From Emblems to Diagrams: Kepler's New Pictorial Language of Scientific Representation

Raz D. Chen-Morris

Draft Version

In his *Natural History*, a text that became the main source and model for Renaissance history of art, Pliny the elder supplied, through several stories and comments, an outline of the significance and power of painting. He tells, for instance, of the Greek painter Apelles who traveled to visit Protogenes, another famous painter, in Rhodes. When Apelles arrived there, Protogenes was not in his studio, but an old woman who watched over a "panel of considerable size on the easel prepared for painting." Apelles decided to leave his mark and painted "an extremely fine line in color across the panel." When Protogenes returned to his studio, he recognized Apelles as the only painter who could have painted such an exquisite line. In return Protogenes "drew still a finer line." Coming back Apelles was "ashamed to be beaten, cut the lines with another in a third color, leaving no more room for any further display of minute work." The result was a panel that "had nothing else on its cast surface except almost invisible lines.'

The other anecdote from Pliny, tells of two painters – Zeuxis and Parrhasios. Zeuxis had painted grapes so deceptively that birds came down to peck at them. Parrhasios contested him and invited Zeuxis to his studio to show him his own work. When Zeuxis eagerly tried to lift the curtain from the panel, he found it was not real curtain.

My final anecdote from Pliny describes an attempt to introduce pictures into ancient Greek Botany:

"In addition … there are some Greek writers who have treated [botany]. Among these … Crateuas, Dionysius and Metrodorus adopted a very attractive method of description, though one, which has done little more than prove the remarkable difficulties, which attended it. It was their plan to delineate the various plants in colors, and then to add in writing a description of the properties, which they possessed. Pictures, however, are very apt to mislead, and more particularly where such a number of tints is required for the imitation of nature with any success."

In these stories and comments Pliny set the domain of pictures between the perfect mimesis of phenomenal reality, an illusion that will baffle the senses, and the domain of abstract ideas, where perfect geometrical lines exist. Pliny's third comment, however, suggests the limits for that magnificent power of painting. It asserts that pictures cannot become a vehicle for a true universal knowledge since they are always connected to the particularity of corporeal bodies. In this middle ground, a painted line may aspire to the one dimensionality of a geometrical line, but it can never become one. The painted line can only imitate a true geometrical line. The painted picture can create, as if by magic, a perfect deception, but only of particularity and cannot convey and recreate the complete nature of a physical object.

These stories set the field for the late sixteenth and early seventeenth centuries debates and discussion on pictorial representation in general, and of the relationship between picture and scientific knowledge in particular. These polemics were part and parcel of an in-depth reexamination of the foundations of human and divine knowledge, which included not only epistemological issues, but explicitly involved

the problem of the representation of knowledge and of the world. These questions are concerned with crucial issues of the self identity of the emerging new science – in what sense has the new science transformed the world into a picture, that is, the world was transformed into a knowledgeable representation? How were the new means of representation to be manipulated in order to produce new knowledge? Could such a manipulation create new objects in the world? These are crucial matters especially in demarcating the autonomous field of scientific knowledge from other forms and practices that involve the production and application of knowledge in early modern European culture.

Throughout the sixteenth century scholars and painters, alchemist and theoreticians of art challenged the Plinian –Aristotelian assertions. Their attempt was to reshuffle the new pictorial means (such as perspective) in order to form a scientific language, constituted from visible signs, that not only represent human knowledge and the physical world, but could also affect physical processes. Since this attempt was made, however, still within the Aristotelian paradigm that a geometrical line is conceived only in connection with a concrete, corporeal line (a line drawn ever more finely), it preserved the unbridgeable dichotomy between concrete appearances and the realm of knowledge.

In his treatise on optics of 1604 Kepler contrived a new pictorial language that transcended this dichotomy inherent in the above stories between universal forms and concrete appearances. Kepler's solution was formulated in direct response to such pictorial experimentation with emblem so popular at the turn of the 16th century. The rich literature of emblems and especially the alchemical emblems offered fantastic pictures as the vehicle to transgress the boundaries of forbidden knowledge through a transmutation of the human gaze. Kepler, in contrast, transformed the visual depiction into an exact representation of the motions of the universe, allowing thus for a new and coherent picture of the world to emerge, while abandoning the claim for the creation of a virtual-magical reality.

The aspiration of the literature of emblems was to challenge the gap between human mental construction, which aspired to the realm of eternal forms, and the ever-changing physical reality. It attempted to accomplish this through paradoxical games that conflated together different level of interpretation with different systems of sensory experience.[1]

The emblem was a focal point for different kinds of knowledge from different sources. By being a verbal expression, a puzzle and a picture it enabled the reader to bridge over gaps and inconsistencies in the different textual traditions. The emblem enabled the concentration of a web of analogies, associations, and implications on the different elements of the universe. In order to know something it is not enough to conceive it as a phenomenon. One can fully recognize something only through its diverse meanings, through the aphoristic wisdom embedded in it, and the different textual contexts in which it appears.

The alchemical emblem attempts to combine in one picture the transmission of knowledge, the explanation of its hidden meaning, together with the potency of the image to create magical effects in the physical world as well as in the human psyche. The emblem produced this effect by suggesting initially, a fictive, yet rigid, spatial arrangement, that combined a dramatic and fantastic action within a schematic setting. It further emphasized its paradoxical appearance by combining visible signs with verbal puzzles, thus displaying different and only artificially connected sensory systems. This paradoxical effect allowed the emblems to guide the reader to simultaneously different and usually contradictory, levels of meaning and methods of interpretation. Lastly, the

alchemical emblem applied mathematical symbols as a means to combine a sense of actual calculation, with allegorical revelation (usually as a mnemonic device) and a demand to see visible signs as pointing towards higher and ideal realities.

One has to recognize each natural object by the metaphorical element contained within it, as a symbol for spiritual and super-sensual ideas that constitute the divine realms of the universe. As an example, I present here some emblems from Michael Maier's *Atalanta fugiens* of 1617.[2] Maier characterizes his treatise as:
"Partly adapted to the eyes and the intellect, with copper etchings, and added sentences, Epigrams and notes, partly [adapted] to the ears and to the recreation of the soul with less than 50 musical fugues in three voices ... to be seen, read, meditated, understood, judged, sung and listened with particular pleasure."[3]

