. In the South, various allusions and direct references were made to it in Dante's *Divina Comedia*, written more or less concurrenty with Giotto's achievements in the beginning of the 14th century. In the North, the Canterbury tales of Chaucer equally demonstrate the topical nature of the optical issues and authors. Chaucer is supposed to have written these tales between 1384 and 1400, a few decades before the major breakthrough of linear perspective in the work of Donatello and Masaccio. It is not too implausible to assume that artists were familiar with the names of popular scientists and that painters in particular had some interest in the doctrines of these authorities when they touched upon issues pertinent to their own trade: the representation of the visual world.

If we could assume some acquaintance of the painters with their contemporary science, innovations such as Van Eyck's meticulous preoccupations with mirrors and reflections would be less surprising. The discussion of mirrors constituted the bulk of themes in optics and some central problems related to them already end up in scenes of Dante's masterpiece. A section of *Paradise* has a discussion of the transmission of the strenght and the size of images transmitted through mirrors at various distances. A 15th century illustration by the Sienese painter Paolo indicates that painters were indeed interested in scientific issues.

When looking at innovations in art such as Masaccio's mastery of perspective or Van Eyck's exploration of texture and reflection, it seems indicated to include possible influences from science, in particular from a discipline such as optics which apparently enjoyed a certain popularity. Therefore, we propose to review the innovations of both Masaccio and Van Eyck in terms of the optical knowledge we can reasonably assume to have been accessible to them. It could be that the difference between South and North is less pronounced than Gombrich assumes and that it is more a matter of choice amongst the different chapters of a standard scientific doctrine. We will explore the issue along the following lines:

- First, an exploration of the differences between Masaccio and Van Eyck;

- Secondly, a determination of the optical knowledge that was possibly and probably available to both;

- Thirdly, an exploration of their major achievements in terms of straightforward applications of concepts or methods from optical science.

Preliminary exploration of differences between Masaccio and Van Eyck

Masaccio and Van Eyck are, for all practical manners, contemporaries. Comparable major works of both are executed between 1425 and 1432. Masaccio's *Trinity* in the Santa Maria Novella church in Florence exhibits structural and thematic correspondence with Van Eyck's *Mystic Lamb* (Fig. 1).

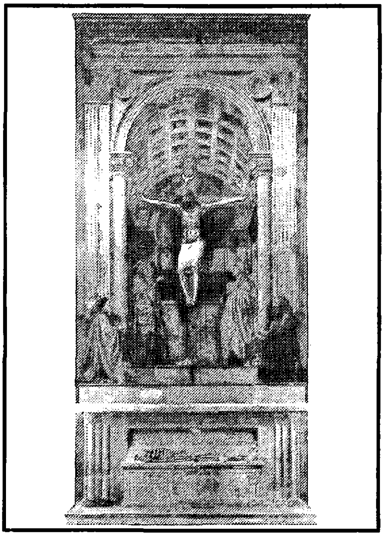

Figure 1

The *Mystic Lamb* panels were originally referred to as *Joos Vijd's tables* (Dierick, 1995), according to the name of the donator. They might have been conceived of and started as early as 1420 by Jan Van Eyck's brother Hubert (Fig. 2).

While Masaccio's *Trinity* is one single large fresco, Van Eyck's *Mystic Lamb* is an altarpiece containing about 20 panels. It can be claimed that both depict the Holy Trinity as central theme.

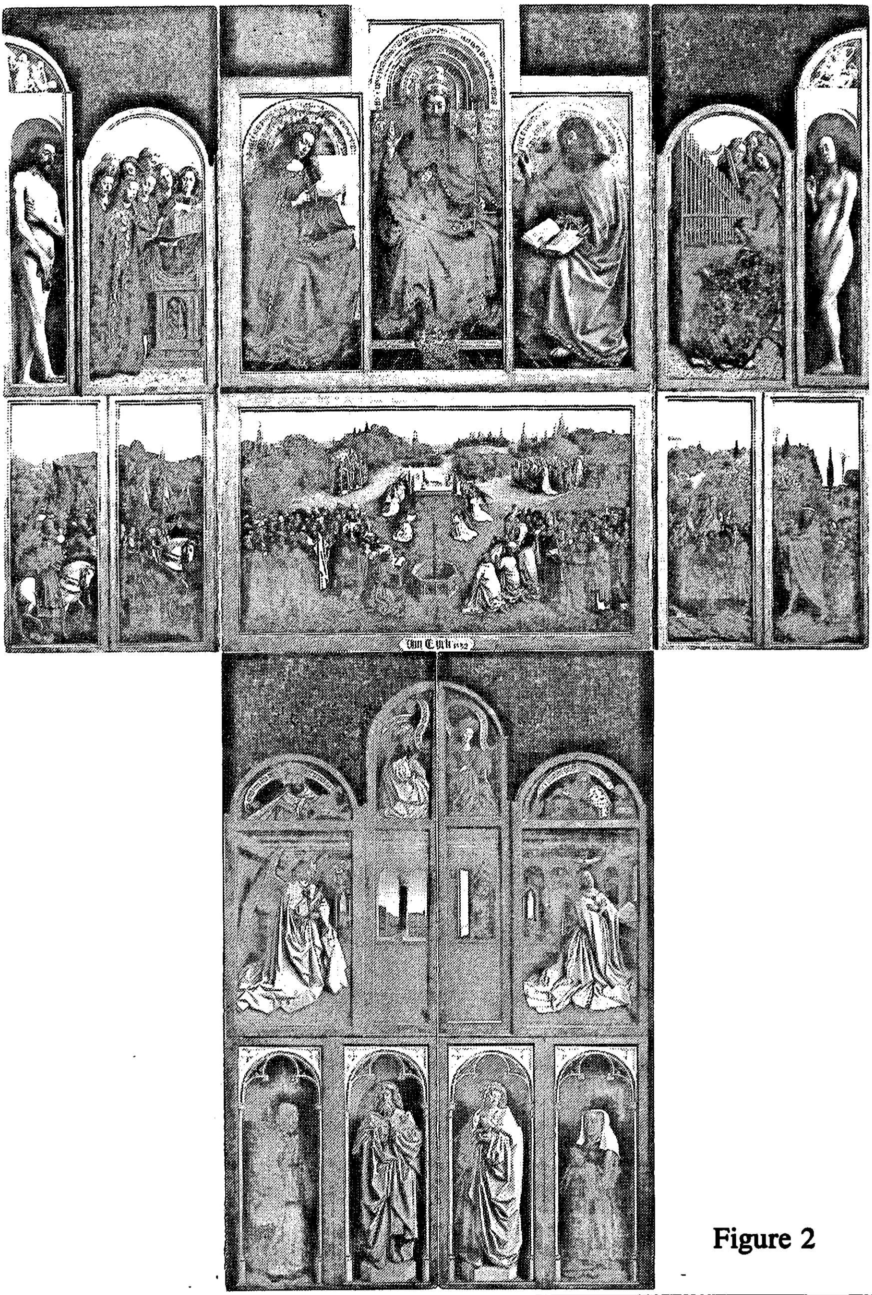

Figure 2

With respect to Van Eyck, there is some ambiguity whether the reigning deity represents either Christ or God the Father. When opting for God the Father, in combination with the Dove present on both paintings, and the Lamb representing Christ, Van Eyck's masterpiece is as much focussed on the Trinity as Masaccio's. The deities are accompanied by the Holy Virgin and Saint John, the apostle in Masaccio's fresco, the baptist in Van Eyck's panel. John the Baptist was the patron saint of the church for which the panels of the big altarpiece were ordered. Today the church has the status of a cathedral and is dedicated to Saint Bavon. In Van Eyck's time, it was Saint John's church. Both paintings also contain on the sides the portraits of the donators. They provide convenient material for comparison although we might need to look at other works as well to explore the full range of Gombrich's statements about these leading representatives of the Southern and Northern school.

Are the differences between them easily detectable? Maybe, the difference in tonal range is not so pronounced when comparing the representations of the two donators in both Masaccio's *Trinity* and Van Eyck's *Mystic Lamb* (Fig. 3, a and b).

Figure 3 a

Figure 3 b

Neither is it very obvious when comparing the faces of God the Father in both works. (Fig. 4, a and b).

