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The Camera Obscura, a Paradigm.

Yvonne Lammerich

A Thesis

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ABSTRACT

The Camera Obscura, a Paradigm.

Yvonne Lammerich

Since Medieval times, the camera obscura has made important contributions to the knowledge base of astronomy, physics, physiology, philosophy, perception and art. As a symbolic space, the camera obscura mediated new links within humanity's mental reconstructions of the world. This promoted a greater understanding of our internal and external realities.

This thesis delineates the parameters of the camera obscura's field of influence which also extended to the North American continent. Joseph Légaré, the nineteenth century Québec artist, personifies this extension. As the founder of Canadian Landscape Painting, his use of the camera obscura is important when we consider the belief structures created by this paradigm. In this thesis these are addressed through philosophy, theology-cosmology and art theory.

To my parents,

Frederich and Barbara Lammerich.

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I am most indebted to my husband, Denis Farley, for having shared my interest in the camera obscura and for being a constant support that sustained me throughout my studies and the preparation of this thesis.

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INTRODUCTION

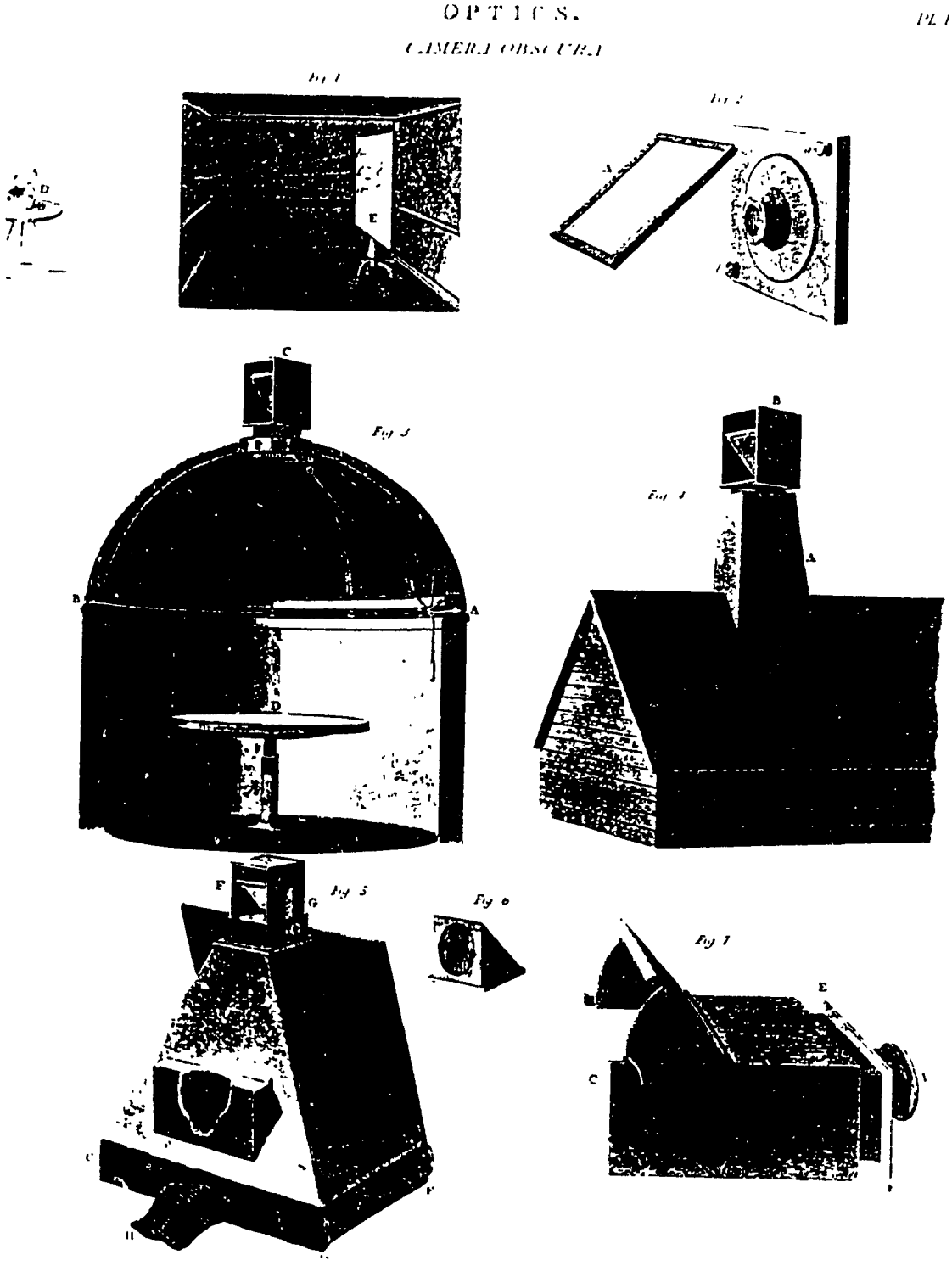
The Camera Obscura: truth, light, body, organ, opening.

> I ascended the stairs to the top of the tower and went into a small circular apartment. I closed the door to exclude all light save for a thin beam reflected by a mirror and filtered through a lens located in the roof. This light fell downwards to cover the surface of a large concave table, painting in sharp coloured detail all that is showing outside. Slowly the mirror revolved, thus exposing a panoramic view. The colours in which this landscape is painted is a perfect imitation of nature and the small people strolling across this mysterious Merlin's table are so deliciously unconscious of me.[1]

This text, an admixture of personal experience and historical fiction, indicates that viewing a camera obscura image in a dark room can generate a very complex human response.

John Hammond, in his book *A Chronicle of the Camera Obscura*,[2] has carefully documented the history of the camera obscura as well as explained its mechanism and physics. Ultimately, however, it was my own experience while visiting several camera obscura observatories, specifically in Scotland, Wales and England, that left me with questions provoking a more searching analysis of what the camera obscura represents as a phenomenon. (Illustration 1.) Why, in fact, from Medieval times to now, has it evoked so many grandiose exclamations and passionate investigations which have established it as one of the great paradigms of western history?

Ill. 1 Photographic reproduction of engravings of five different types of camera obscura from a nineteenth century encyclopedia of science, London, England, 1817. See description of figures in Annex 1.



The camera obscura no longer represented for me simply a great invention or a phenomenon of physics. It became an event of consciousness. Paul Virillio writes:

> We might also note that the great inventions are events in the order of consciousness more than in science. Archimedes, Newton, Einstein sensed the principle of relativity while observing the flight of gulls over the sea.[3]

I began to see the camera obscura as a perceptual filter that pulled science, medicine, socio-political history, religion, philosophy, art and psychology (even before inter-disciplinary separations) into its frame. As I moved through the literature directly and indirectly associated with this subject, I found myself moving into deeper and deeper recesses of its meaning, aware that I was constructing a paradigmatic *aleph*[4] of a very ephemeral form.

Within the scope of this thesis, I hope to unfold the changing relationships of phenomenological conception and understanding of vision as they relate to the history of the camera obscura. Daniel C. Dennett, in his book *Consciousness Explained,*[5] discusses contemporary aspects of the perceptual relationship that is set up between the viewer or observer and the image. The issue is one of clarifying our notions and assumptions of the internal and external worlds which act as connectors with the continuing echoes of the dark chamber, while crisscrossing the old world with the new. These emanations were also absorbed in the eighteenth and nineteenth centuries by North-American artists, one of whom, Joseph Légaré of Québec, will be discussed as a specific example in this thesis.

The camera obscura captured a part of the omnipresent sun. As Abel Gance would later affirm, "the future of the movies is a sun in each image"[6] in the chamber of consciousness. Medieval man anatomized the world's projected fragmented body by a stratification of what Gilles Deleuze, a contemporary French philosopher, and Félix Guattari, a practising psychoanalyst, term "the plane of consistency."[7] The projected image or omnipresent plane presented very different problems with respect to the understanding and assumptions of vision and perception, not only at different moments of the past but also in different parts of the world. Different models of understanding were simultaneously developed. All of these, in turn, varied to different degrees with the contemporary synoptic model. Nevertheless, similar impulses are supplied, simulating a network of reflections in the contemporary world body: "Man, fascinated with himself, constructs his double, his intelligent spectre, and entrusts the keeping of his knowledge to a reflection."[8] The reflective constructions underlie the desire for communion and communication with the apparition of the multiple selfs.