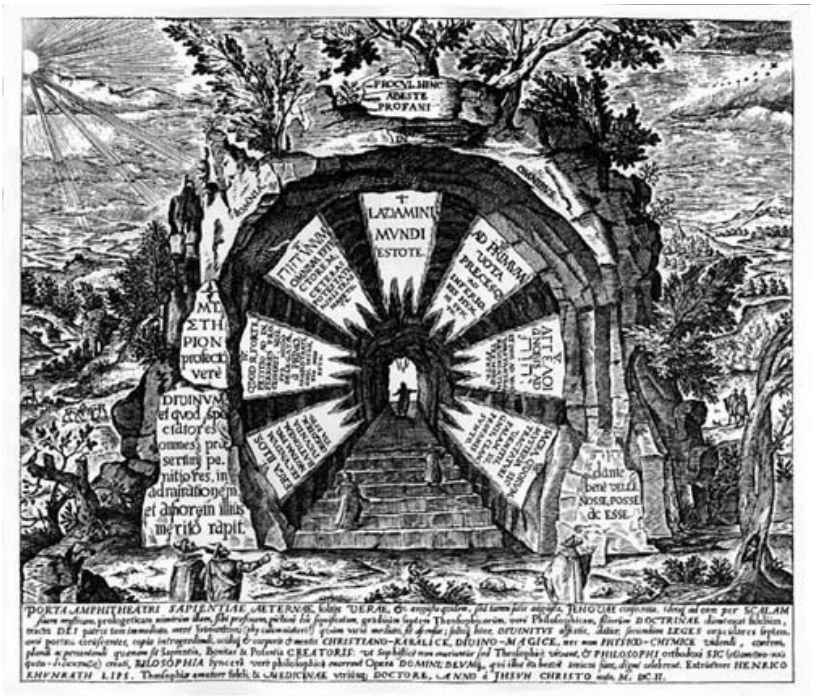
Maier's intention is the paradoxical combination of solitary contemplation and application of sensual pleasure. The engraving as a visual device opens up for the reader a treasure of texts, which in any other way would seem to contradict each other, or to initiate an endless stream of different interpretations. The engraving together with the aphorism and the enigmatic verse enable the contemplating reader to overcome the gap between the two systems of representation, to integrate his sensual experience and to guide his mind to that truth which is situated beyond his visual experience and beyond the obscure ancient texts in which that truth was initially revealed. The emblem makes it possible for the contemplative spectator to awaken his mnemonic powers, not in order to induce fantasies of the sensual and material realm but to rise into that garden where roses of philosophy bloom.

An additional element is the place and role of mathematical symbols in the emblem and especially those symbols concerned with perspective. In late sixteenth century art theory, "perspective'" became a complicated, somewhat obscure and highly mathematized domain. It turned out to be an arcane and secret subject. Some of the associations concerned with perspective turned out to be negative. Perspective became associated with saturnine humours. However, it kept certain an ambiguity: the "corridor space" suggests both the infinity of death as well as of Heaven.

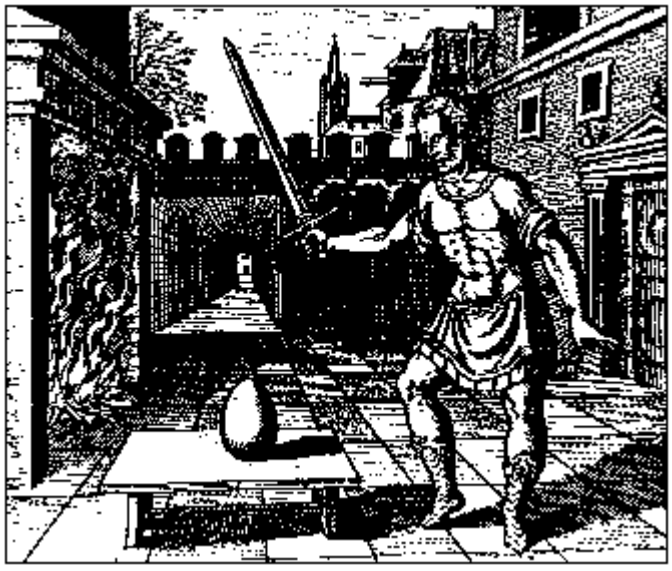
A somewhat different symbolic meaning is attached to perspective in the alchemical emblems. For instance in an engraving of the magus room in Heinrich Kunrath's *Amphitheatrum sapientiae* from 1608, a hall is depicted in a strict one-point perspective. This method of depiction creates the illusion of progressing from the musical instruments and measuring devices in the foreground to the alchemical furnace,

and then to the magus who kneels in front of an altar of enlightenment within majestic a tent, where, with the help of geometrical diagrams and combinations of Hebrew letters, he aspires towards illumination. Finally the spectator's gaze is directed towards a window open to an invisible world.

The same process occurs in the depiction of the gate leading to the doors of the amphitheatre of eternal wisdom. A tunnel is depicted under a one point perspectival grid, directing the spectator's gaze from a world of visible light to an invisible world, yet illuminated by a mysterious source.



A similar structure of perspective appears in Maier's treatise in emblem number 8. Here, at the background of a highly theatrical scene, in the back wall of the theatre's closed space, a vestibule opens up, depicted in one point perspective, leading to an invisible area. The motto to this engraving reads "Take the egg and pierce it with a fiery sword".[4] The epigram continues and develops the allegory. The egg is a source from which, through the combined help of Vulcan and Mars, a bird would rise that will conquer the realm of fire and metals. [5]

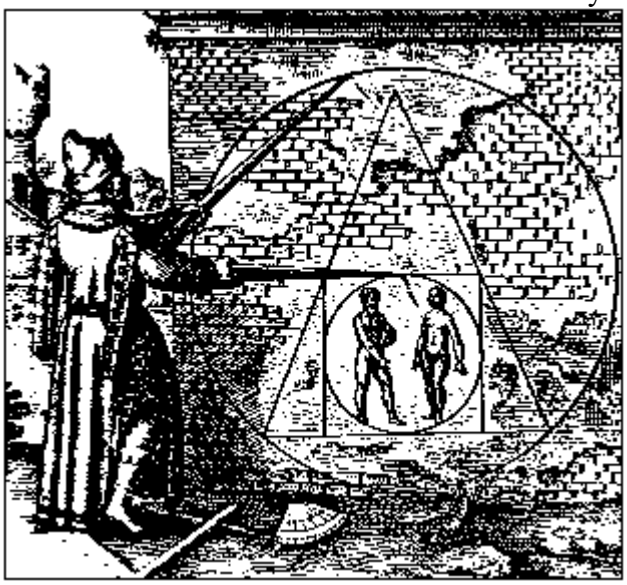


As with the other emblems, the same kind of complicated web of associations and allegories is knitted here, leading from the Greek mythology to Christian allegories and Alchemical symbols dealing mainly with the transmutation of metals. The alchemical process, according to the emblem and the discourse appended to it, is portrayed in analogy to other processes of transformation: from an egg to a mature bird, from the womb to an adult human, and especially from Maria's womb to divine perfection. The alchemist's task is to follow these processes in his attempt to realize his aspired perfect control over nature. The perspectivist vestibule guides and directs the reader from the material and sensual gaze to a different kind of gaze, a perfected one, structured according to perfect

mathematical proportions. This gaze will be made possible when the egg is cracked open in the material theatre from which the magus embarks on his way after supreme wisdom. Thence, the meaning of the vestibule drawn in perspective is the transformation of human cognitive processes and the shift to another form of consciousness and awareness, which exists on a separate level of reality.