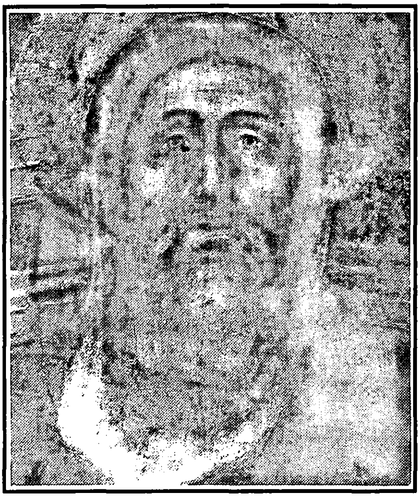

Figure 4 a

Figure 4 b

It becomes more pronounced in a comparison between the two saints John, where the sculptural qualities of Masaccio's depiction become apparent. (Fig. 5, a and b).

Figure 5 a

Figure 5 b

And despite the damaged condition of Masaccio's Holy Mary, in the comparison of the black and white representations, it seems indeed to be the case that he uses a subtler and wider range from white to full dark than Van Eyck. In this, however, Masaccio tends to blend highlights and illumination, two different qualities which Van Eyck carefully keeps apart. (Fig. 6, a and b).

Figure 6 a

Figure 6 b

Though Masaccio's capacity for modelling is especially prominent in the heads and faces of the figures in his Brancacci chapel scenes, also his *Pisa Madonna* with child and angels, now at the National Gallery in London, demonstrates his eagerness and ability to exploit spatial characteristics of individual objects as well as of entire scenes. (Fig. 7)

The use of lightfall is emphatically present in the patch of light on the upper right wing of the throne. Also, the light from behind the throne contributes to a sculptural presence of the object. If we compare Masaccian figures with some of Van Eyck's, the volumetric composition of the Child seems superior to its symbolic counterpart: the Lamb. However, the woolly skin of the latter allows for more virtuosity on

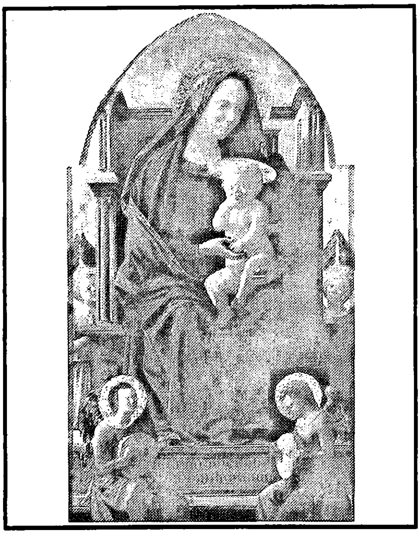

Figure 7

texture than on volumetric shape. However, a comparison is not fair since Van Eyck's Lamb-figure has undergone deforming restaurations.

More of Masaccio's modelling can be seen in the two angels consistently lighted from the left in their different poses. Furthermore, two identical musical instruments seen in different orientations allow the painter a brilliant demonstration in foreshortening. (Fig. 8, a and b).

Again, the faces of Van Eyck's counterpart figures, the singing and music playing angels, might seem somewhat flatter. Is Van Eyck

Figure 8 a

Figure 8 b

less daring in handling chiaroscuro or is it because his handling of texture is stealing the show? (Fig. 9).

Figure 9

Masaccio too can handle texture as is demonstrated in the golden aura behind the head of the Virgin Mary and the gossamer veil that covers her cap. As with modelling, Masaccio's handling of texture might be even more austere, going only after the essentials. But this is not supporting the claim made by Gombrich that texture is the specialty of the North. Another contemporary of Van Eyck, such as Gentile da Fabriano, also illustrates that painters of the South are capable of observing the fine structure of textiles and the way it can be revealed by light. However, Gombrich points to an important difference when indicating that the Italian painters use light and reflection only to reveal the structure of the object whereas Van Eyck seems as much interested in the light itself as in the object. At times, the object is primarily used to depict the light, and the structure or content becomes a secondary matter. Compare the stola's on Fabriano's *Saint Nicolas* and Van Eyck's Saint Donatian in *the Virgin and Child with canon van der Paele* (Fig. 10, a and b).

While both show careful attention to the microstructure of the fabric and the revealing qualities of gold fiber, only Van Eyck dares to give priority to the incidence of light at the expense of a homogeneous rendering of the depicted figure or scene. Some of Fabriano's figures wear clothes similar to some of Van Eyck's figures, richly decorated with gold and jewels. Although there is a subtle indication of the enchanting influence of reflection, there is not this pertinacity of following through on the behavior of light that is so typical of Van

Figure 10 a

Figure 10 b

Eyck. Clearly marked highlights are almost absent from the eyes of either Fabriano's or Masaccio's figures. Van Eyck traces them consistently and represents them meticulously. It is not so much the representation of texture as the dedicated rendering of highlights that seems to be a distinctive feature of Northern versus Southern painting. From where this preoccupation with reflection?

Perspectiva as a popular scientific discipline in the 15th century

Several kinds of hypotheses are conceivable for explaining the preoccupation with reflection and refraction so characteristic of fifteenth century Flemish painting for which Van Eyck provided such a spectacular onset.

Gombrich, as mentioned, refers to the tempering influence of classical art in the South. For the Italians, this kept the sense for measure and control intact, even when novel approaches and techniques were explored. The North, lacking the presence of classical examples was also lacking the moderation that that culture could provide and therefore it could indulge more wildly into the exploration of spectacular brilliance and superficial glitter. Could the lack of constraints be sufficient to explain the thoroughness and perseverence with which reflection and refraction were traced by Van Eyck? Is this fascination with peculiar aspects of light to be reduced to gothic exaggeration?

As indicated before, optics as a science developed in the thirteenth century, known as "perspectiva", was also popular outside of scientific circles. We mentioned Dante and Chaucer as famous literary personalities who referred to it. We also pointed out that in the fifteenth century, Giovani di Paolo, a Sienese painter working during the same period within which Van Eyck was active, made illustrations for Dante's *Divina Comedia* indicating that painters too were familiar with some specific theorems of optics as a discipline. That painters were indeed expected to have some acquaintance with such science is also reflected from Bartolomeo Fazio's contemporary praise of Van Eyck as someone well conversant with both "letters and geometry" (see Panofski,1953, p 361). In the tradition of Euclid's and Ptolemy's optics, perspectiva was mainly developed as a geometrical discipline. It is plausible to assume that Van Eyck's "geometric" competence touched upon this discipline in particular. As demonstrated through Ghiberti's eagerness to master it, a few years after Van Eyck's achievements, it was of direct concern to artists in general and to painters in particular. At the end of his career, the sculptor Ghiberti went through a tedious study of the discipline, assembling an impressive collection of notes indicating what he could make of it (for Ghiberti's *Third Commentaries*, see translation and commentary in Bergdolt, 1988). What can one reasonably assume to have been accessible as semi-popular account in the first half of the 15th century? Obviously, the notes of Ghiberti constitute an interesting entry, but given his close adherence to the 13th century text of pioneers such as Pecham and Witelo and even the Arabic founder of the discipline Al Haytham, it seems more indicated to look for more contemporary texts.

A manuscript bearing the label of *Riccardiano 2110* of the Biblioteca Nazionale of Florence, published by Parronchi as *Della*

Prospettiva in 1991 and assigned by him to Toscanelli, seems a reasonably reliable source for a view on a 15th century semi popularized version of perspectiva as a science. Though its ascription to Toscanelli can be seriously debated (De Nil, 1995), its 15th century origin is relatively certain so that, even if from an unknown author, it can be seen as a fair description of an introductory text in perspectiva. It is indeed phrased as a popular account, meant to introduce an interested layman into the basic concepts of this science. In this sense, it is equally fair to assume that a famous and well paid court painter as Van Eyck, who frequented a cosmopolitian community of diplomats and scholars, either at the court or on his travel assignments, should somehow have come in touch, in one form or another, with these concepts.

Accepting the Riccardiano 2110 manuscript as representative of the 15th century popularized science of perspectiva, what are its central themes?