I intend to describe all aspects of the camera obscura assemblage by folding some of the meaning locked up in its history with my understanding of the contexts, motivations and debates that have surrounded its investigations at different historical moments. In essence, my reading of the historical articulation of this "opening,"[9] grounded in philosophy, theology and art theory, is intended to define the parameters of the camera obscura's influence and not solely its relationship to art. My reading will not lead to questions of right or wrong interpretation. Differences, I believe, are due to

inevitable changes in positions in space and time.[10] It is these positions that I hope to define. The subject of the camera obscura is, in fact, already a multi-dimensional story and I intend to deal with it in this way. Also, many texts, some original, dealing with the camera obscura are capable of being both semantically and critically[11] interpreted, and I think it is important to keep that distinction in mind. Throughout this thesis, I will be introducing texts which will require interpretation beyond the first level. I will also try to construct these texts in such a way that they might, at times, seem unconventional but will carry, in their constructions, another layer of anatomization than would be apparent in the first reading.

Having experienced contemporary individuals observing the camera obscura image for the first time and still being fascinated, mystified and full of exclamations even today (with all the sophistication of our contemporary baggage), I am convinced that this assemblage of events is far more complex than can be reaped from the limited studies done on this subject. My own contribution is an attempt at a simple shift from traditional considerations of the camera obscura as the vehicle that helped to break the *premum mobil* of the Middle Ages, a concept I do not disagree with, to the inversion of this view. I perceive the camera obscura as an event or entry into a greater complexity towards the understanding of the potential of a simultaneous navigation between man's internal and external worlds--a movement that resonates with the impulses of trying to picture the whole universe from the inside out or the outside in, towards the experience as a time

traveller,[12] understanding it a bit at a time while still believing in the potential of the whole.

The camera obscura image, as a fragment, provided the opportunity for the construction of a different absolute reality[13] which, in its seed, contained the potential of nineteenth and middle-twentieth centuries deconstruction. The de- and re-construction of absolute reality initiated, for example, in the Middle Ages, located the observer in a cosmologically closed, dark model, not unlike the dark confines of a camera obscura chamber. In this space, free movement is possible for the body and the eyes. However, there is only one illuminated place, the reconstructed world fragment. Because of the visible absence of the observer's body, the projected image acts as an internalized vision.[14] Jonathan Crary in *Techniques of the Observer* suggests "that the camera obscura performs an operation of individuation"[15] by the observer's isolation resulting in "a withdrawal from the world in order to regulate and purify ones relation to the manifold content of the now exterior world."[16]

Crary is saying that the classical view of the camera obscura suggests a withdrawal from the world. I, however, see it more as simply moving into another room where it is possible to reconstitute the absent body which is essentially what started to take place in the Renaissance. This gives status to the camera obscura as a symbolic space which allows for the stratification[17] of a plane of consistency.[18] In that way, it is not a withdrawal but rather an entry into this plane and a continuing construction of

our world in the most encompassing sense. As Deleuze and Guattari describe this plane of consistency, it knows nothing of the differences in level, orders of magnitude, or distances. It knows nothing about the differences between artificial and natural. It knows nothing of the distinction between contents or expression, or that between forms and formed substances. These things only exist in relation to the strata.[19]

In this way, I believe the camera obscura provided the opening into this neutral, yet provocative, less than two-dimensional plane of consistency within whose parameters were forged new links within our own mental reconstructions of the world. It is therefore one world that consists both of internal and external characteristics. The projected screen acts as a sensitized neural plane.

Although I would like to put the camera obscura image and that of the photograph far apart in this thesis, the same distance approximately as photography[20] is from Malevitch's suprematist canvas *White on White*,[21] I have to acknowledge that all of these paradigmatic openings have something in common. They are not about processes of simplification but about developments of greater complexities, new structures of consciousness.[22]

The Camera Obscura phenomenon is the result of an abstract articulation[23] that occurs to light as it travels in straight lines through an opening and reconstitutes an image of the world outside, the other side of the aperture, on an opposing surface. This

photonic simulation of the world has been subjected to changes in scale, position in space, materiality and dimension. Despite these variant transpositional characteristics, this parallel world was pronounced "the new truth" by Constantijn Huygens (1596-1687).[24]

The question I will examine in chapter one is, what truth? And what is the authority of this truth? What are the means by which to measure it?

Chapter two deals with the vehicle for carrying this truth. It is transmitted by light travelling through a small opening, only singularly visible due to the absence of other light sources. It was the concept of divine light which was the impetus for the analysis of the aperture phenomenon in the European Middle Ages, making its primary component a belief-structure that became invested with an ancient measure which lent it authority.

The "apparatus of capture"[25] makes the projected world, suspended in the isolated confines of a darkened chamber, like an organ to a dark and invisible body. The camera obscura is what Deleuze and Guattari would call an assemblage,[26] something that is "simultaneously and inseparably a machinic assemblage and an assemblage of enunciations."[27]

In chapter three, I will discuss the paradoxes confronted by the observer in relationship to this assemblage, experiencing it simultaneously as its own potential body as well as an extended body. In the text, I use the male form of gender because the documentation surrounding the camera obscura is male dominated. The enunciations that consequently emanated from the camera obscura body are articulations of changing mental models that found their expression in religion, science, art, philosophy, psychology and history.

Chapter four more specifically addresses the field of art and, in particular, the relationship of the organ/image to painting. This unstratified projection becomes the psychological field of investigation for the observer. The image is the abstract separation from the world that leads the observer to a new perceptual opening.

The camera obscura, as seen from the concept of an aperture, is in its most rudimentary form neither solely a machine nor simply a reflecting surface for social and cultural discourse. It is an opening which gave birth to a world within a world--*de nieuw-geboren warheit*, "the new born truth, for here is life itself."[28] An *aleph*[29] with no concise beginning or end, a space that accommodates all space but also has none: "I saw the *aleph* from all points; I saw the earth in the *aleph* and the *aleph* in the earth and once more the earth in the *aleph*."[30]

Every opening is potentially both an entry and an exit, it holds transient dimensions that sustain distance for inquiry into the origin and ontological speculation of ourselves, our world and other worlds, whether they be man-made or not. An opening can be as varied as a door, a wound or an aperture. Associated with each is an intention which becomes its gesture and gives it form.[31] The camera obscura aperture has its associated gesture that gives, through cultural stratification and coding, meaning to its form or truth.[32]

In conclusion, I will discuss the consequence of this monocular opening and its associated gesture as a desire for the re-affirmation, but also its inversion, the denial of origin.[33] I am particularly interested in the thesis of the camera obscura as an "opening" to cultural strata and their belief structures which have both created and willed the camera obscura's existence, rationalized its application and interpretation, and, in this way, shifted the cultural field. I hope, in this thesis, to move away from the conventional separation of technology and nature to show that the camera obscura, framed as a piece of technology from the earliest times, was equated to the human eye which, in the fifteenth Century, was already understood by Leonardo Da Vinci to be the mirror of the soul.[34] I see the camera obscura acting as an extension of human mechanisms, a sentient machine whose construct is a composite articulation of concepts of truth, light, the body, the organ and the opening as part of our continuing anatomization of our existence as a means to securing "certainty."[35]

Notes to Introduction.

1. Yvonne Lammerich, "Histoire, Désir de la Mémoire Aveugle," historical fiction in *Les Mois de la Photo, à Montréal.* Catalogue. (Montreal: Galerie Prim Video, 1989) 74-75. An excerpt of a text written to accompany an installation work by Denis Farley and Yvonne Lammerich for the exhibition *The Month of Photography* presented at Galerie Prim Video, Montreal.

2. John H. Hammond, *The Camera Obscura, a Chronicle* (Bristol: Adam Hilger Ltd., 1981). Surprisingly, this book is the first history written on the camera obscura.

3. Paul Virillio, *Aesthetics of Disappearance*, translated by Philip Beichtmann (New York: Semiotext(e), Columbia University, 1991) 45-46. Virillio points out the paradox of preceding centuries where less knowledge created a model of certainty and totality, and consciousness, imposed on events or vice versa, rationalized observations into the great inventions.

4. Jorge Luis Borges, *The Aleph and Other Stories, 1933-1969* (New York: E.P. Dutton, 1970) 8-15. In this story, Borges describes the aleph as a phenomenon, a brilliant ball suspended in the air that simultaneously contains all images of the world but has no linear or even spacial dimension as we understand it. It allows one to view, without prejudice or editing, all that is but not necessarily all that one wants to see. It is a world that is simultaneously capturing the world but also exists within it. It is unlike an assemblage in that it is not territorial but purely conceptual. And, unlike a rhizome, it is not yet stratified. Perhaps it can be described as an heterogeneous plane of consistency.