However, mathematical symbols acquire additional meanings in the emblematic world. For instance in emblem XXI in *Atalanta fugiens,* the motto commands: "Make a circle out of a man and a woman, out of this a square, out of this a triangle, make a circle and you will have the Philosophers' stone." [6] The epigram develops further the symbolic nature of the geometrical shapes:

"Make a circle out of a man and a woman,
From which a quadrangular body arises with equal sides,
Derive from it a triangle, which is in contact on all sides with a round sphere:
Then the Stone will have come into existence.
If such a great thing is not immediately clear in your mind
Then know, that you will understand everything, if you understand the theory of Geometry."[7]



Maier asserts then that geometrical shapes and their manipulation acquire new meaning - the squaring of the circle is a symbol now of the unification of contraries. The shapes themselves acquire a dimension of sexual identity and difference that the magus aspires to transgress. One of the means the magus can apply is the activation of images and their combination, a process that will affect and bring about unification and harmony in the universe - and vice versa, processes in the universe (like the creation of a super sexual being) will cause the squaring of a circle. Maier is following here a tradition that took geometrical shapes as means to mobilize external forces. The association between the geometrical shape and the natural object is not a quantitative representation but a qualitative analogy. In other words, the geometrical figure itself becomes an emblem that concentrates within itself a web of verbal, i.e., textual, associations.

Until now, I pointed to two uses of mathematics within the emblematic world: Initially, mathematical entities are conceived as causing and symbolizing the metamorphoses of the magical gaze. The magical vision moves from the perception of the material world into conceiving a different realm arranged according to pure proportions. These proportions guide the contemplative eye to a higher sphere of being.

The other use of mathematical entities fixes them as symbols of magical processes that cause the unification of contraries, or as talismans that concentrate in them the powers of the universe - this is usually the case in Renaissance theories of astrology. This utilization of mathematical symbols aims at influencing the material world itself. It is the use of the knowledge acquired through the first process for the transformation and salvation of the visible realm. The square and circle are abstract entities their meaning is

not easily recollected. Thus one's understanding of these geometrical figures must go beyond their quantitative aspect. Recollecting the essence of geometric shapes will lead to the understanding that a square is not a mere theoretical quantity but actually a symbol for the chemical qualities of the four elements. The circle is not merely a visual shape but the symbol of the simple body. Thus, the process described in the emblem is not just the squaring of the circle (which Maier claims the natural philosophers knew) but an alchemical process in which the four elements are transformed into three: body, spirit and soul. These in turn correspond to the three primary colours: The earth or material body is black (the colour of Saturn). The spirit is water and appears in the whiteness of the moon, and the soul, as the air, is the yellow colour of the sun. The triangle must be transformed into a circle, which is unity, and its colour is red. This is the process through which a woman turns into a man to become unity. In such a way, the numbers are perfected by One that is "rest and eternal peace".[8] Through the contemplation of these analogous processes the initiate will advance towards true enlightenment.

The alchemist perceives the natural world to have deteriorated from its initial divine grace and perfection. Nature has been corrupted and disintegrated as a result of human original sin. This lapsed natural state is not limited only to the sub-lunar realm: Many philosophers, during the sixteenth century, watched with anxiety how decay and corruption spread to the eternal heavenly bodies. Fludd and his circle saw in this state of affairs an urgent call for an extreme effort to save the universe. Maier, following Paracelsus and other alchemical theoreticians, conceived the transmutation of metals as a salvation of their primary, exalted and divine nature. The task of the alchemist is to retrieve and recollect these memories of the divine Creator's act that are enclosed within fallen matter. The process Maier describes, takes place on two analogous levels in the human mind and in physical nature. Contemplating emblematical scenes initiates a mnemonic process whereby the human mind dissociates itself from the material world to gaze instead on spiritual and divine essences. The human contemplator aims for the retrieval of divine sparks, which were imprisoned in the material realm of bodily passions, and for their reunion with their divine origin. This process is complimented by the alchemical transmutation of metals whereby debased metals are transformed back to their noble and golden essence. These two processes are connected, each reflecting the advent of the other. The alchemist experiments with fire in the material realm to inspire and induce the mental processes and vice versa. Thus the salvation of Nature will take place simultaneously with an apocalyptic salvation of the human race.

The alchemical emblems tackled the Aristotelian gap between the realm of concrete visual signs and the realm of universal concepts by turning this gap into a paradox, into a serious play. In this play the serious conclusions are always ephemeral, always hinting that things are not what they seem, and that any serious truth arrived at, will evaporate immediately in front of the frustrated gaze of the sinful human mind.

In order to understand this ambiguity of the emblem as a mnemonic device on the one hand, and as pointing beyond memory to the source of divine wisdom on the other, one has to look into the psychological system of vision as Fludd presents it. Overlooking it may foster a misunderstanding of Fluddian rhetoric, as if Fluddian science envisions a proto-empiricist scientific method.

In the second volume of his monumental work dealing with the history of the Microcosm, Fludd gives an idiosyncratic account of the triple division of the soul's vision. This account combines a strange mixture of Neoplatonic, Hermetic and an awkward version of Aristotelian psychology. The first stage in the soul's visual perception is the corporeal vision that perceives the colours and dimensions of the external bodies.[9] The soul needs this corporeal dimension since otherwise it is not able to

perceive the external physical reality due to itself being an invisible and spiritual substance. The second type of vision discerns the spiritual images of the corporeal bodies[10]. Although these images originate from material bodies, Fludd names them spiritual because they do not posses a body. Furthermore, for Fludd the process through which these images are created is an occult power that enables the external bodies to express themselves in the same manner as images are produced in a mirror.[11] The third type of vision is the intellectual vision that aims at a realm beyond the physical world and perceives the truth itself.[12]

The next step is to put these three types in an ordered hierarchy according to their cognitive value. In contrast to Aristotle in *De anima,* who assumes the proper sensual to be infallible, Fludd declares that the material sense of vision itself is responsible for errors of perception in the soul.[13] Fludd gives different and topical examples of visual errors from the sailors who imagine the shore to withdraw to the stick that appears to be broken in the water. Fludd concludes this section by denigrating vision as a prime deceiver of the soul: "*Immo vero inter omnes alios sensus maxime visus, quamvis praestantissimus, decipitur*".

All these matters are treated in the science of optics. However optics does not seem to solve the problems concerned with visual deception but only to trace the problems and the extent of visual illusions in human daily experience.[14] Fludd rejects then the Aristotelian definition of proper sensibles, and locates the visual distortions in the eye itself and not in the judgement of the soul. Moreover, the soul can adjust (as well as produce) these distortions by using the science of optics and perspective.

It is clear, then, since the power residing in the more spiritual elements of the soul is greater than in the senses concerned with material reality as such, that the distortions produced in the spiritual parts are more potent and with more lasting effects. These distortions not only cause the soul to fail but also bring suffering and aggravation.[15] The principle, which guides and moulds these effects, is that the second type of vision is concerned not with the things in themselves but with their similitude and the mind perceives these simulacra as in a polished mirror. However, these images are not only the product and expression of things in themselves but are their reflection, the image of these things exerted from the unreliable external senses.[16] It is through this type of vision that one discerns the three dimensional outlines of the corporeal world and it is the place where the images of the celestial bodies and of the zodiac are constructed. However, Fludd is careful to emphasize the difference between this spiritual vision and the intellectual vision. The latter can never err and is always contemplating those higher realities, such as "*Deus, mens rationalis et intellectualis, ratio, virtutes cardinales, castitas, pietas et quaecunque alia sunt eius generis,*" whereas, through the former type of vision one sometimes acquires correct perceptions and sometimes wrong perceptions. Thus, the spiritual vision sometimes agitates the soul and sometimes brings it to tranquility.[17] The main cause for this problematic state of affairs is the fact that the spirit is not a body but participates in the bodily qualities either by being the form and similitude of the body or by participating in the nature of the lower and material kind of light. While one is sleeping, the more agitating effects of the spiritual imagination are revealed in sexual dreams and nocturnal emissions of semen.[18] The imagination, although it may have some cognitive value, is more dangerous and false than the external senses because it can move the flesh while the normal inhibitions are weakened in sleep. Thus, even the chaste and more religiously minded people are not protected against its evil temptations.[19] For if the soul adheres to the superior mind then its vision is turned to more mental and intellectual pursuits. However, when the soul is subjected more to the sensual elements of cognition then it employs more of its inferior vision. If