The structure of the 15th century popularized account is not markedly different from the structure of classical texts on optics or perspectiva. It follows the skeleton established by Ptolemy, starting with an account of the process of vision, be it less anatomically explained than in the authoritative texts. Then it deals at large in a standard fashion with planar and spherical mirrors, both convexe and concave. Finally, it discusses the issue of refraction. The treatment is not revolutionary new, but it seems more condensed and original than Ghiberti's *Third Commentaries* which, as indicated, are largely taken over from texts of 13th century perspectivists or even earlier ones like Al Haytham. Furthermore, it contains an interesting set of drawings, some of which could have an appeal to painters as particularly clear illustrations of surprising and controversial claims of science. Again, it should be understood that in no way it is to be suggested that a painter like Van Eyck had access to this paricular version of "perspectiva"! It remains an isolated manuscript addressed to a specific reader and probably written in the second rather than the first half of the 15th century. Nevertheless, what it offers is a representative view on concepts and images probably accessible and possibly on occasion debated by artists in the fifteenth century. A few representative theorems and figures should indicate the kind of suggestive images and ideas the doctrine of perspectiva could contain.

The visual cone

The treatment of the process of vision is organized around the pivotal concept of the visual cone. Perceiver and perceptual object are connected by a bundle of rays constituting a cone of which the top is located in the eye of the perceiver while the base coincides with the contour of the perceived object. (Fig. 11)

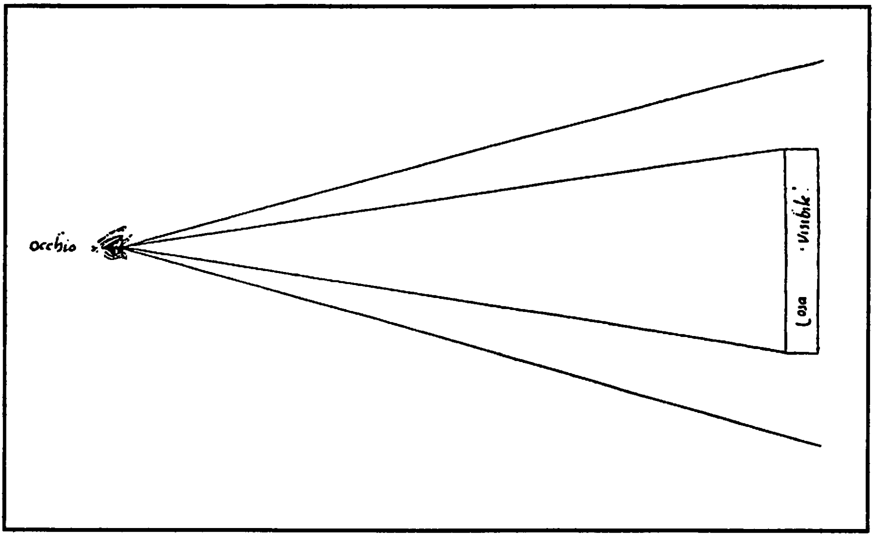

Figure 11

The pattern of rays converging upon a single point can apparently be misleading. When inversely applied to the radiation of light from a luminous body, rays are shown as originating in a single center rather than radiating in all directions from every point of the surface of the body (as shown in Ghiberti's superior scheme quoted in Bergdolt 1988, p 12 (Fig. 12).

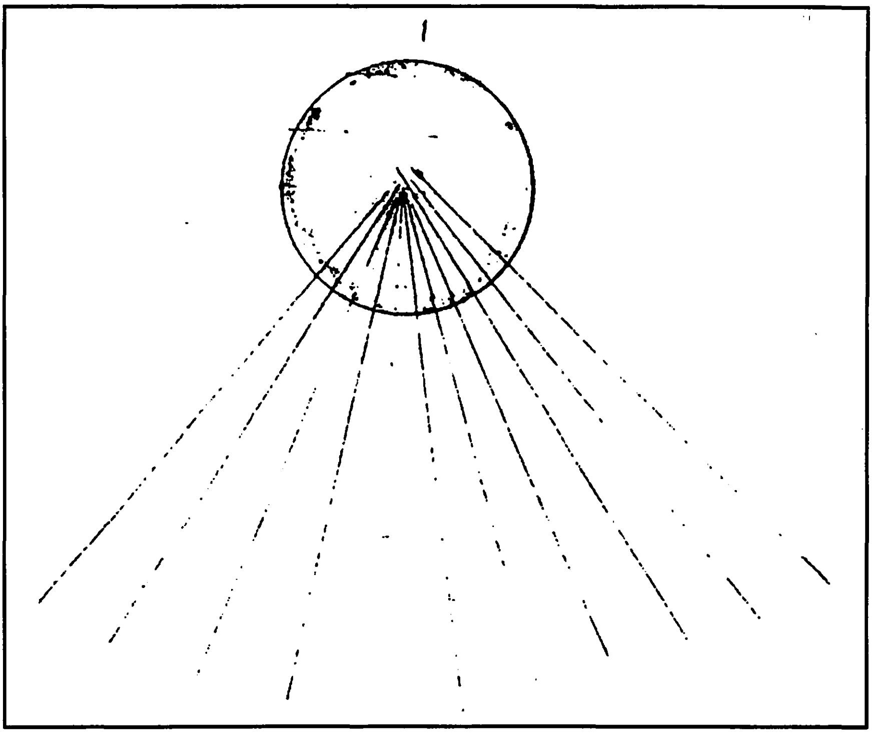

Figure 12

This confusion between a single point source and the cone of rays originating in every point of a luminous surface is possibly due to the illustrator rather than to the author. Would it be typical of a kind of degradation induced by popularization?

The circular square

The Euclidian concepts of visual cone and visual angle have obvious applications in explaining the perception of size and the degree of detail with which a visual object is seen. A qualitative extension of this principle leads to the rather remarkable Euclidian claim that a square seen from a distance will look like a circle. Our fifteenth century author emphasized that this only applies for really big distances (Fig. 13).

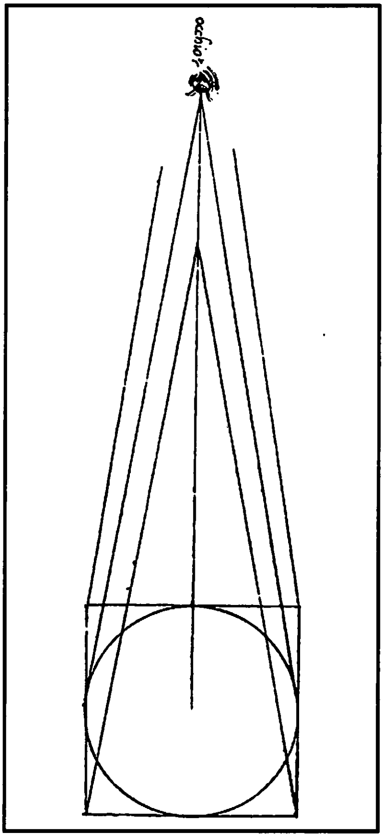

Figure 13

The circle evoked by a torch in an orbit

How there can be the perception of a circle without a genuine circular object is argued and illustrated with the case of a torch rapidly swing in a circular pattern. The drawing depicts how the visual cone of a circle is evoked by the images of the various sequential positions of the torch which are refreshed each time again before they can die away (Fig. 14).

The coin in the cup

Another Euclidian theme is related to refraction for which the mathematician designed simple but convincing experiments. An experimenter puts a coin in an empty cup and then reclines until the coin is out of sight for him. Then an aide fills the cup with water and although the experimenter has carefully remained on the position from where he could no longer see the coin, he can now see it again because of refraction (Fig. 15).