5. Daniel C. Dennett, *Consciousness Explained* (Boston, Toronto, London: Little, Brown and Company, 1991) 46-60. Dennett discusses the conventional model of visual perception equated to the camera obscura to which Descartes attributes mechanical qualities when, in fact, he argues that visual phenomenology is unlike any other mode of representation (not cinema or photography, etc.), a separation of the outer world of vision. He agrees with the British Empiricists that, in some way, the inner world is dependent on sensory sources. He uses the phenomenology of sight as a major integrator of the outside and the inside, extraversion/introspection, into more inclusive states

6. Virillio, 54-55. "...a sun for visual truths, these thoughts are a reflection on the entrancing in an image capable of bringing the spectator, in each fraction of a second, this unknown feeling of ubiquity in a fourth dimension, suppressing space and time..."

7. Gilles Deleuze and Félix Guattari, *A Thousand Plateaus, Capitalism & Schizophrenia* (Minneapolis: University of Minnesota Press, 1987) 69-74. Deleuze's and Guattari's thinking, which I have found very much in sympathy with my own reflections on contemporary reality, is a cross-fertilized line of nomadic thought with contemporary

theory. I have used several of their concepts in this thesis in order to help me position my subject. All of the terms are footnoted. The plane of consistency is a concept, previously termed matter or the unformed, unorganized, non-stratified. "Strata are spin-offs, thickening on a plane of consistency, that is everywhere, always primary and always immanent. The plane of consistency is occupied, drawn by the abstract machine; the abstract machine exists simultaneously developed on the de-stratified plane it draws, and enveloped in each stratum whose unity of composition it defines."

8. Virillio, 46.

9. "Opening" is a concept that I am developing in this text which stands for an active participation in its construction, application and interpretation. The motivation and consequences are what interests me in relation to the camera obscura phenomenology.

10. "Positions in space and time" are a more conceptual view of locating historical moments which, in this way, can be seen in relationship to each other, not necessarily as linear or chronological.

11. Umberto Eco, *Limits of Interpretation* (Bloomington and Indianapolis: Indiana University Press, First Midland Book Edition, 1994) 54-57.

12. Paul Davies and John Gribbin, *The Matter Myth* (New York: Simon & Schuster/Touchtone, 1992) 104. If the old paradigmatic model of how we pictured the universe was based on an ever larger intelligent machine, the physical universe is seen today more as a gigantic information processing system whose output is not yet determined. Consequently, every field force, even space-time itself, is revealed to us only in bits of information.

13. I use the term "absolute reality" in relationship to the camera obscura's occidental history only. It was the intention or gesture of the Renaissance practitioners to re-construct their idea of reality in absolute terms, imposing qualifying expectations such as complete, perfect, pure, real, unconditional and self-existent, not merely relative or comparative.

14. Jonathan Crary, *Techniques of the Observer* (Massachusetts: M.I.T. Press, 1990) 70-71. Goethe conducted many experiments in a dark room in order that the subject, closing his eyes, experiences vision that is generated by the proper body itself. I extend this idea to the acceptance of the image not as a separation of the body from the world but as the world of the body. In other words, the dark room provides the in-body experience of the image, therefore no distinction is made between inside and outside.

15. Crary, 70-71. Crary bases his analysis on the performance of separation of the physical limits established by the walls of the building of the camera obscura which is, in my mind, the very space that is being de-constructed.

16. Crary, 38.

17. Deleuze and Guattari, 45-76. Stratification is the action of the creation of the world from chaos--a continual, renewed creation. Stratification occurs outside the plane of consistency or pure matter. The mechanism for stratification is the abstract machine. It is not a machine as such, but rather stands for all the categories of cultural construction that we know, such as artistic, psychological, philosophical, etc. Movements of de-stratification occur when one side of the machinic assemblage faces the strata, defining it as a kind of organism signifying totality while the other side faces the body without organs, which is continually dismantling the organism. In models of striation, you have a parallel system that intersects as a vertical and a horizontal. The more regular the intersections, the tighter the striation, the more homogeneous the space tends to become. Therefore, the striated at its most extreme is homogenous. However, it may appear similar to the smooth space of the plane of consistency which is, fundamentally, heterogeneity--rhythmic rather than harmony/melody, Riemannianspace rather than Euclidean space--a line that does not pass between two points, and a plane that does not proceed from parallel and perpendicular lines. (Deleuze and Guattari, 488)

18. Deleuze and Guattari, 68-70.

19. Deleuze and Guattari, 69.

20. The photograph has been traditionally considered as simply a fixed image of the camera obscura. However, the very nature of the photographic process, if only considering one of its intentions as a permanent document, changes its parameters. The material manifestation which is manipulated by process from the very inception, not to mention contemporary photographic transformations with a computer, gives totally different parameters to the meaning of the photograph and therefore constitutes, beyond the most primary moment of inception, a different field.

21. Malevitch's suprematist painting *White on White* of 1910 is in fact an opening and simultaneously a screen for the projection of a humanitarian metaphysical space that re-organized the social structure--a de-stratification defining the body without an organ. The striated relates to a more distant vision and a more optical space, which is what Malevitch was getting away from. He was interested in the creation of another smooth space from which a different striated space could be constructed.

22. "Structures of consciousness" is, in a sense, a rhizome working on the principle of connection and heterogeneity. Any point can be connected to any other--essentially new conceptual links that bridge the self-organizing complexity of ever more information with the developing mental model that we construct of the world.

23. Deleuze and Guattari, 40. In "abstract articulation" it is possible to have single or double articulations. In any case, an articulation is the coming together of two events through a joint. An articulation in this way is a folding that can be about strata of

meaning. In the case of the camera obscura, the "opening" is such an articulation. It allows light to project through its opening while at the same time being an opening or a frame out onto the world. The intention of both these aspects of this double articulation is very different, as is their meaning despite the common joint.

24. Svetlana Alpers, *The Art of Describing* (London: John Murray (Publishers) Ltd., 1983) 12. Constantijn Huygens (1596-1687) was the secretary to the first stadholder of the new Dutch Republic. He was also an admirer of Rembrandt and wrote extensively on his experience and observations of the camera obscura. It is he who exclaimed "the new truth is here" while describing the image of the camera obscura.

25. Deleuze and Guattari, 425-473. I have transferred the concept of the "apparatus of capture" to the metaphorical camera obscura since a closed room, chamber or box can be described as the apparatus of capture of truth, light, the body, the mind and other cultural articulations that entered into its domain.

26. Deleuze and Guattari, 503. "Assemblages" are produced in strata. They operate in zones where milieux become decoded. Every assemblage is essentially territorial. The first definer is the discovery of their territory. In every assemblage, one can distinguish between content of expression. The camera obscura is one of these assemblages.

27. Crary, 31-32. An "assemblage of enunciations" describes the consequence of the exclamations surrounding the camera obscura as a paradigm.

28. Alpers, 12.

29. See note 4.

30. Borges, 8-15.

31. While in Paris in the spring and summer of 1994, I attended several lectures by Georges Didi-Huberman at the École des Hautes Études en Sciences Sociales. It was there that I first heard of the concept dealing with the notion of social gestures (in his specific case, it was Aztec sacrifice) creating the cultural form.

32. DiDi-Huberman argues that the concept of truth is directly related to the cultural form which is established by the gestures of its community.

33. Joseph Campbell, *The Hero with a Thousand Faces* (New York: Princeton University Press, Bollinger Series XVII, 1973) 315. Origin is referring back to the creation myth in which the development of the male and female identity is evoked through myth. This conversation is further extended by Riane Eisler, *The Chalice & the Blade* (San Francisco: Harper Collins, 1988), in an historical synthesis of the shift from a matriarchal culture that worshipped its origin to the patriarchy that prospered in Medieval Europe and whose essential contradiction was, and to a large extent still is today, a search for origin yet a simultaneous denial of it.

34. Mary Sayer Hammond, "The Camera Obscura: a Chapter in the History of Pre-History of Photography." Dissertation, Ohio State University, 1986. Hammond quotes from Leonardo Da Vinci's notebooks when discussing vision and the eye: "the eye...is the mirror of the soul," 140.

35. John L. Casti, *Searching for Certainty* (New York: William Morrow and Company Inc., 1990) 323-403. The desire for certainty has been a primary driving force for man's inquisitive nature. The camera obscura image was an ideal map for superimposing this desire for certainty by delineating a net of geometrical constructions that became projective geometry or perspective. The conclusions reached through this system of measurement had major implications on how we understood and experienced our world. Casti questions this search for certainty in a number of different fields, mathematics being one of them.