one attempts to gaze at the Truth, one must first release the middle spirit from its corporeal temptations, and from its inclination toward the material. Fludd implies the means for liberating the soul from the grip of material passions in his discussion of dreams. While for the most part dreams, the hallucinations of the madman, or day dreaming are just a re-enactment of daily material bodies and desires, there are certain kinds of dreams and visions in which one is not viewing external and material bodies but the spiritual content of the soul itself. In this kind of internal vision, the soul perceives not those simulacra it received from external bodies but it inspects its own inner forms in themselves. In order to achieve this kind of vision, Fludd testifies that he contemplates remarkable emblems (*admiratio insigni*), that bring him to amazement and wonder. This vision is disconnected from the material corporeal vision: "Yet, whatever the nature of that vision is, it is for certain not corporeal. For no [corporeal] body produces those images in the spirit. Nor has it this power to shape something spiritual; but the spirit by itself presents it in its own wonderful speed, as one might expect of [something] spiritual, intellectual or rational".[20]

According to Fludd the material eye can produce no meaning but meaningless visual impressions; it gazes at the passing reality and receives its shadowy impressions, which become pictures in the internal eye of the spirit, where fantasies retain the content of one's memory. However, as long as this pictorial content is associated with the external world, it has dangerous implications. It excites the human imaginary power to false dreams and moves the human psyche mainly in the direction of sexual stimulation. Thus it moves one's mind away from its aspiration to wisdom and truth. The only way to turn the human internal mind away toward the superior domains of true wisdom is by arousing the spirit's inner content and kindling the intellectual eye. This can be performed by refurnishing the theatre of memory with pictures and buildings that have no origin in the external and sensual world. The emblem although it has a sensory aspect, by being a fantastic picture, divorced from ordinary human experience, allows the spiritual eye to overcome sensual temptations and to turn towards intellectual contemplations of the Godhead.

Yet, although the stakes are high, and the promise of the alchemical emblem was tempting, at the heart of this tradition was an epistemological obstacle. The gap between the concrete phenomenon and the realm of universal concepts was preserved with the sense of playfulness that while bringing the particular and the universal ever so close, still always left the spectator/reader of the emblem in uncertainty: was it a glimpse of the Truth or just another level of allegory one has reached?

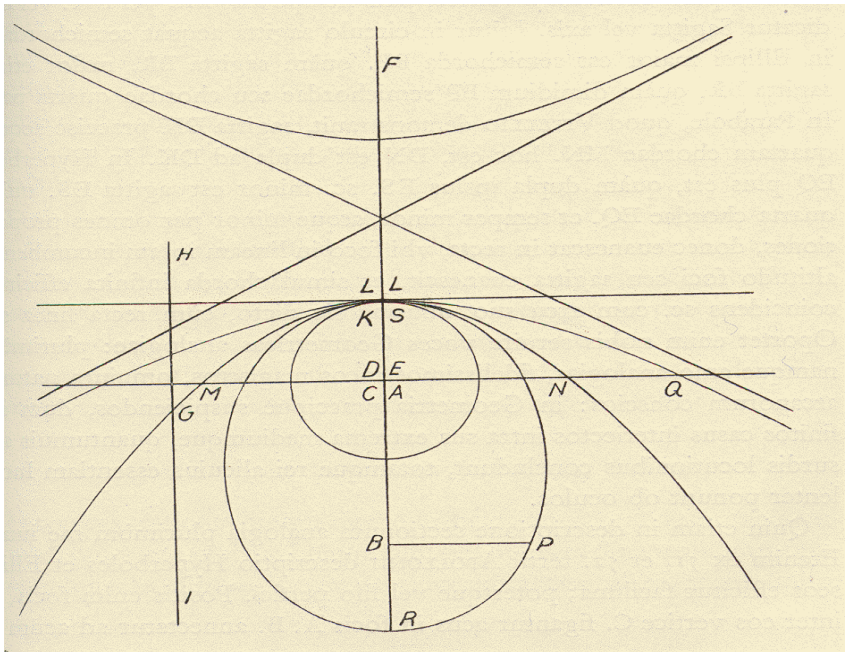
******

In order to surmount the gap between knowledgeable universals and physical reality Kepler had to redefine both the relationship between geometrical figures and the phenomenal realm, and the ontological and epistemological status of pictures. Kepler turned on its head the process of abstraction and with it the process by which mathematical entities originate.

This is neatly exemplified in Kepler's treatment of the conic section. According to A. E. L. Davis Kepler's system is "the first 'non-cone-based' system of conics."[21] J. V. Field specifies that: "Apollonius had in general treated the conics as separate, though related, curves. Kepler seems to have been the first mathematician to describe the conics as forming a system, that is, to attempt to give a unified account of their properties"[22] Kepler's main move was to consider the sections not as specific abstractions of specific sectioning of a specific cone but to emphasize the analogical relationship between them. Thus instead of the plane cutting a cone he concentrates on the *foci* (probably a linguistic invention of Kepler). His system "passes from a straight line through an infinite number of hyperbolas to the parabola, thence through an infinite number of ellipses to the circle."[23]

Kepler goes on and explains how the single focus of the circle and the two of the ellipse are related and continues that:

"In the parabola one focus [D in Kepler's diagram] lies within the curve, while the other is represented either outside or within it on its axis at an indeterminate [infinite] distance from the first, so far that a line [either HG or IG in the said diagram] drawn from that *blind* focus [at either end] to every point of the curve [G] is parallel to the axis [DK]."[24] Kepler can now complete his system of analogies: "It follows by analogy that, for the straight line, the focus (as we will use the term, in relation to the straight line, without precedent, to complete the analogy) in both cases coincides with the line itself, so that there is only one focus, as for the circle. Then in the circle the focus is at the centre itself - the point furthest from the circumference - in the ellipse it is less far from the circumference, and in the parabola much less, in the end being the minimum distance away: that is, it falls on the line itself."[25] Moreover while Kepler attempts to present a method for its construction this method and the *a-priori* reasoning that bring this system into being are not enough to make it meaningful. This system will be meaningful only if the mind is able to recognize these curves in the movements of the physical world that is as a surface that would turn into parallels all rays emanating from a fixed point and will describe a pattern of the angles of refraction.



Kepler's new conception of light as a principle of physical motion and not as an emanation from the realm of Ideas, supplied him with the grounds for a thorough critique of the emblematic pictorial language of late sixteenth century alchemy. The emblems attempted to bridge over the gap between abstract ideas and concrete

appearances through a paradoxical application of sensuous picture that will lead the spectator into the experience of an intellectual and spiritual truth.