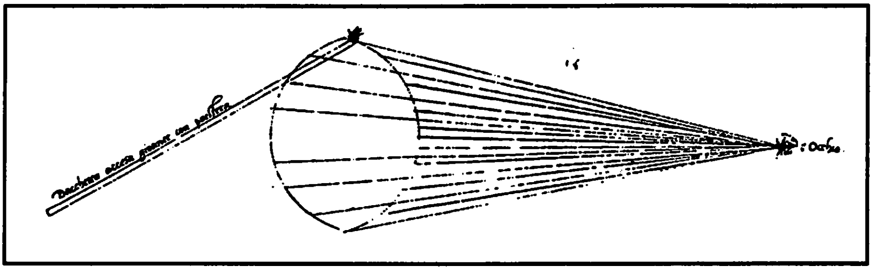

Figure 14

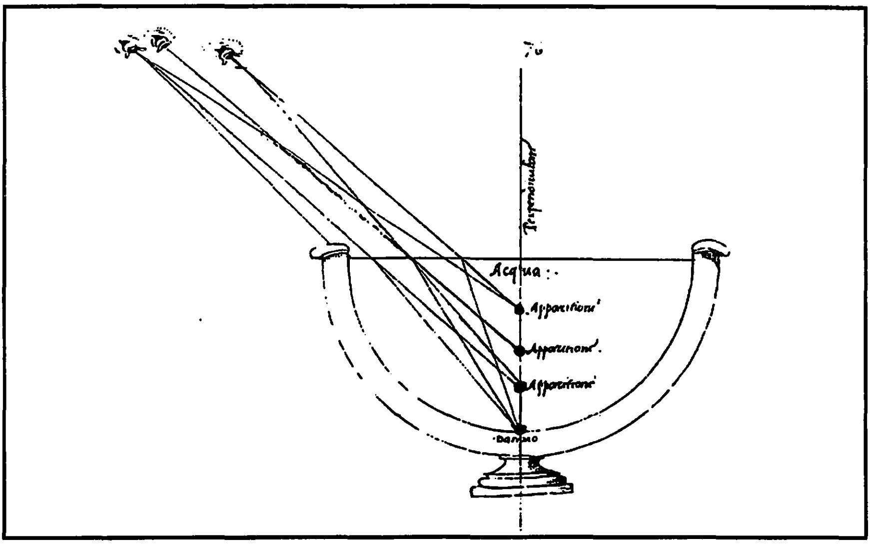

Figure 15

With a transparent vessel, a similar situation explains the double image of a cherry in a glass (Fig. 16).

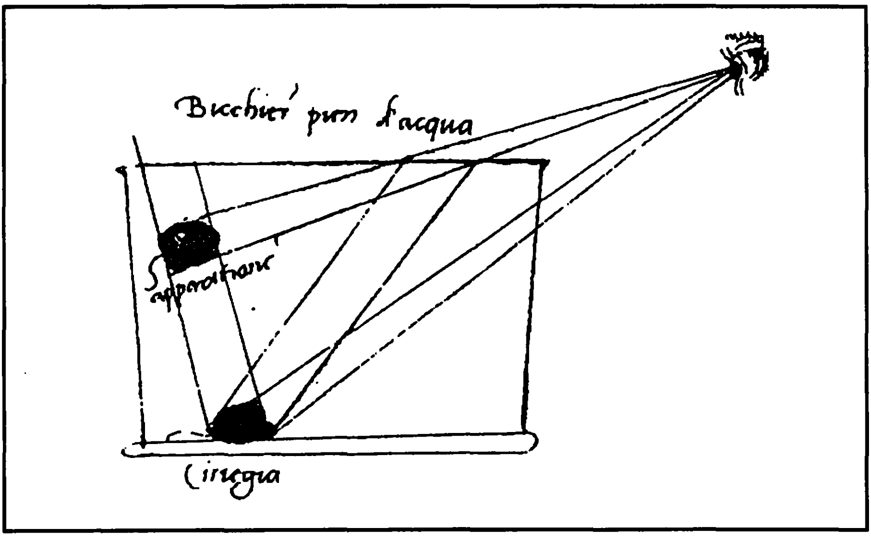

Figure 16

Luminous qualities of a chandelier

Refraction is equally evoked in explaining the use of intervening media in amplifying and distributing the light from a single (point) source. A chandelier encompassed by glassy arms in the shape of a semi-circle and filled with water is expected to enlighten the room through division and recombination of light. An angular structure of the arms which will evoke even more diffraction or sparkle might even be a better lighting instrument (Fig. 17, a and b).

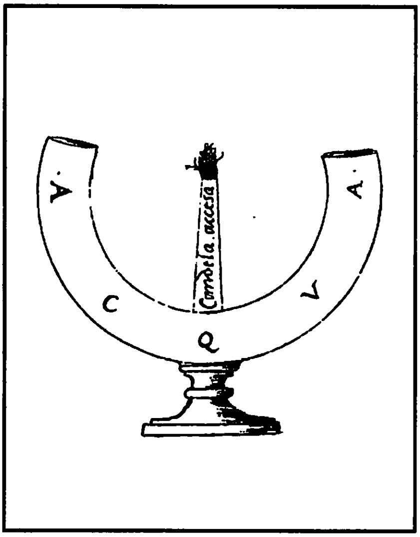

Figure 17 a

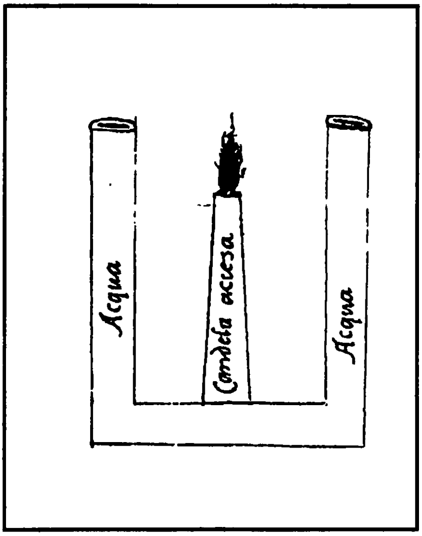

Figure 17 b

The burning glass

In the explanation of the chandelier, it is stressed that to increase the efficiency, the device should be constructed so as to allow more rays to converge upon a single point. A burning glass in the shape of a sphere filled with water can apparently refocus the rays of the sun in such a way as to light up a candle. Again, the misleading symmetry of diverging and reconverging rays derives from handling the sun erroneously as a point source of rays (Fig. 18).

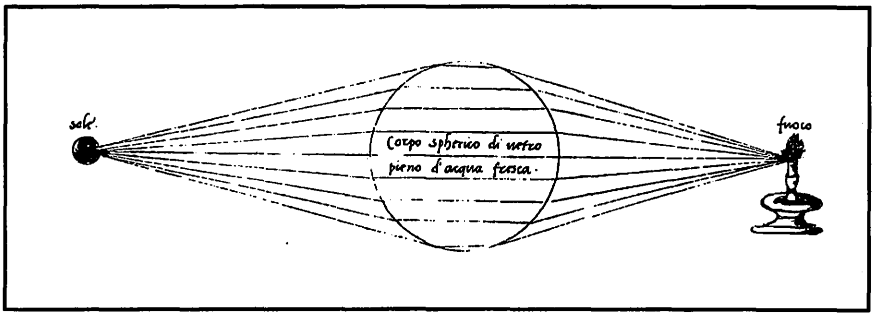

Figure 18

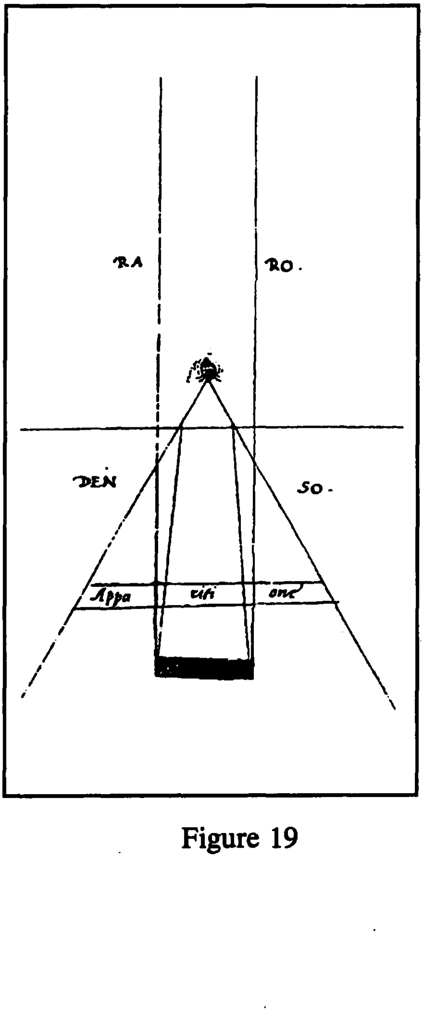

Figure 19

Refraction and eye glasses

How refraction produces an enlarged image of an object is equally illustrated by a diagram showing the passage of rays through optical media of different density. The more dense material is not depicted in the shape of an eyeglass but the accompanying text clearly explains the functioning of eyeglasses as an effect of refraction. (Fig. 19)

The inverted image in a planar mirror

In perspectiva texts, the bulk of theorems and illustrations is devoted to the study of mirrors. A simple scheme explains how a planar mirror provides an inverted image. Such a mirror, lying flat on the ground, will show a tower upside down, the top being seen as farthest away from the viewer. (Fig. 20).