CHAPTER 1

Truth: as ecstatic motivation

"The New Truth Is Here."[1]

In contemporary analysis we are no longer able to make a simple relationship between thought and truth, or will to truth, as was the case in ancient Greece and Medieval and pre-industrial Europe. Gilles Deleuze and Félix Guattari described our contemporary state in *What is Philosophy*:

> The first characteristic of the modern image of thought is, perhaps, the complete renunciation so as to regard truth as solely the creation of thought, taking into account the plane of immanence,[2] that it takes as its presupposition, and all this plane's features, negative as well as positive having become discernible. As Nietzsche succeeded in making us understand, Thought is creation, not will to truth.[3]

If, today, truth as a concept is multivalent and not fixed, as in Goedel's incompleteness theorem, true and provable are not always the same.[4] Truth as belief and aspiration in pre-nineteenth century thought was just its opposite, it was the will and struggle to apprehend, to prove and to permanently fix concepts and structures of truth. In essence, all the "exclamations" surrounding the camera obscura speak of the anticipation of this possibility.

This chapter lays out the parameters that involve the definition of truth as related to the field that "created" the body or the assemblage of the camera obscura and

discusses in turn how its constructed presence created its own field in which it projected its own truth, as a continuum in creation.

The complexity of a sentient organism, in this case the human being, with a multitude of conflicting sensory data needs to build itself a vessel with a rudder to territorialize the world's chaotic plane of consistency. Cosmology was one of its primary vehicles. By the ripples of the cosmological terrain we are able to perceive the parameters of thought of the ancients inscribed in the ontology of concepts of truth.

In order to construct cosmological concepts, it is necessary to move out of the immediate physical body and observe the universe from the creator's perspective. This in itself suggests an innate ability to conceptualize time and space. Also, the fabrication of a cosmological model of the world hints at the innate capacity to construct abstract models.[5]

One of the first Greek models to explain human origin was set down by Hesiod in 800 BC. His theogony described human beings as the rational result of the union of earth, the underworld and love, created from chaos. Material questions about the cosmos[6] were posed by Thales two hundred years later, no doubt applying empirical observations as it was considered the first recorded scientific philosophical statement. He concluded that water is the primary substance of all material reality. Extending water to its former state of gas as air or ether was consequently substituted by Anaximenes

(545 BC) as the ultimate divine mind stuff that surrounded the cosmos and filtered down to earth.[7]

From *terra firma*, to water, to gas, materiality to immateriality, the evaporation of the solid put mind and body into suspended animation. A liberation ensued that dismantled the Greek mythical concepts of gods, divinity of the sun and the sacred disease of epilepsy of the oracle, and made room for the postulations of the potential nature of the ether as a reconstruction through thought and/or observation of material reality.

Pythagoras (585-507 BC) rose to the occasion. He chose to reconstruct the world through thought and not by the analysis of the nature of matter by empirical observation which was the current belief of his day. His belief-structure (Appolonian in essence--purification of the soul and the body through abstention)[8] prescribed limitations on physical engagement, a position that gave priority to mind and thought, an opening onto an abstract model, which he conceived of with numbers and geometry.

Geo(earth)metry was a simple strategy applied by the Egyptian farmer using a string and making straight lines to measure fields after the flood of the Nile.[9] The geometrical forms that the Egyptians developed from this were arrived at by inductive reasoning[10] but without any formal proofs.[11] It was Pythagoras's intention to develop geometrical theorems and proofs to support the synthesis of religion and

reason, an "interconnection and interpenetration of nature through mathematics or the intellect."[12]

The axioms and theorems based on geometry were deemed to be self-evident truths and were held to be true of actual space which is given by actual experience. It therefore appeared possible to discover things (truths) about the actual world by first noticing what was self-evident and applying deduction to this.[13] It is with Pythagoras that demonstrative deductive arguments (for truth) begin. The idea that points or numbers are a connecting value to and with all things gave Pythagoras a belief that all matter can be reduced to numbers and shapes--geometric shapes as quantified provable knowledge. It was on the basis of this mental construction of mathematics that he gave thought a superior position to sense, and intuition to observation.[14] With this prejudice, Pythagoras set up a chain of oppositions that have rebounded throughout the whole western cultural fabric. Philosophy, theology, science, optics,[15] and art not only came directly under the influence of this bias, but also mathematical speculations, with their connection to truth, became a legitimizing agent that gave status to art, shifting certain crafts to "liberal arts" in the Renaissance.[16]

What made the camera obscura assemblage susceptible to mathematical speculations is its specific mathematical-geometrical relationships which the body, the opening and the projected image have with each other, the size and place of the opening in the body if there is a lens, and the focal distance of the lens and the surface on which

the image is projected. It is this relationship that ultimately constructed the body which first had to be anatomized before it could be invested with verificational potential.

Light entering this body became the organ with potential. The conduit or light was the constant measure, the hypotenuse: the stretched straight line of the Egyptian farmer, the geometrical relationship that linked the opening to the projected image as its point of resolution. It is for this reason that the observations and conclusions on the nature of light in relationship to the opening or aperture are important, for it is here that the internal construction of the camera obscura body rests.

The first recorded study of light and its aperture or opening was made by the Mo Tzu scholars of China (479-381 BC). They understood the propagation of light in straight lines by constructing a series of dark rooms with only small openings and observing the straight path light took from one room to another.[17] Aristotle (387 BC) was the first to question the relationship of projected shape and opening. He observed the discrepancy between a square or round aperture projecting the crescent shape of the solar eclipse. "But we know that the model he constructed of the double cone propagation from the sun to aperture to earth, is based on conceptual rather than visual proof."[18] Euclid (295 BC) applied geometry to the propagation of light through an opening,[19] and also studied reflected light.[20] Ptolemy (140 AD) studied refraction of light[21] and Alhazen (965-1038 AD) demonstrated that, with geometry, "the image becomes the shape of the aperture, when the focal distance is shortened, or the aperture

enlarged."[22] He, however, studied this empirically as well as explained it theoretically. Alhazen also studied image formation. This information, however, did not reach Europe until the sixteenth century.[23]

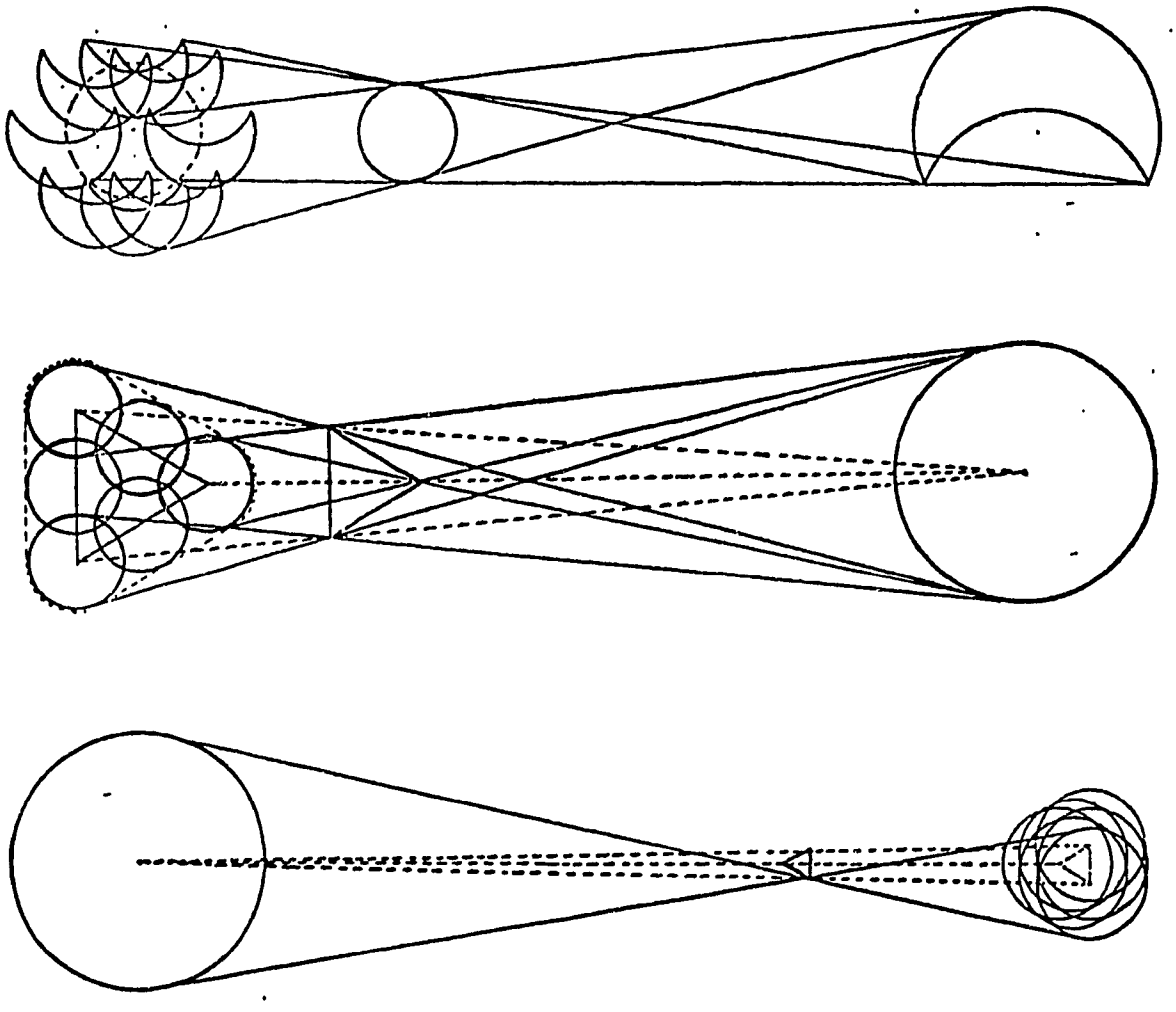
With these selected reflections on light and opening, none of which were yet concerned with image formation as the main event, these pre-Medieval thinkers were asking questions about the nature or condition of the opening and what occurred to light on the other side of it. (Illustration 2, figures 1, 2 and 3.) Through these intentions it is possible to see the beginning of the internal conceptual construction of the apparatus of vision as the camera obscura. The essential geometrical relationship which they deducted between apparatus and light, with its axioms of self-evident truths, was beginning to be understood. What was not yet clear, however, was the behaviour of light--the physical nature of light. Since geometry set up the relationship, it was left to the study of matter-physics to lead to the understanding of the nature of light.