In order to solve and overcome these difficulties Kepler had not only to transform geometrical entities into a representation of motion, but also to redefine the essence of a picture, and to align it with a new theory of cognition, and finally to reassign the playing mode to the process of an serious enquiry after the physical truth.

Kepler's definition of picture appears in Chapter V of *Ad Vitellionem paralipomena*: "Whereas up to now an image has been [considered] a rational entity, now figures of objects truly existing on paper, or other screens, are called pictures."[26] Kepler preserves this difference between real and virtual optical effects and defines the image as "when an object is seen, with its own colors and parts, but not in its own place, not showing the proper quantities, and its parts holding wrong proportions. In short, the image is the vision of a certain object linked to an error of the faculties concurrent with vision. The image itself, therefore, is hardly anything and it would have been better called an imaginary fabrication. It is something made up from the species of real color and light and [from] intentional quantities."[27]

Chapter V of *Ad Vitellionem paralipomena*, the summation of Kepler's optical arguments, begins by emphasizing and rehearsing the epistemological context of his optical discourse. "The astronomers place at the foundation [of their science] the diameters of the luminaries and the quantities of solar eclipses; now, some visual deception is produced, partly from the conduct of the observation, which we discussed in chapter 2, above [i.e., where Kepler discusses the formation of images in *camera obscura*], partly from simple vision itself: …as long as the latter is not dissipated, it would create considerable difficulties for the astronomers and diminish their judgment capacities. Therefore, the occasion of such errors in vision has to be investigated, and that according to the shape and functions of the eye itself."[28]

The main part of the fifth chapter, dealing with human eyes and sense of sight, is devoted not to anatomical data but to adjusting Kepler's optical theorems to a particular set of experiments. Kepler details the experimental context immediately after he summarizes his anatomical description of the eye's structure. The anatomical backdrop is utilized to isolate the two main components that produce the sensation of vision, namely the crystalline humor and the retina.

Kepler discusses two fundamental phenomena in this context: the appearance of a picture on a paper placed behind a crystal ball or a glassy urinary flask filled with water placed against a window in a room; and the disappearance of the picture when the eye is positioned where the paper was before. Kepler asserts that the main factors responsible for these phenomena are the refractions of rays of light and the convex shape of the glass globe filled with water [*Haec omnia fiunt circa globum aqueum, propter refractiones et figuram, eo quod convexitas aliqua insit figurae*]. In the following propositions, he attempts to explicate these phenomena and especially to delineate the psychological factors that determine the disappearance of the picture on the paper and the appearance of images on the surface of the ocular lens (namely, the crystalline globe]. Thus, the presence of the eye transforms one's optical experience and turns a physical picture into a mere image. Kepler's first step is to explain the image as a psychological phenomenon dependent on the activity of the eye. Initially he proves that, following his catoptrical propositions, the geometrical locus of the image is between the eyes and the globe. The problem arises as to why the eye sees the image on the surface of the globe and not in mid air where it appeared before on the sheet of paper. The answer is that "there is no place in front of the ball or globe of water for the image of a thing hidden behind the ball." [29] The reasons for this are wholly dependent

on the natural disposition of the eye. Kepler defines three factors, physical and organic, functional and psychological.

The physical reason is defined in proposition 2: "Vision perceives with more difficulty the nearer [objects] than the remote ones." Since the eyes tend to preserve their parallel position, any attempt to perceive a nearby object strains the eyes to turn and to contract toward it. [30]

The second factor is the natural disposition and function of the eyes to perceive light: "Vision is attracted by brilliant objects, but it is hardly drawn to fleeting and feeble things." This disposition derives not only from experience but also from the essential property that sight is moved by light. Thus, the stronger the light the more agitated the eyes are. Therefore, the eyes follow the stronger illumination at the expense of the lesser-illuminated areas.[31] The last factor is the ability of vision to actively create images. This ability is destroyed by strong light that diverts the beholder from the supposed location of the image. Thus, Kepler proves that the image cannot be seen between the eyes and the globe because the eyes are attracted to the illumination coming from the globe. Furthermore, this illumination will overpower and disperse the image.

This analysis leads Kepler to define the image as an intentional entity that the sense of sight creates as an active agent. The human mind is forced to supplement the missing data that the sense of sight is unable to perceive, not because of the external environment, but on account of its own disposition. In these cases, the mind naturally constructs the mathematical ratios that would inform visual reality and would present it coherently. Kepler provides an explicit case of such kind in his catoptrical discussion. Since the eyes cannot perceive the point of reflection [or refraction], the mind has to fill in the sensual data and structure them geometrically. He contends that this is the reason for one's perception of the image over a perpendicular line drawn from the object to the mirror. As he showed in the catoptrical part of the treatise, the perpendicular line is not produced either by the object or by the form of the mirror's surface, but is a mental construct:

> "For nothing concerns the location of the image, other then the surface of the mirror opposing the object, since all the reasons for the formation of images are obtained from that part of the mirror, in which are the two points of reflection to the two eyes. Therefore, the cause why the location of the image is along that perpendicular is in this part of the mirror, and not in the perpendicular [drawn] from the object itself. Accordingly, it is necessary to represent mentally the ratio of the curvature, produced by the refraction, as a complete circumference, and in order to define the location of the image, a perpendicular from the [visible] object is drawn over this imaginary sphere."[32]

Illusions are not games played by nature in order to delude the human mind. On the contrary, the limited nature of the human senses forces the mind to play and to invent the mathematical constructions that produce an intelligible visual reality. While an image is determined by the natural disposition of the human mind and of the human sense of sight to produce a coherent perception of reality, it depends for its particular appearance on a concrete set of physical circumstances.[33] The convergence of the mind's compulsion for mathematical regularity and of the particular physical and psychological conditions cause the image to appear "confused and doubled" [*confusae et geminatae*]. Hence the meanings of Kepler's terminology "Ens rationale," "Ens intentionale" and "quantitas intentionale" are all intended to emphasize the active and inventive role vision plays in rationally producing an optical image. The difference between an image and a picture does not concern the process through

which they are produced mathematically or physically but only the psychological aspects that force the mind to actively complement its sensual data. The picture is a passive product of the visual process and this passivity secures its epistemological status as a true depiction of visual reality.

> "Therefore, since illumination is an action, and since vision is not an action but a passion, the contrary of an action, for the places to correspond, it is necessary that the regions of the patient and the agent be opposite. However, the places are perfectly in opposition when the same center is shared by all opposing lines which will not happen if the picture were erected.* Accordingly, in an inverted picture, although universally and in respect to some common line, right and left are exchanged, still the right [part] of the object is perfectly opposed to the right part of the picture, and the higher part of the object to the higher part of the picture (considered in itself) so also the curve to the curve. There is nothing to fear, that sight will err in the area. … Rather, if the picture were to be erected, then vision would have been misled. …Therefore nothing absurd is committed by [assuming] an inverted picture…"[34]

In the process of image formation, sensual data is lacking or obstructed (the eye cannot perceive the point of reflection, or strong illumination erases other optical phenomena). However, in the formation of an optical picture all data (external to the eye) arrives at the retina. Moreover, since the picture preserves the mathematical arrangement of the visible object, there is no need for the mind to complement it with imaginary geometrical constructs in order to produce a coherent perception of visual reality. The mathematical regularity of the inverted picture vouchsafed against any mistaken identification of place or area.