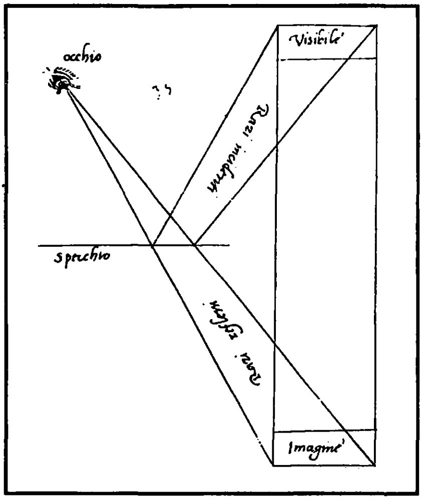

Figure 20

The image in a spherical mirror

The problems of spheric mirrors constitute the most substantial part. Before the distinction is made between convex and concave mirrors, a more general discussion deals with the reduced sizes of the image and the degree of curvature of the mirror. (Fig. 21).

Also the point is emphasized that the outcome of an observation in a mirror always depends on the location of the viewer. A complex scheme indicates the viewer location dependence for a number of interpretations. (Fig. 22).

The shape of shadow cones

A recurrent scheme to account for the formation of shadow cones is present in a comparison of relative sizes of light sources and the object intercepting the cone of rays. The shape of shadows is not systematically dealt with as this is the outcome of a complex interaction between the shape of the light source, the shape of the object producing the shadow and the shape of the object on which the shadow is projected. (Fig. 23).

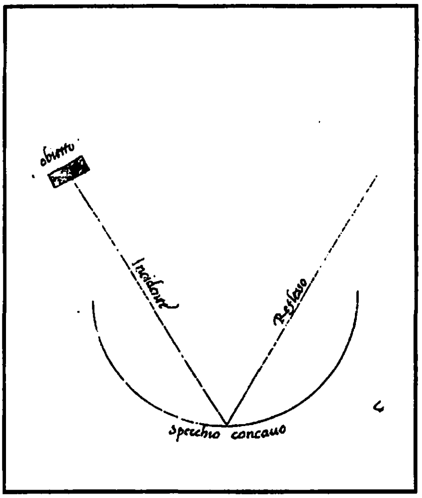

Figure 21

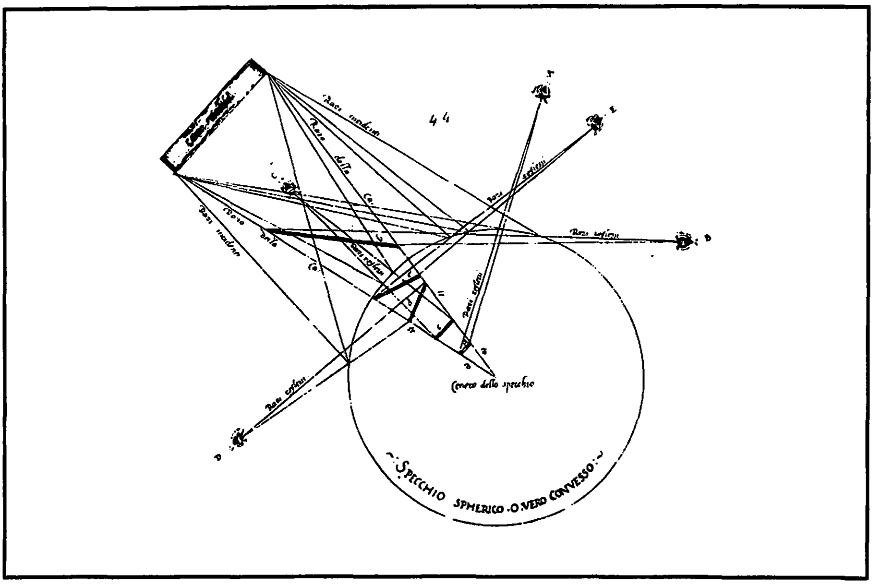

Figure 22

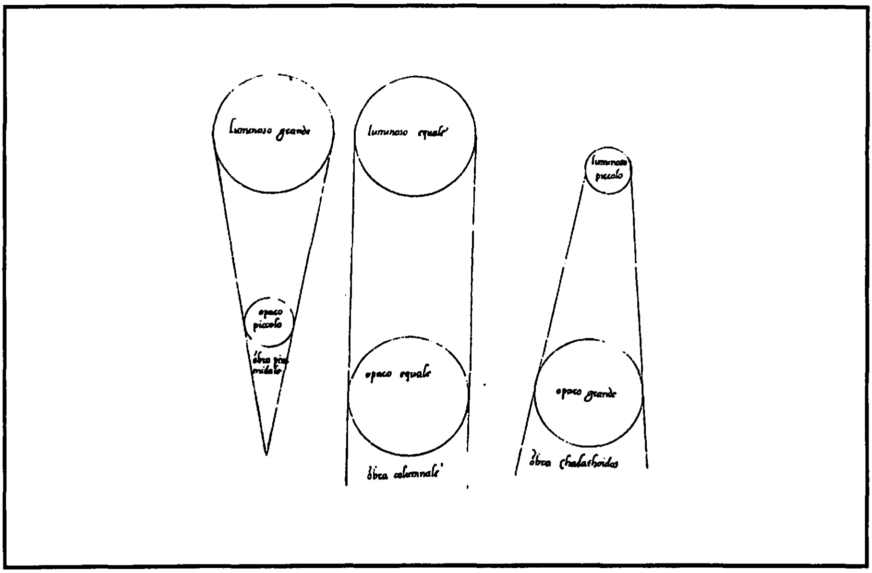

Figure 23

Distinct optical options with Masaccio versus Van Eyck

A closer look at a few representative achievements of both Masaccio and Van Eyck will reveal a difference in their adoption of the various chapters of classical optics or perspectiva. Masaccio manages to control the visual cone and intersects it to intercept the image on the way from the scene toward the eye. Van Eyck traces the trajectories of lightrays in their bouncing path on surfaces and mirrors and in the bending they undergo when passing through different media. Masaccio focusses upon what can be learned from the standard opening chapter, describing the eye and the direct visual process. Van Eyck includes the indirect vision of the more complicated chapters further on, dealing with the process of seeing as it is affected by the reflecting surfaces and refracting materials through which the rectilinear lightrays reach the eye. Both are apparently working along lines suggested by the science of perspectiva, though with differing sensibility.

Masaccio's achievement with linear perspective

Besides his Donatellian sense for sculptural quality and dramatical tension, Masaccio is particularly famous for what is considered the oldest surviving painting which demonstrates perspective in the modern interpretation of today. While there have been earlier demonstrations by Brunelleschi (around 1413, two lost panels) and Donatello (1417), his *Trinity* fresco from around 1425 remains the achievement that proved both mathematically coherent and observationally convincing in establishing a genuine experience of space. (Fig. 24).