Robert Grosseteste, Bishop of Lincoln,[24] initiated at Oxford the study of optics for this reason. The influx of translations, interpretations of and contemplations on Aristotle, Euclid and Ptolemy by Arab scholars was both symptomatic and causal. As a theologian, Grosseteste believed in the concept of divine light and that "the action and behaviour of light revealed the nature of causation, and was itself the source of all created being."[25] With the aid of less than complete or faithful translations,[26] he set out to understand the nature of light through empirical experiments.

III. 2

Fig. 1 Towards circularity. When the moon is projected through a large aperture, the result is the propagation of more than one moon reproducing in circular motion. The roundness of the aperture is reproduced and not the characteristic shape of the moon.

Figs. 2 and 3 Relationship between the size, the aperture and the distance from the image. In figure 2, the large triangular aperture close to the screen reproduces the round sun as a repetition of circles, therefore recreating the shape of the large triangular opening on the screen. In figure 3, the triangular opening is smaller and farther away from the screen, thus propagating the circular image of the sun and not of the opening.



Grosseteste experimented with light and opening in the context of his fascination with the Greek concept of the propagation of light as a model for the propagation of all species.[27] He took the Greek concept of the pyramid and cone of light and made it part of his theory on causation (bodies giving off light, multiplying their power according to the geometry of the pyramid), but asserted that geometry could only give an account of what happened, it could not explain what (why it) happened.[28] For these reasons he considered the study of optics paramount. It is important to mention here that for a long time the study of optics was only taught at Oxford to Medieval scholars as Grosseteste's student, Roger Bacon, complained while living in Paris,[29] the other primary intellectual centre of Europe.

This desire to search for truth of creation through observation, as opposed to geometric axioms, created the first clear axial opposition through the opening of the camera obscura body that played an important role in the redefinition of Medieval truth and concepts of visual reality in Europe.

Roger Bacon, Grosseteste's most famous student at Oxford, continued to study the propagation of light as species[30] and concentrated on the opening or aperture problem in relationship to a round image through a square hole.[31] This led to his speculation that "laws governing the transit of force (energy, light) through space...must be looked for in the science of optics."[32] These conceptual forcelines are in fact the roots of visual perspective addressed in the tract on optics called *Perspectiva*,[33] first

published in 1614. Bridges suggests that Bacon was the first to attempt to construct an instrument for the purpose of increasing the power of vision and the first scholar in the West to record the use of a camera obscura to observe the solar eclipse. It was, however, the thirtheenth century astronomer, Guillaume (William) St. Cloud who gave the first written description of an enclosed chamber:[34]

> In the year of our Lord, 1285, on the 5th day of June, it happened that those who too intently observed the sun [during the eclipse] found their vision was impaired when they went into the shade again. This dazzled condition lasted with some two, with others three and with some others for several days, according to the time they had glanced at the sun and the degree to which their eyes were sensitive....In order to eliminate this and to be able to observe without danger the beginning, the end and the extent of the eclipse, one should make in the roof of a house, or in the window, an opening towards that part of the sky where the eclipse of the sun will appear, and the size of the hole should be the same as that made in a barrel for the purpose of drawing of wine. A ray of light will then be seen delineating itself on the screen in a round shape, even if the aperture is angular.[35]

The camera obscura body came into existence around the opening or aperture, thereby giving an internal and external quality to the line of propagation which unites the external model with the internal truth. However, as I will discuss later, this is a two-way conduit in which the external truth becomes reconstructed in accordance with its internal reality.

The camera obscura as a model could not survive, or indeed could not fulfil, its potential without the fertility of the soil in which it was rooted. This was significantly provided by the scholastic philosophers of the Middle Ages who had to come

to terms with Aristotle on physics, metaphysics and psychology as well as with scientific writings from Alexandria by Euclid and Ptolemy and the biology of Galen.[36] The interpretations of these texts with their varying conclusions precipitated a revolution that threatened the foundation and authority of the Christian doctrine and the institution of the Church in the twelfth, thirteenth and fourteenth centuries.

I believe it is important to understand some aspect of these arguments and their conclusions as doctrines of truth since they influenced the passions, or reasons, that construct the organ at the end of the conduit of light inside the body.

The Realists[37] advocated the unity of substance, its identity as matter, mind and God. The problem for the Church with this interpretation was how to separate God from matter. For Aristotle, matter was potential and subject of form, but if all forms were destroyed, then God was still in matter and God could not be considered mere matter in the concept of the universals.[38]

In order to maintain the Church in these philosophical speculations, Thomas Aquinas[39] borrowed Aristotelian concepts and fused them with Christian beliefs. Man, he believed, had superior comprehension which allowed for abstract universals to be arrived at from sensory impressions. The whole order of the universe was inscribed in the soul. Man's empirical and rational intelligence could penetrate the multitude of created objects in the world, their order, directness and finiteness. By expanding his

knowledge, man was becoming more like God which was the desired end. Knowledge as Truth was the way to the holy spirit, but God was the sustaining cause of all religion.[40]

With these concepts, Aquinas mediated Aristotle. Inevitably, discrepancies between Aristotle and Christianity where noticed by a group which became known as the secularist philosophers, among whom was Averroes.[41] The secularist philosophers taught Aristotle without linking scientific and logical conclusions to religion.

There are three main proponents of this scientific spirit, all from Oxford: Grosseteste and Bacon performing concrete scientific experiments and, somewhat later, the priest philosopher, Oackham, who developed a highly logical method and argued empiricism[42] against the secularists to preserve and uphold the doctrines of the Church. In the process, he destroyed the metaphysics of ontology that Aquinas had erected for the Church. The concepts he laid down were so modern that essentially what happened after him until the nineteenth century was an acting-out of all the aspects of his conception.[43]

Oackham believed that reality, universals and language did not exist outside the human mind. Nothing exists except individual beings, concrete experiences and universal concepts. What was real was the particular thing outside the mind, not mental concepts of that thing. Knowledge had to be based on the real; existence, as individual being's knowledge, had to be of particulars. Universals existed only in the mind. God

was free to create what he wanted, and when and how he wanted. The question then shifted to: how do abstract universal concepts come from "real" individuals? In this way, matter became epistemology, grammar and logic.[44] The problem became that human's could not claim knowledge of the cosmos other than through relative means which was further explained by the idea that the world was not so coherently ordered as to perfectly interconnect the knower and the known. Knowledge, Oackham posited, was gained through the senses. These ideas, based on empirical arguments, consequently severed the Medieval cosmological model and, with it, the concept of the (Aristotelian) model of man. This became known as Oackham's Razor.