The medieval theorists defined species as the direct physical impression on the eye that travels along perpendicular lines to the crystalline humor. They differentiated between species as physical effects and images that are imaginary constructs governed by geometrical laws of reflection and refraction. Kepler's images, however, while still products of the human imagination did not differ from pictures in their formative process, both being the result of refracted/reflected rays of light. The difference rests in the entirety of the visual data supplied by the process. In picture formation, all the reflections/refractions take place within the eye thus preserving their geometrical arrangement, though still finally producing an inverted picture. In image formation, some data are missing and the intervention of the human imagination causes the final result to be a certain artificial entity, where things are not what they appear to be.

Keplerian inner imaging is responsible for visual distortions and errors. The mathematical arrangement supplied by the process of reflections and refractions of light and color within the eye can produce meaningful pictures of external reality. Kepler recognized the power of the human imagination to inform one's perception of reality. However, he aspired to limit this power and to supply the criteria for differentiating between real and false perceptions. Initially, he assumed that physical reality tends to express itself through geometrical figures and regularities. Thence, the human senses respond to these geometrical forms, since these senses are formed according to the geometrical archetypes that reside in the human mind. Only when the human mind recognizes its own archetypal content in the sense data, can the true knowledge of reality become possible. In other cases, when objects are perceived through reflecting or refracting surfaces, the visual data are incomplete and the mind enforces its own geometrical constructs in its perception of the world and thus creates

chimeras and false images. Only a geometrical correspondence between physical reality (as it is represented by the geometrically governed propagation of light) and the mind's inner geometrical archetypes can create true knowledge. Any attempt to deny one of these components results in meaningless and ludicrous games and illusions. Therefore, while accepting the Platonic description of the mind as an inner painter, Kepler summons the painter to respond to the visual demands of the material, sensual, and geometrically regulated world.

Kepler's pictures are the products of refractions; they are not emanations from the visible object itself but are produced by light as an external agent and colors (which, as already noted, are quanta of light hidden within the object's matter). Thus, the retinal picture is a doubly mediated (i.e., reflected) appearance of the visible object. The result of the visual process is an inverted and reversed picture of the external object; that is, the parts on the right are now on the left and those at the top appear at the bottom. For the medieval and renaissance sensibilities, Kepler's retinal picture is a distortion on the verge of a chimera, or a monstrous depiction of reality. What saves the retinal picture from absurdity is the geometrical regularity of the inversion of the retinal picture. The stable center, through which pass all the lines from the corresponding points on the object and on its inverted picture, limits the mind's ability to play with the sensual data and thus guarantees one's visual knowledge. In a sense, Kepler's retinal picture is a sort of a "serious joke": though it represents the world upside down, it allows one to perceive the truth. However, artistic jokes in the manner of Arcimboldo are human creations that suggest playful leaps between multiple levels of meaning and signification. Thus, their truth is hidden and evasive. In contrast, Kepler's retinal pictures are natural creations and thus limit human creative playfulness and, by their geometrical regularity allow only one true depiction of visual reality. Kepler asserts that unlike the human mind, "Nothing designated by Nature is wasted."[35] He differentiates between the realms of human creativity and natural truth. While the first produces illusions that are the result of epistemological uncertainty, the latter, when carefully analyzed, exhibits geometrical regularity and certitude.

Kepler turns the meaning of serious play on its head. Instead of a game that always exemplifies the gap between visible phenomena and the realm of knowledge, always leaving the players wondering between several options for interpretation and meaning, Kepler's game results in one definite and clear solution:

> "I too play with symbols and have planned a little work, Geometric Kabbala, which is about the Ideas of natural things in geometry; but I play in such a way that I do not forget that I am playing. For nothing is proved by symbols; no hidden thing is brought to light in natural philosophy, through geometrical symbols, things already known are merely fitted [to them]; unless by sure reasons it can be demonstrated that they are not merely symbolic, but are descriptions of the ways in which the two things are connected and of the causes of these connections." [36]

Kepler succinctly summed his position in regards to emblem in an epigraph he wrote on the margins of his own copy of an emblem book. There opposite the picture of the falling Icarus, Kepler commented: "Nemo cadit, recubans, terrae de cespite planae; Ocuras hominum, o quanta est in rebus inane."[37] The emblem of Icarus warned against the search after forbidden knowledge, epitomized in the practice of astrologers aiming both to calculate the paths of the celestial bodies and to foresee the future of human affairs. Kepler, in contrast, differentiates sharply between the search for knowledge and the magical motivation. One must leave the flat earth and aim at the laws that govern the

universe, yet any attempt to ascribe meaning to the tupsy-turvi human world of misfortune and chance accidents is futile.

Keplerian pictures are a means of acquiring knowledge because of their geometrical regularities. They are transformed into diagrams. Yet, these diagrams are not abstractions from static corporeal bodies but representations of possible motions and the relationship between those motions of physical bodies. A Keplerian line does not have to be ever more fine in order to remind the observer of a true geometrical line. It has to be only accurately calculated, so it can convey the exact path of a possible motion of a physical body in space. By relegating the emanation of visual signs from a motionless corporeal reality, i.e., by discarding the mimetic aspect of pictures, Kepler liberates scientific pictures to become exact human-made representations of disembodied motions.

[1] The emblematic tradition had emerged from the Renaissance interest in hieroglyphs, Roman coins and the symbols impressed on them, and from fables and epigrams collected from classical sources. The original aim of the "inventor' of the emblematic literature, Andrea Alciati (1492-1550), was to compose epigrams especially enigmatic, so the readers would feel a pleasant and surprising enlightenment when they would have succeeded in solving them with the help of the attached interpretation. Alciati's original plan did not include an adjusted picture to the written epigram, but when the *Emblemata* was first published in 1531, engravings were added, and in mid-century the visual picture was an integral part of the emblem. The emblem itself included three parts: a visual picture, a short motto, and a somewhat longer epigram. In an ideal epigram all the components were necessary, but not sufficient, for a complete understanding, and only the combination of the components together enabled a useful and pleasant moral insight. The emblematic tradition has flourished all over Europe. Alciati's book came out in dozens of editions and extensions, and these brought about dozens of other books of emblems. Around 1600 hundreds of emblem books were in print and this flow kept growing until, around mid-century, it started to recede.

[2] Michael Maier, *Atalanta Fugiens, hoc est, Emblemata nova de secretis naturae chymica* (Oppenheim, 1617). In my interpretation and traslation of the following citations I followed H. M. E. De Jong, *Michael Maier's Atalanta Fugiens: Sources of an Alchemical Book of Emblems* (Leiden, E. J. Brill, 1969), unless specified otherwise.

[3] Accommodata partim oculis & intellectui, figuris cupro incosos, adjectisque sententiis, Epigrammatis & notis, partim auribus & recreationi animi plus minus 50 Fugis Musicalibus trium Vocum, ... singulari jucunditate videnda, legenda, meditanda, intelligenda, dijudicanda, canenda & audienda" {My transaltion}.