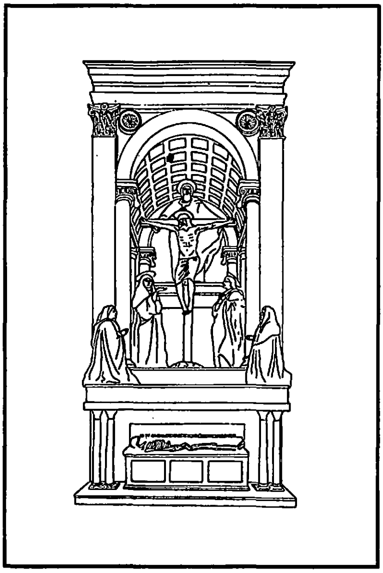

Figure 24

Some authors have claimed that the mastery of linear perspective is the pivotal breakthrough of science within art. For Santillana (1973), it means even the onset of the scientific revolution because it results from a solid bond between sensory experience and mathematical principles. For our purposes, it is sufficient to indicate that linear perspective as elaborated by Masaccio is mainly the idea of the visual cone followed through to the conception of the picture plane as a cross section through the cone. A century later, around 1515, Dürer has depicted the practical means for obtaining it by means of a rope with a fixed anchor point in the wall. (Fig. 25)

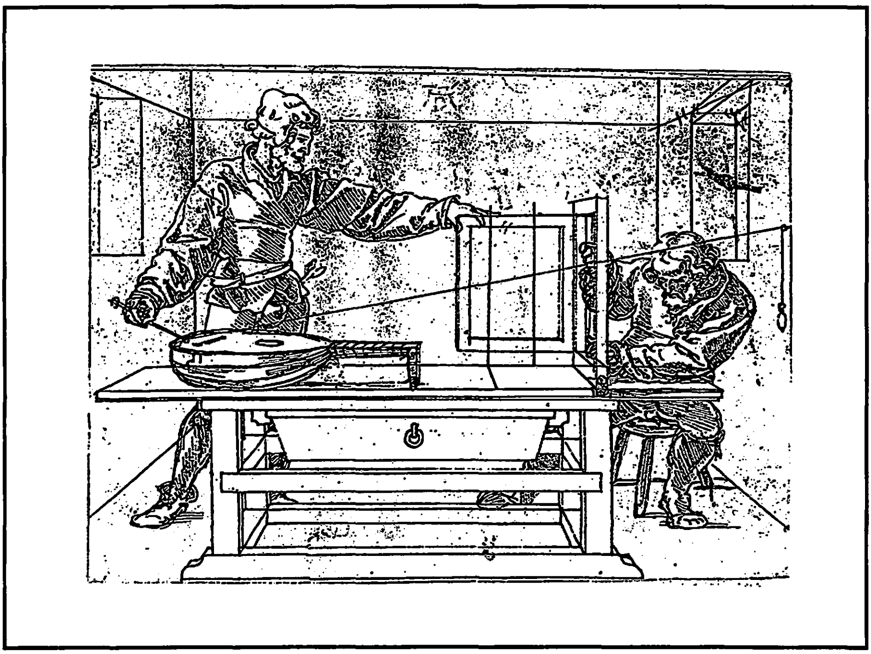

Figure 25

Elsewhere, we have indicated how indeed Masaccio's 2D fresco contains sufficient data to allow for a 3D computer reconstruction (De Mey, 1995). The endeavor is not entirely unambiguous and, as the plans proposed by several art historians suggest, several alternatives exist. Nevertheless, whatever depth is agreed upon (one of the issues debated), the prevailing notion remains the visual cone. (Fig. 26)

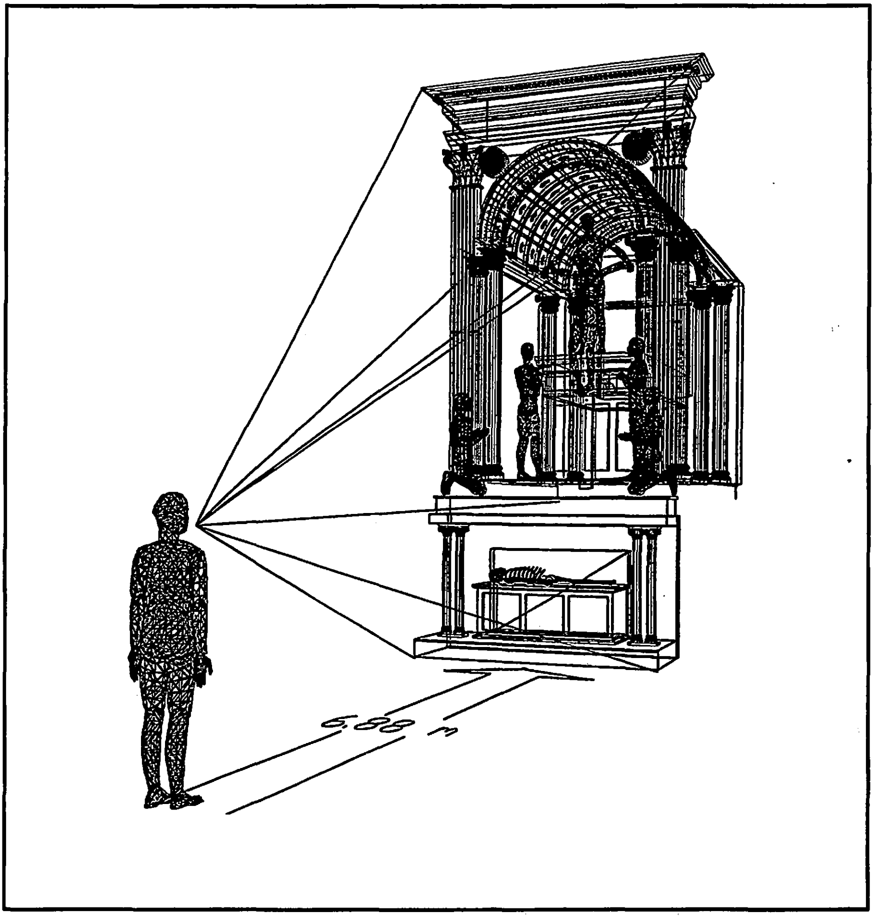

Figure 26

With the assimilation of the visual cone into a sophisticated geometrical technique for drawing and painting, Masaccio integrates only the introductory part of the classical doctrine of the perspectiva, established 150 years earlier. As indicated above, the most substantial part in any treatise on vision of late medieval origin is concerned with reflection and refraction. Compared to Gombrich's asymmetrical approch, it seems at least equally plausible to explore whether the developments in Italy and Flanders could not be considered more symmetrically as alternatives in the choice among the chapters of optics.

Van Eyck's preoccupation with reflection and refraction

From the outset, it should be clear that there is no frenetic adherence to the principles of science among our artists, neither for linear perspective nor for reflection or refraction. One can hardly find in Van Eyck a straightforward application of the Euclidian principle that "Seen over a large distance, a square appears as a circle". For him, perceptual features do not deteriorate over distance, although they change character in many subtle and detailed ways. Consider the central castle far away in the midst of the river depicted in *The Virgin Mary and Chancellar Rolin*. (Fig. 27)

When looked at from close by, the black dots representing the windows are not perfectly rectangular. Their rounded shape is probably not an intended effect for illustrating an optical principle but probably due to natural limits of human dexterity. That the windows are just calligraphic touches of paint, steadily applied in one single stroke, should be apparent once one realizes that the representation of the entire castle is only 16.5 mm wide and, reflection in the water included, 24 mm or about 1 inch high. Notice however how carefully Van Eyck observes the different visual angles under which the central tower of the castle is seen in comparison to its reflection in the water. As the view is from above, the representation of the tower encompasses a larger angle than the representation of its reflection in the water (while respecting all along the principle of angle of incidence equaling angle of reflection and Euclid's famous theorem 10 with respect to a non orthogonal section through the visual cone).

Light source and highlights in Ghent Altarpiece

To illustrate the optical problems that Van Eyck really cares

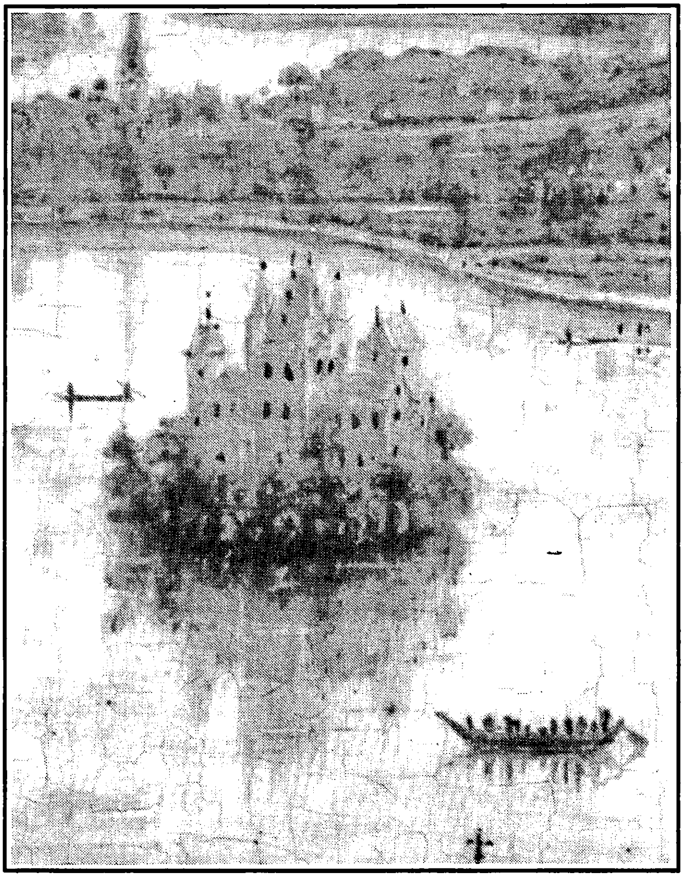

Figure 27

about, we should indicate some of the lighting aspect of the Ghent altarpiece. The original location of the Van Eyck altarpiece is not the location where it is currently shown to the public. The current location is in a room of the tower part at the entrance of the cathedral, used until recently as a baptistry. That tower construction was added to the building in the second half of the 15th century, several decades after Van Eyck's panels had been executed.