The arbitrary limits that Oackham felt the Church had put on God were, among others, represented by the cosmological model established by the Church; the earth-centred premum mobil of the Middle Ages with its fixed periphery of stars is an example of this kind of relative model.[45] The expansion of its limits beyond human comprehension meant displacement of the earth as centre. It was not necessary that astronomers had not yet proven it. Oresme's *Book on the Sky of the World* (1377) defended the theoretical possibility of a moving earth, as would Copernicus and Galileo and, finally, Kepler.[46] Philosophically, its potential already existed in concept.

What Oackham set in motion in relationship to the camera obscura assemblage is the creation of a symbolic space, a collecting centre, that acted as a focal point not in the sense of it only being real as a physical construction or object-space, but

all its implications as a liaison with the re-centring, and therefore definition, of the also de-centred human whose relationship to God, and consequently the world, had, over the last three hundred years, so dramatically changed. As a body or space, the camera obscura acted also as a receptacle that captured the imaginary-space of body and mind through the re-centring of place and therefore identity. The camera obscura body also became the symbolic mind-space[47] as the reflected image was already an abstracted reality or model of the world which progressively became anatomized: the archaeology of the mind-space, through the senses, revealed the truth.

Leonardo Da Vinci, in his speculations on the sense of vision, compared the camera obscura to the eye:

> The Eye is the window of the human body through which the soul views and enjoys the beauties of the world....Who could believe that so small a space could contain the image of all the universe? O mighty process!... Here the figures, here the colours, here the images of every part of the universe are contracted to a point. O what point is so marvellous! oh wonderful, O stupendous necessity though by thy law constrainest all effects to issue from their causes in the briefest possible way.[48]

When these emanations of truth set up by the Ancient and Medieval scholars left the camera obscura body to re-construct the world in relationship to its own order or truth, it did so from its point of aperture, or point of vision, through the senses. The fact that it is completely artificial and that it is impossible to separate the geometrical from optics (opening from the internal reality) is consistent with our desire to separate the organ from the body or apparatus, much like Pythagoras separated thought from

sense, or the Church, God from matter. We feign amnesia in order to construct these separations.

Da Vinci and Kepler did not go beyond claiming that the camera obscura was simply an equivalent to the organ of the eye. They did not acknowledge, as Alhazen had done before them, that the eye and the camera obscura differed. Alhazen posited that "vision is complete [only] when the form of the visible thing received by the crystalline humour passes through into the optic nerve."[49] In the case of the camera obscura, this optic nerve is the emanation going out from the camera obscura back into world space.

Space is time-defined and fixed, a multidimensional potential. Space as a photonic reflection or image on a plane becomes reduced to an internalized Euclidean possibility which was the first step in constructing a theoretical monocular truth. However, the camera obscura became the arena where not only one truth but two isometric truths existed--the theoretical and the empirical--depending on the priority given to either deductive reasoning or inductive observation. It is the monocularity of the single opening or vanishing point that leads to the conclusion that it promoted the construction of only one kind of space. However, the concept of light as the double conduit or the exchange between the internal and external reality of its double articulation conducted the changing perceptions of the world existing behind the eye to express different cultural truths as qualitative differences in the relationship between the observer (subject) and space.

Giotto (1266-1337) was the first Medieval artist to develop an analysis of spacial pictorial constructions to which he applied rules. It had almost been one hundred years since Roger Bacon experimented with the aperture and light, or forcelines, which Piero Della Francesca, one of the most important fifteenth-century mathematicians and painters, described as: "with the force of the lines and angles produced by perspective."[50] The camera obscura was known and written about in the thirteenth and fourteenth centuries when it was used primarily for astronomical observations. For this reason, the internal geometrical relationship of the camera obscura (light passing through the opening to its point of resolution) was not in itself investigated. Whatever diagrams exist from this time are crude. Proof was being sought in the formation of light itself, in the constant roundness, despite observing crescent-shaped images of the eclipse.[51]

It now seems impossible to me, after seeing Giotto's frescoes in Florence, that he was not aware of the forcelines created by light that projected heavenly bodies through the camera obscura aperture which Bacon discussed in his propagation of light and set down in the publication entitled *Perspectiva*. It could be interpreted that the straight linear connections between mortals and the divine in Giotto's frescoes at the Church of Santa Croce in Florence are forcelines as understood by Bacon. Giotto's conceptualization of space is, of course, the consequence of many factors, including twelfth-century sculpture, but surely one of them must have been a commitment to acquire knowledge of the world through his sense of vision which also implies the experience of the present moment through observation in the moment,[52] an attitude

supported by both Aquinas and Oackham. Erwin Panofsky summed up this determination to define the new consciousness through space as the idea of the *kunstwollen*, or the immanent meaning, of that period.[53]

The rules that Giotto established through observation have almost all the consequences of the geometric formula of perspective. Above-eyelevel lines are to slant downwards, below-eyelevel upwards, to the right inclined to the left, the left inclined to the right, and a horizontal division between zones to separate different sections.[54] These rules are demonstrated clearly in Giotto's painting, *Confirmation of the Rule of St. Francis* (1325, Florence). What essentially was missing was a vanishing point which was ingeniously discovered by Fillipo Brunelleschi in or around 1413.[55]

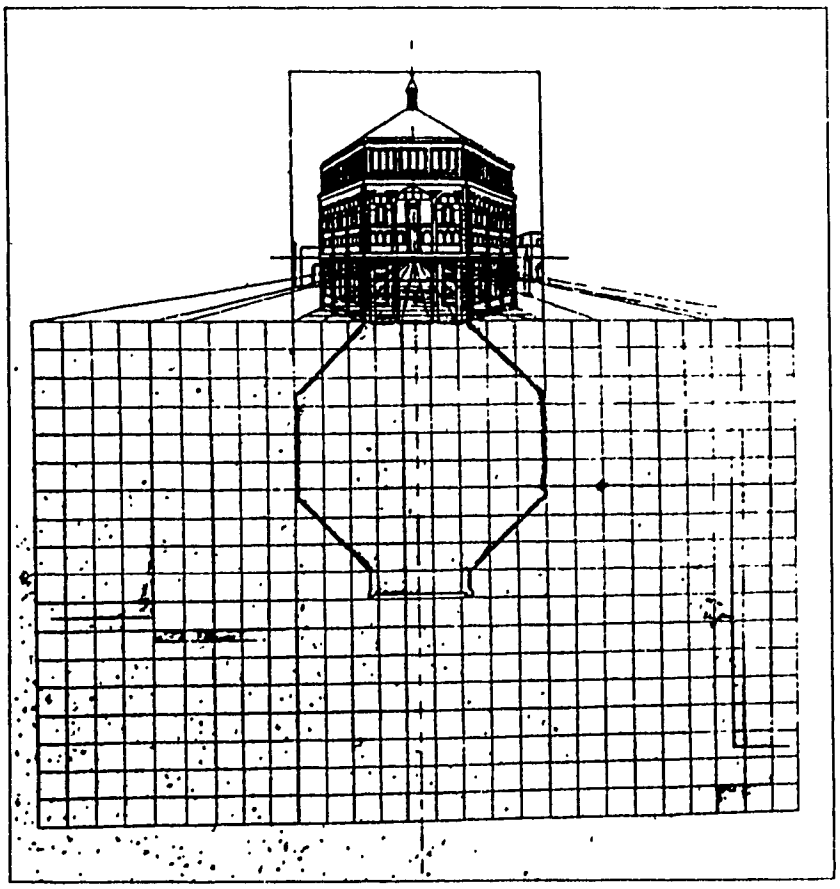
It is particularly interesting that the camera obscura is or can be connected to this event as the preoccupation with it diminished dramatically in the fifteenth century. The cause was the difficulty to resolve the problem of persistent roundness of light, an occurrence which could not be rationalized. This became a philosophical problem "blocking the intellectual nerve"[56] and did not implicate the study of geometry. Its interest seems to have persisted, for obvious reasons, only in the hands of the architect and painter, Brunelleschi, and with Leonardo da Vinci whose faith in the certainty of numbers made him proclaim that without mathematics and geometry nothing was possible, seeing in this "eye" the secret to human vision.[57]