[4] Accipe ovum & igneo percute gladio

[5] Est avis in mundo sublimior omnibus, Ovum
Cujus ut inquiras, cura sit una tibi.
Albumen luteum circumdat molle vitellum,
Ignito (ceu mos) cautus id ense petas;
Vulcano Mars addat opem; pullaster & inde
Exortus, ferri victor & ignis erit.

[6] Fac ex mare & foemina circulum, inde quadrangulum, hinc triangulum, fac circulum & habebis lap. Philosophorum.

[7] Foemina masque unus fiat tibi circulus, ex quo
Surgat, habens aequum forma quadrata latus.
Hinc Trigonum ducas, omni qui parte rotundam
In Sphaeram redet: Tum Lapis ortus erit.
Si res tanta tuae non mox venit ob via menti,
Dogma Geometrae si capis, omne facies.

[8] These three elements correspond to Dee's conception of three grades in the advent of the initiate towards perfection and wisdom: The realm of *pneumaticus* (the spiritual) is divided into three levels. Leading from the *philosophos* associated with the element of water, and having a 'taste of the fundamental truths of natural knowledge". The *sophos* follows - this grade is associated with the element of air. He explores the "celestial influences" and "the reasons for the rise, condition, and the decline of other things". Finally reaching to the *Adeptiuus* who is associated with the element of fire and aspires to explore and understand "the supernatural virtues and metaphysical influences". See C. H. Josten, "A Translation of John Dee's *Monas Hieroglyphica* (Antwerp 1564), with an Introduction and Annotations," *Ambix* 12 (1964), pp.114-21, and Nicholas H. Clulee, *John Dee's Natural Philosophy: Between Science and Religion* (Routledge, London and New York, 1988), pp.81-2.

[9] "Tria visionum in anima esse genera ab effectu infalibili animadvertimus; quorum primum est corporale, quo per corporis sensus corpora rerum colorata eorumque dimensiones & alia sensibus obvia percipiuntur" (Fludd, *Utriusque Cosmi Maioris*, Vol. II, tractatus primi, sectionis I, liber X, p. 204).

[10] "*Secundum*_ visionis in anima *genus spirituale* est , quo corporum similitudines spiritu solummodo, et non ratione seu mente, cernuntur" (*ibid.*).

[11] "Idcirco quadam vi occulta & spirituali ita rapitur anima, ut loco corporum expressas eorum similitudines, tanquam in speculo videat" (*ibid.*).

[12] "Tertium visionis genus est intellectuale, quo res illae, quae nec corpora, nec corporum formas habent, conspiciuntur; quales sunt, ipsa mens, Deus, justitia, sapientia & omnis animae affectio bona" (*ibid.*).

[13] "In visione vero corporali quam saepissime errat & fallitur anima, secundum vetus illud et verum axioma philosophorum: sensus fallitur circa proprium et verum objectum, cum in ipsis corporibus fieri putat, quod videtur apparere in phantasia" *(ibid.)*.

[14] "Atque sic in caeteris infinitis, de quibus opticae scientiae periti luculenter egerunt; Imo vero & nosmetipsi in scientia nostra optica, in libellis de radiis refractis & reflexis haec omnia succincte & unico quasi verbo delineavimus ... Ex quibus evidens est, quod visio illa animae corporalis, quae sensibus exterioribus pro organis suis utitur, circa objecta corporea fallatur. Atque hic est primus visionis in anima gradus, quo corpora sentimus, quam quidem functionem anima per quinque corporis sensus expedire solet" (*ibid.)*.

[15] "De secundo gradu visionis animae, quae est in imaginatione seu phantasia, et ... anima in ea nonnunquam fallatur, patiatur, atque aggravari videatur" (*ibid.*).

[16] "Secundo genere visionis animae, quo non corporea, sed corpori similia, atque adeo etiam nosmet ipsos non aliter, quam corporibus similes, intuemur, res in spiritu phantastico conspiciuntur, quemadmodum imago in speculo politissimo. Atque ut imago corporis in speculo se habet ad corpus; quod extra speculum existens, imaginis figuram sua praesentia exhibet: sic etiam corporum a sensu externo visorum icones atque effigies spiritui imaginationis imprimuntur" (*ibid.,* pp. 205-6).

[17] "Sed & fallitur anima in visione spirituali, de qua his agemus, atque illuditur; quoniam ea, quae videt, aliquando vera, aliquando falsa, atque nonnunquam perturbata et interdum tranquilla sunt" (*ibid.* , p.206)

[18] "Hinc igitur apparet, animam non esse corpoream, sed potius corporis quasi similitudinem, quae non est corpus; quaeadmodum spiritus non est corpus, sed de corporis & lucis natura participans, quoniam dormienti & in somno alicui veluti corporeus apparebit, neque tamen id corpus eius est, sed anima, nec verum corpus, sed similitudo corporis eius. Jacebit enim corpus eius, ambulabit anima; tacebit lingua corporis ejus, ac loquetur ipsa; causi erunt oculi tui, videbit autem tem illa; & ita in ea tota ac integra cernetur similitudo carnis ejus. In hac similitudine quasi per loca cognita & incognita discurrit, et sentit laeta vel tristia ... Unde saepe imagines rerum corporalium tanta expressione obiiciuntur in somnis, quanta praesentantur ipsa corpora vigilantibus, in tantum quidem, ut etiam inter visionem dormientium et veram cognitionem vigilantium non discernatur, sed continuo iis caro moveantur,& contra propositum suum, vel contra mores licitos, concumbere sibi videantur, ac quod naturaliter collectu est, per genitales vias emittant; quam quidem actionem medici nocturnam pollutionem nuncuparunt" (*ibid.,* pp.206-7).

[19] "Hunc motum casti vigilantes cohibent et refraenant, quem dormientes ideo compescere non possunt, quia in potestate non habent imaginis corporalis expressionem, qua caro naturaliter movetur, unde sequitur illud, quod cohibitum sequi solebat, et quod sine peccato a vigilantibus fieri non potest, sit in spiritu, et multa pro arbitrio finguntur, vel praeter arbitrium demonstrantur, dum corporalium rerum imagines apparent. Ipsa namque anima, quae motu proprio semper in motu est, quia a corpore non sinitur, etiam plane non sinitur corporalia sentire, aut ad corporalia vim suae intentiones dirigere, idcirco, corpore sopito, spiritu ipsa agit, sicuti imagines corporum cogitando ex seipsa versare assolet, aut subjecta intuetur, cum ad ea videnda aliquo spiritu assumitur" (*ibid.,* p.207)

[20] "Qualiscunque tamen illa visorum natura sit, procul dubio corpus non est. Non enim corpora visa illas imagines in spiritu faciunt, nec eam vim habent, ut aliquid spirituale forment; sed ipse spiritus in seipso celeritate mira id praestat, utpote spiritualis, intellectualis atque rationalis"(*ibid*., p.208).