The original location for the Van Ecyk altarpiece was in one of the chapels built around the Gothic choir of church in the late 14th early 15th century, a few decades before the painter received the assignment. The chapel bears the name of Van Eyck's patron: it is the Joos Vijd chapel located on the South side.

The Gothic Saint John's church was built on the foundations of a Romanic church of the 12th century. In the 13th century, plans were made to enlarge the church along the lines of a Gothic building. In the midst of the 14th century, a Gothic choir was more or less superimposed upon the Romanic structure. The Vijd-chapel was the most Southern one of a series of side chapels to be added in the second half of the 14th and the beginning of the 15th century. In plan, the first enlargements of the church were the two sides and the top of the choir. The additions which were to contain the Vijd chapel were the side chapels around the apse. By the time Van Eyck received his assignment, only the choir with its large side chapels had been completed. The constraints within which he had to work were an irregular pentagonal room with the eastern wall available for his panels. The panels would be facing west and for a viewer standing in the chapel looking at them, would receive light from two windows, one facing to the south and one facing south west. The baroque fence which now separates the Vijd chapel from the main choir area was absent, so that the panels could be completely opened.

Having a view upon the situation of the panels and the light sources in the chapel, it is now possible to indicate how Van Eyck attempts to integrate the chapel windows into his painting. (Fig. 28)

Highlights on the eyes

In general, the eyes of all depicted human figures on the various panels, looking toward the window exhibit highlights. Those looking toward the other side lack them. The figures of Adam and Eve provide a clear illustration of this. Adam faces the window and has the reflection shown on his eyes. Eve looks into the other direction and has none. The optical explanation is straightforward. The highlights on eyes consist of the reflection of the light source on the spherical

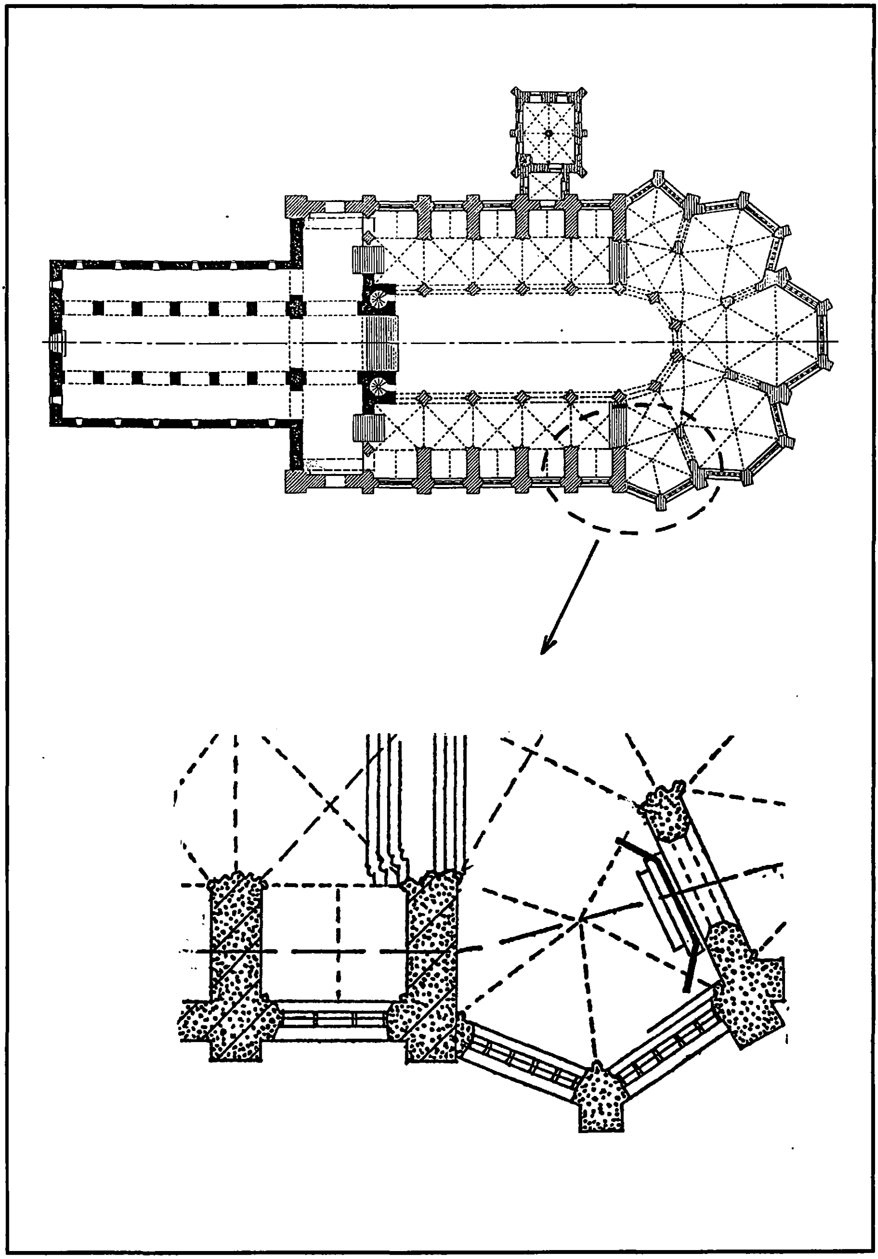

Figure 28

surface of the eyeball. Their understanding requires the straightforward application of the theory on spherical mirrors. From the way Van Eyck handles the location of the highlight with respect to the pupil according to the orientation of the eyeball, one can infer that he is fully aware of these optics. (Fig. 29, a and b)

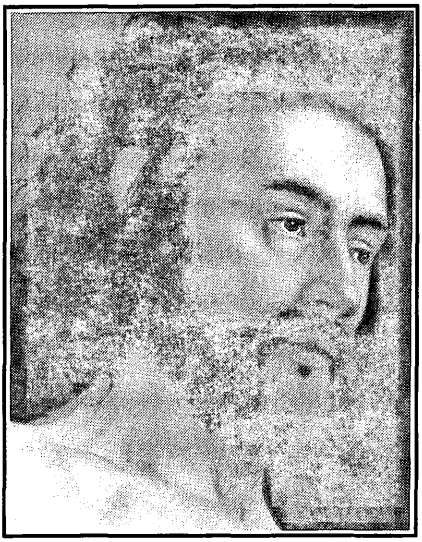

Figure 29 a

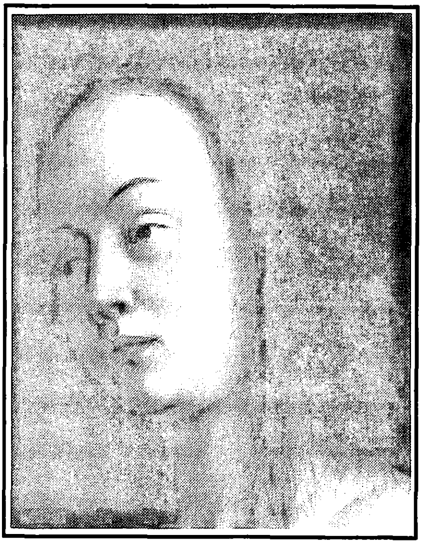

Figure 29 b

Localisation of highlights on jewels

Also in numerous spherical pearls, the highlights are consistently placed as genuine reflections of the light source. In the Ghent altarpiece, this source is to the right and the highlights are shown accordingly. In the Canon Van der Paele panel of Bruges, the light comes from the left and here, the highlights are shown with the appropriate shift to the left. (Fig. 30, a and b)