The two panels connected with the invention of perspective (that unfortunately no longer exist) were painted by Brunelleschi and depicted the Florentine Baptistry of San Giovanni. Antonio di Tuccio Manetti, in *The Life of Brunelleschi*, relates an eye witness account of the first public viewing of these panels:

> And this matter of perspective, in the first thing in which he showed it was in a small panel about a half braccio square, on which he made an exact picture [from outside] of the church of San Giovanni di Fierenze, and of that church he portrait as much as can be seen at a glance from the outside: and it seems that in order to portrait it he placed himself inside the middle door of Santa Maria del Fiore, some three braccia, done it with such delicacy, and with such accuracy in colour of the white and black marbles, that there is no miniaturist who could have done it better... picturing before once face that part of the piazza that the eye takes in.[58]

The panels have been taken into the Cathedral opposite San Giovanni and Shigeru Tsuji theorizes that Brunelleschi positioned himself inside the entrance of the dark church and, with the aid of a camera obscura, projected San Giovanni from this position, traced it and painted it. (Illustration 3.) In his studio, he filled in the sky with burnished silver to reflect the sky and clouds, in that way optimizing the illusion. Brunelleschi made a hole in the panel and asked the viewer to position himself in the piazza at the right distance, facing San Giovanni. The viewer was asked to look through the lentil-sized hole at the back of the panel while holding a mirror in the other hand which he could move in and out for focus. In this way the viewer saw the Cathedral correctly displayed from right to left, as the camera obscura would have reversed the image, and was able to simultaneously compare the original Cathedral to the mirror-image of the

Ill. 3 The Baptistry of San Giovanni as seen in perspective with the vanishing point. This is a perspectival construction schema by A. Parronchi, using both a plan and an elevation of the Baptistry.



painted panel. The viewing hole through the panel is the clue to the vanishing point. In his text Tsuji concludes:

> Also of significance are the fundamentals he incorporates from which emerge the important concepts of monocular perspective and perceptual depth effects through the homologous triangles described above. These developments where a major factor and inspiration in the realization of a formal perspective system for a realistic expression of form and depth.[59]

The viewer, looking through the lentil-sized hole in the back of the panel as though from inside the camera, sees his reflection in the mirror at a distance and recognizes the opening, through which he looks with one eye, as the vanishing point of the "monocular perspectiva" of the painting on the panel.

> Perspective creates distance between human beings and things, the first is the eye that sees, the second is the object seen, the third is the distance measured between them.[60]

What is being reflected in the mirror is the position of the subject who is holding the mirror and moving it back and forth, like a focusing lens, until he finds his individual focal point, and seeing in the cosmological infinity beyond his scope a vanishing point that becomes finite. The proof that two lines do meet in the distance and can be measured and controlled by his own design allows the observer to territorialize this space which has been defined by God or the Christian church. With perspective, the subject appropriates his own space. He observes, in the reflection of himself as subject in the mirror, the opening. The camera obscura as a mirror also becomes the mimetic model of propagation.

In time, the accumulation of our belief structures as woven threads leave patterns. Through the repetition of similar gestures our memory is engaged and reconstructs similar models. It was at this time that the Platonic model was rekindled. The evaporation of the material that created Pythagoras and, through him, Plato, now re-appropriates him to re-invest the infinite with the finite. All points or numbers are connecting value with all things. In Oackham's thoughts, knowledge is based on the real that exists outside the human mind, but its reality or mental construction as reality can only exist in the human mind. With this gesture as perspective, the double articulation of light or the double conduit brought the empirical perception and the inductive reasoning in the form of geometry together for a moment into a state of harmony.

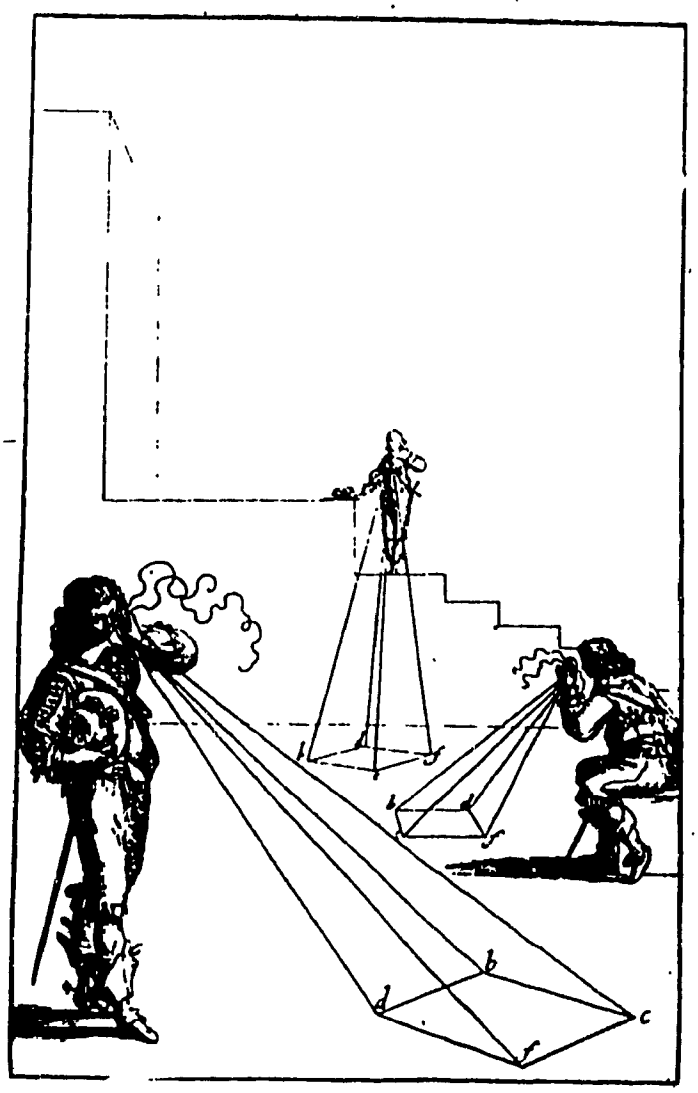
The camera obscura as gesture of the mind-space is the blueprint for a convention that became a measurable, quantifiable truth as perspective. Plato (425-347 BC), in the development of his own creation myth, adapts concepts from Pythagoras, reuniting concepts of religion and science: "The divine craftsman creates unchangeable forms, archetypes, which are the blueprint and pattern of the world."[61] As Panofsky stated: "The achievement of perspective is nothing other than a concrete expression (Ausdruck) of a contemporary...epistemology or natural philosophy..."[62] Gombrich, on the other hand, simply left the conversation more open with his comment: "Form and representation cannot be divorced from its purpose and the requirements of a society in which it gains currency."[63]

Brunelleschi's methodology was object-based and his conclusions were arrived at through empirical observation; the theoretical or synthetic constructional system of perspective was systematized by Leon Battista Alberti,[64] Brunelleschi's friend and theoretician whose multi-disciplinary formation included cartography, mathematics, geometry and humanist studies. This gave him the background to conceptualize practice into a system of rules.

Perspective defines the field in which the camera obscura is situated, and the camera obscura as subject defines the field of perspective. Instruments had been fabricated to take measurements inside the subject or camera obscura. The *instrumento-revalaiore* was recorded by Levi Ben Gerson (1288-1344) and used in measurements of solar and lunar eclipses.[65] These instruments of measure, as was the Egyptian string or Hypotenuse, were now taken out through the opening and extended to points in space in order to locate the position of an external object or the location and angle of a plane. (Illustration 4.) This artificial delineation and quantification of the physical world, the real world, had taken the geometric axioms of the plane and transliterated it into real space. As Damish suggests, "The nature if not the structure of the perspective paradigm is such that by necessity it imposed itself fully formed from the outset."[66]

The artists of the Renaissance studied Alberti's treatise on perspective published in *Book One* of *Della Pittura*. It was written in a style of logic with a method

Ill. 4 Abraham Bossé, *Les Perspecteurs*. Print from *La Manière Universelle de M. Desargues Pour Traiter la Perspective*. (1648)



of analysis and, at the end, a synthesis. This made it accessible to the specialist as well as the layman. Alberti advocates in this treatise that knowledge is primary to sensory perception. Consequently, man is both the point of departure as well as the centre of investigation. Nicolas of Cusa,[67] as he described it in his book *Idiota* written in 1450, saw the new intellectual problematics of this period: "To take measure of the empirical world: to weigh to clock to determine sizes, distances and weights, durations and speeds."[68]

Joan Gadol summarized well the disposition of Alberti in relationship to these challenges:

> This aim at once practical and abstract, was the objective of all Alberti's technical writings. All of them represent experience mathematically, for he extended to almost all technical problems that engaged him the same kind of geometric "seeing" that characterizes his aesthetic outlook. In art Alberti had fused perception and abstract mathematical ideas, to produce the kind of artistic form which he could regard as truly representative of nature. In the domain of physical problems, his mathematical imagination saw machines as similar instantiations of ideal, proportional rules.[69]

Rules originate from theory. New theories, made possible through the observing body, produced a new system of quantification through the plane (surface of moon, solar activity, curvature and path of the earth, its location or loci as observed in the eclipse) and insinuated the measurability of our own planet in the field of astronomy.