[21] A. E. L. Davis, "Systems of Conics in Kepler's Work," *Vistas in Astronomy* 18 (1975), pp. 673-85.
[22] J.V. Field, "Two Mathematical Inventions in Kepler's *'Ad Vitellionem paralipomena'*," *Studies in History and Philosophy of Science* (1986) vol. 17, no.4, pp. 449-68.
[23] "Quod a linea recta per Hyperbolas infinitas in Parabolen, inde per Ellipsis infinitas in circulum est transitus." *GW* vol. 2 p. 90
[24] In Parabole vnus D est intra sectionem, alter vel extra vel intra sectionem in axe fingendus est infinito interuallo a priore emotus, adeo vt educta HG vel IG ex illo caeco foco in quodcunnque punctum sectionis G. sit axi DK parallelos." *Ibid.,* p. 92
[25] "Sequitur ergo per analogiam, vt in recta linea vterque focus (ita loquimur de recta, sine vsu, tantum ad analogiam complendam) coincidat in ipsam rectam: sitque vnus vt in circulo. In circulo igitur focus in ipso centro est, longissime recedens a circumferentia proxima, in Ellipsi iam minus recedit, et in Parabole multo minus, tandem in recta focus minimum ab ipsa recedit, hoc est, in ipsam incidit." *Ibid.,* p.92).
[26] "Cum hactenus Imago fuerit Ens rationale, iam figurae rerum vere in papyro existentes, seu alio pariete, picturae dicantur" (Kepler, *GW*, vol.2, P. 174). The definition is problematic since nowhere before did Kepler supply the term "rational entity" with a definition. Thus, the contrast between these two modes of imaging is not at all clear.
[27] "*Dicunt enim imaginem Optici, cum res ipsa quidem cum suis coloribus et figurae partibus cernitur, sed situ ali … alicubi et alienis induta quantitatibus et partium figurae proportione inepta.* Breviter, imago est visio rei alicuius, cum errore facultatum ad visum concurrentium coniuncta. Imago igitur per se pene nihil est, imaginatio potius dicenda. Res

est composita ex specie coloribus vel lucis reali, et quantitatibus intentionalibus" (Kepler, *GW*, vol.2, p. 60).
[28] Dum diametri luminarium et quantitates Solis Eclipsium, fundamenti loco annotantur ad Astronomis: oritur aliqua visus deceptio, partim ab artificio obseruandi orts, quam supra cap. 2. Discussimus, partim ab ipso visu simplici: quae quoad non tollitur, plurimum negocii facessit artificibus, detrahitque artis existimationi. Erroris itaque in visu, occasio quaerenda est in ipsius oculi conformatione et functionibus"(*Ibid.,* p. 143).
[29] Ante pilam seu globum aquem nullus est locus imagini rei post pilam latitantis." "(*Ibid.,* p. 164).
[30] "Visus ad multum propinqua aegrius respicit, quam ad remotiora. Dictum enim est, in visione rerum propinquarum contorquendos esse oculus. Contortio est praeter naturam, quae oculis situm parallelum tribuit. Quare sequitur fatigatio, et a minori contortu minor fatigatio. … Est autem haec, quod oculorum musculos remittunt, quo minus ad res proximas contorqueantur. Tunc igitur recurrunt ad situm parallelum" "(*Ibid.,* p.163)
[31] "Visus ad evidentia rapitur, tenuibus et vanescentibus maligne allicitur. Quod experientia testatur, visus proprietas coarguit. Nam ideo datus est, vt moueretur a luce, a forti igitur mouebitur fortiter. At moueri a luce, est videre. Quare qui prius ad debilem lucem respexerat, oriente fortiriori luce ab eadem regione; eandem consectabitur, priorem amittet. … Visus vero sequitur collustrationis rationem" (*Ibid.).*
[32] "Nihil enim interest ad locum imaginis, quali superficie speculum rei opponatur, cum rationes formandae imaginis omnes ex illa parte speculi sumantur, in qua sunt bina puncta repercussuum lucis ad binos oculos. In hac igitur speculi parte, non in ipsa perpendiculari ex re, causa inest, cur locus imaginis in illa perpendiculari sit. Itaque tunc mente intelligere oportet, continuari rationem curuitatis, quae repercussum fecerat in omnem ambitum, et super hanc sphaeram imaginariam ducere etiam oportet perpendicularem ex re pro definiendo loco imaginis" (*Ibid.,* pp.76-7).
[33] A paper or a screen does not respond to those affects of strong light or color. Therefore the image is stabilized and appears over the paper or screen when they are positioned in the correct geometrical locus where the rays intersect. In this sense the paper is a passive agent and the appearance of the image is wholly determined by mathematical considerations. This does not hold for human perception. "But if you place a paper, say, if you insert a paper between the lens and the eye… now the image is not seen hanging in the air, but fixed on the paper. Because the paper strikes more clearly the eyes, it stabilizes them on the place of the image, … the paper is seen principally, and the image secondarily. For not only mathematical dimensions create the image, but also and much more colors or illumination and physical causes…" [At si papyrum obiicias, si inquam interponas papyrum inter lantem et visum… iam non pendula in aere, sed fixa in papyro videbitur imago. Papyrus enim euidentius feriens oculos, stabilit illos in loco imagine, papyrus praecipue videbitur, imago secundarie. Non enim solae mathematicae dimensiones imaginem creant, sed etiam et multo magis colores atque lumina et physicae causae…" (*Ibid.,* p.164).
[*] In an erected picture the line from A to A' will not share a common point with the line from B to B', whereas in an inverted and reversed picture all lines from the points on the illuminated object to the corresponding points on the picture will pass through the same point.
[34] The whole passage reads: "Quemadmodum non ideo visio est actio, quod illustratio sit actio, sed contraria actioni passio: ita etiam, vt loca respondeant, patientia agentibus e regione oportet esse opposita. Tum autem perfecte sunt loca opposita, cum idem centrum mediat in lineis oppositionum omnibus, quod non erat futurum, si pictura erecta fuisset. Itaque in inuersa pictura, etsi vniuersaliter et respectu communis alicuius lineae dextra sinistris permutantur: dextra tamen rei, dextris picturae, et supera rei superis picturae (sui ipsius respectu) perfecte opponunturr, sicut cauum cauo. Nec metus est, vt in plaga erret visus … Errasset potius erecta existente pictura. Alicubi enim oculi interior paries obiiceretur rei directe, alicubi non, vt a lateribus: declineret enim ab oppositione. Nihil igitur absurdi committitur, inuersa pictura…" (*Ibid.,* p.185).
[35] Natura enim nihil iacturae destinat" (Kepler, *GW*, vol. 2,, p. 144).
[36] "Ludo quippe et ego Symbolis, et opusculum institui, Cabalam Geometricam, quae est de Ideis rerum Naturalium in Geometria: sed ita ludo, ut me ludere non obliuiscar. Nihil enim probatur Symbolis, nihil abstrusi eruitur in Naturali philosophia, per Symbolas geometricas, tantum ante nota accommodantur: nisi certis rationibus euincatur, non tantum esse Symbolica sed esse descriptos connexionis rei utriusque modos et causas..." (Kepler, *GW*, vol.14, p.158).

[37] (Francisco Sanchez of Salamanca, *Commentary on Alciati's Emblemata*, Lyons 1573, in the British Library, Egerton MS 1234).
For the general theme of Icarus, see also Carlo Ginzburg, "High and Low: The Theme of Forbidden Knowledge in the Sixteenth and Seventeenth Centuries," *Past and Present* 73 (1976), pp. 28-41.