Van Eyck clearly distinguishes between the glossy shine of the whitish fine pearls and the clear crystal beads on which the highlights are better defined and smaller because of the difference in texture and transparency. The light reflected back through reflection against the inner surface of the transparent sphere is the kind of reflection

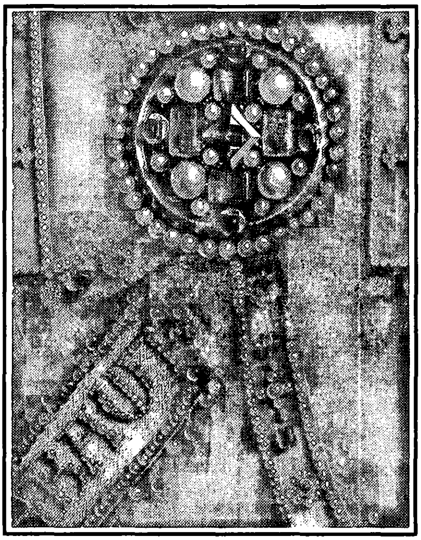

Figure 30 a

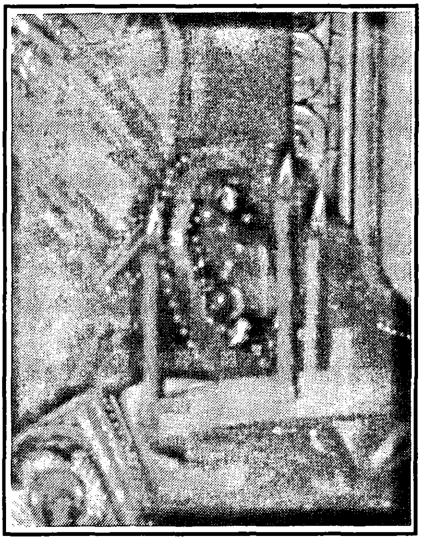

Figure 30 b

Theodoric von Freiburg invoked to describe the behavior of light in raindrops and to explain the rainbow. Van Eyck is clearly fascinated by this process in the watercolumn leaving the fountain depicted in the central panel and in the transparant medium of the vertical beam of the cross carried by one of the depicted popes in the same panel. In the panel to the right of the central one, the same optical mechanisms are demonstrated on the beads of the rosary of the hermit. (Fig. 31)

That effect is repeated and extended with patches of light produced by refraction in the beads hanging to the left of the mirror in the Arnolfini couple of the National Gallery. In the *Arnolfini Marriage*, one can distinguish four or five distinctive optical effects on the beads: highlights, internal reflection on the inner surface, refraction producing patches of intensified light on the wall behind and shadows of the beads on the same wall. To show the transparency of the beads, Van Eyck manipulates the visibility of the connecting rope and also a subtle inner light in each bead resulting from secondary and tertiary reflection or what is more generally known as radiosity. With Gombrich one wonders indeed whether "the meticulous observation of

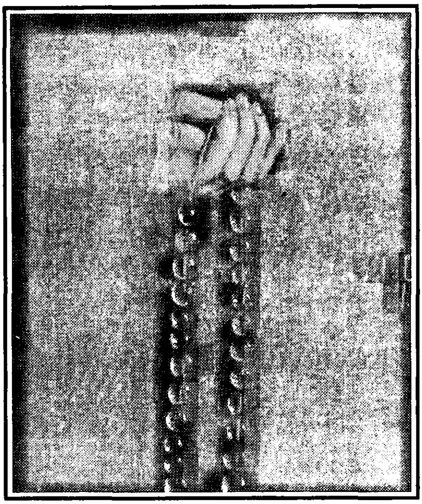

Figure 31

nature" could really account for such a degree of precision and optical sophistication. Evidently, a painter acquainted with concepts of optics would undoubtedly distinguish between these various effects much better than one "just copying meticulously what he sees."

Mirror effects in jewels

In the Ghent Altar, Van Eyck's fascination with mirroring is also manifested in the reflection of the window on the cylindrical jewel decorating the buckle of the angel choirmaster's cloak. A window is clearly suggested in line with the situation of the room and optically plausible for a cylindrically reflecting surface. (Fig. 32)

Color carrying rays

A pervasive notion throughout optics from Aristotle onwards and shared by major authors such as Ptolemy and Al Haytham is that what is ultimately carried or assimilated by the rectilinear rays of optics, is color. How the color of a neighboring cloth is almost contaminating the color of the metallic angle on top of the fountain is shown in the subtle reflection of red on the top of his wings. Notice also the multiple reflection of the light source (the double window to the right) in the

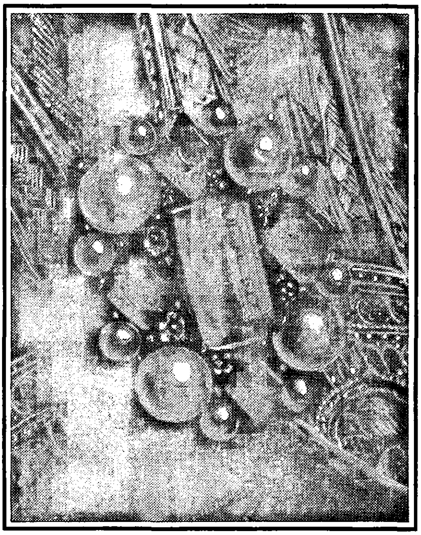

Figure 32

metal parts of the fountain.

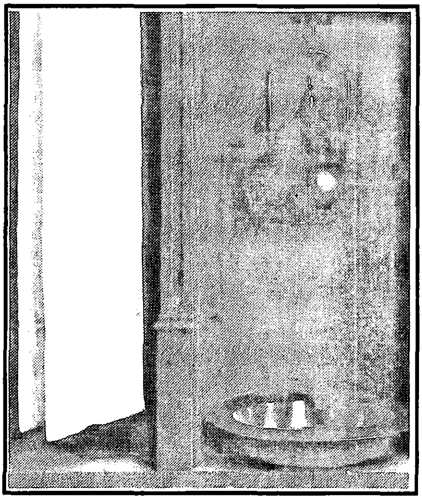

Figure 33

Convex versus concave mirroring

The optical effects on simple daily houseware are dealt with as carefully and dedicated as in the handling of jewels and golden brocade. In the *Annunciation*, the reflection on the kettle is different from that on the washbasin. The kettle qualifies as a convex mirror, the washbasin as a concave mirror. The first one yields a reduced upright image of the light source, the second one an inverted image of the light source and, in this case, secondary reflections of the primary image through radiosity. (Fig. 33)

Ophtalmologists have even scrutinized Van Eyck's depiction of Canon Van der Paele's eyeglasses in the *Virgin and Child with Canon Van der Paele*. The canon should apparently have been myope because Van Eyck's depiction of the refraction qualities of the eyeglasses allows to infer that these consist of concave lenses! (Fig. 34)

Figure 34

All of this demonstrates a sensibilty for optical effects that should have been nourished, at least in part, by the science of perspectiva about which Van Eyck should have known. The dominance of issues on mirrors in that discipline is reflected in the dominance of the same theme in his works. Together with the visual cone, these issues constitute the core of the discipline and a painter dedicated to their application could be expected to focus on either one or both. If perspective comes down to providing the viewer with information about his position, Van Eyck provides it by using the light source as an orientation device. The viewer should be expected to have noticed where the source is (the window) within the viewing room. Seeing it reflected through the highlights in the picture, he can infer where he is supposed to stand.

Light versus lines

Already for Masaccio's *Trinity*, the exercise of going through a computer reconstruction turned out to be extremely useful in learning to appreciate the artist's discoveries and innovations. In the case of Van Eyck, the same impression prevails. Despite various sophisticated rendering techniques which embody the principles of optics to an impressive degree, it remains extremely difficult to match the subtlety with which a master as Van Eyck handles light and texture. It is not so much the linear perspective as the rendering which constitutes the ultimate test. It is in meeting the challenge of the rendering that one learns to appreciate the keen eye of the painter whose either conceptual or perceptual understanding of the complexities of light and light reflection achieves a level of penetration that is only matched by the analysis of science. While stressing their complementarity, Sarton (1941) emphasized the basic differences between science and art. We should not misunderstand his position as a warning against any search for loci of fruitful interaction between both.

Note

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