An imperative to connect terrestrial matter to the subject or man seems to be inscribed in the consciousness of this time. Explorers in their circumnavigation

connected continents by the observation of the stars and the discovery of a convention (perspective) connecting schematically all visually knowable things. The former is the Euclidean geometry of plane, experience of the physical navigation of space, and the latter results in the Euclidian projection or projective geometry of space which then is "reduced" back to a plane, to a less than three-dimensional equivalent in an effort to "expand" our knowledge.

By fulfilling Aquinas's prophesies that man, by expanding his knowledge, would become more god-like (Genius), a new authority was given to man's sense of sight as knowledge and self-knowledge which was also to become the new desired end.

The new measure of Truth now became certainty, in the form of vision through perspective, and gave entry to the artists, new scientists, and mathematicians through theory (this orphic Greek word was originally understood as passionate, sympathetic contemplation) into the "ecstatic space," as witnessed by those who were inspired by Pythagoras in their studies of mathematics and who believed that the formulation of a theorem was considered a religious experience. Russell in his philosophical deliberations states of this period that: "Mathematics retained an element of ecstatic revelation, an experience of intoxicating delight of sudden understanding."[70]

The camera obscura body, as a contemplative ideal, was constructed by the desire for secular truths as knowledge. Suspended in the exclamations surrounding the camera obscura, we witness the ecstatic revelations of truths.

Notes to Chapter 1.

1. Alpers, 12. Constantijn Huygens made this exclamation while describing the image of the camera obscura.

2. The plane of immanence describes well the parameters of truth erected by Greek and Medieval forbearers. Immanence is defined as: "A permanent abiding within; an indwelling. The presence of God pervading all creation." (Funk and Wagnal Dictionary, Toronto, 1973).

3. Gilles Deleuze and Felix Guattari, *What is Philosophy?* (New York: Columbia University Press, 1993) 54. Deleuze and Guattari argue that it is necessary to take the plane of immanence that is instituted and to separate from it the new concepts that are being created.

4. Douglas R. Hofstadter, *Goedel Esher Bach* (New York: Vintage Books, 1980) 87. Goedel has posited a difference between human and mechanical reasoning suggesting a discrepancy in the power of the living and non-living system which is mirrored in the discrepancy between notion of truth and theoremhood.

5. E.H. Gombrich, *Art and Illusion* (London: Phaidon Press, 1977) 276. J.J. Gibson conducted perceptual experiments in World War II with pilots and concluded that we are born with a capacity to interpret visual impressions in terms of a possible world, that is in terms of space and light.

6. Kenneth McLeish, *Key Ideas in Human Thought* (New York: Facts on File, 1993) 169. Concepts of the cosmos have, until the last 400 years, been constructed without any formal proofs or by what we describe as scientific methods. Before rational cosmology, one could nevertheless perceive familiar parameters being articulated, even though the form was that of myth and, in that sense, the beginning of a rational approach.

7. Geoffrey Parrinder, ed., World Religions (New York: Hamlyn Publishing Group, 1971) 155-56.

8. Morris Klein, *Mathematics in Western Culture* (New York: Oxford University Press, 1982) 40. Klein writes that Pythagoras believed the soul needed to be purified from the taint of the physical and redeemed from the prison of the body.

9. Klein, 15. Herodotus relates that in the fourteenth century B.C. King Sesostis had so divided the lands amongst his people that all Egyptian landowners were taxed according to the same-sized rectangles which increased or decreased in size according to the flooding of the Nile.

10. Richard L. Gregory, *The Oxford Companion to the Mind* (New York: Oxford University Press, 1987) 361. Inductive reasoning is commonly, but not always, in contrast with deductive reasoning. There is a transition in thought between one or more propositions (premises) and a further proposition (conclusion). The conclusion of deductive inference cannot be rejected without contradicting the thoughts contained in the premises, and are already in that sense contained in it.

11. Gregory, 211. The Egyptians were extremely practical in their concerns regarding science and mathematics. They tried to anticipate the gods and drew inductive conclusions between events in heaven and nature. In effect, in sacrifice, they looked, for example, at the colour and texture of the blood and the liver, drawing conclusions about future events from observation, or empirically. Their arithmetic multiplication was done with two-times tables like the present day computers, and their geometry was simple, practical and lacked any formal proof.

12. Richard Tarnas, *Passion of the Western Mind* (New York: Harmony Books, 1991) 22-23. The intellectual progress of the Greek was away from the mythical towards the naturalistic, creating in this way a dichotomy between religion and reason. Pythagoras, Tarnas believes, was motivated by this very seeming opposition towards a synthesis, as his reputation amongst the ancients was that of a man who was equally committed to both religion and science.

13. Bertrand Russell, *History of Western Philosophy* (London: George Allen & Unwin Ltd., 1974) 55. This view influenced Plato and Kant and most of the intermediate philosophers. Where the Declaration of Independence reads "we hold these truths to be self evident," it is modelling itself on Euclid. The eighteenth-Century doctrine of natural rights is a search for Euclidean axioms in politics. The form of Newton's Principia, despite its empirical material, is entirely dominated by Euclid.

14. Russell, 56. Mathematics is, I believe, the chief source of the belief in eternal and exact truth as well as in a super-sensible intelligible world. Geometry deals with exact circles, but no sensible object is exactly circular. This, Russell believes, suggests the view that all exact reasoning applies to ideal as opposed to sensible objects; it seems natural then to go further and suggest that thought is nobler than sense and the objects of thought are more real than sense-perception.

15. Russell, 55.

16. Stephen Morey Straker, *Kepler's Optics. A Study in the Development of Seventeenth-Century Natural Philosophy* (Ann Arbor, Michigan: Indiana University, U.M.I., 1971) 241. The purpose of Alberti's tract to apply geometrical rules to perspective, and therefore art, was to support the conclusion that painting is truly a liberal art since he was writing as a humanist; painting is the *istoria* which conveys genuine knowledge.

17. Wang Ling, *Science and Civilization in China*, Vol. 4, Part 1, (London: University of Cambridge Press, 1962) 81. When light arrives, the shadow disappears. But if it were not interfered with it would last forever. When there are two shadows there are two sources of light. Two rays of light grip to converge to one light-point and one shadow results from each point. This clearly indicates that the mohists appreciated the linearity of light rays.

18. M.S. Hammond, 17-18. In a work attributed to Aristotle, *Problemata*, in Book XV, the indication of the description of the projected crescent shape of the sun does not give us sufficient data to be able to say that this observation was made in an actual darkened room, ie. a camera obscura. However, the solution to image formation, although confused, comes at a time when an artistic vision of space by the Greeks has been developed to complement the conceptual geometry of Aristotle.

19. M.S. Hammond, 10-11. Euclid applied geometry to the theory of rectilinear propagation of light, equating straight lines with the visual ray and making this "perspective" the beginning of geometrical optics based on the concept that rays of light or vision follow a straight or rectilinear path if otherwise not obstructed at the opening.

20. John Henry Bridges, *The Life and Work of Roger Bacon* (London: Williams & Norgate, 1914) 103. Euclid was aware that light travels in straight lines but also worked with mirrors and suggested that visual rays where reflected from plane mirrors in such a way that the angles made with the surface on each side were equal. He conceived of the assemblage as a cone having its apex in the eye and its base in the boundary of the object.

21. Bridges, 103. Ptolemy carried this much further. To the study of reflected light he added the study of refracted light. Ptolemy, using experimental methods (the only other Greek to do so besides Pythagoras who experimented in acoustics), discovered the fact that luminous objects deflected through a medium and depended on two distinct factors, the angle of incident and the nature of the medium concerned, thereby explaining the error introduced by defraction in astronomical readings.

22. Straker, 78-84. Alhazen, in his treatise *Perspectiva*, remained identical to the geometry of Euclid's emission theory. They both made use of a visual pyramid having its base on the object seen in the vortex in the eye. The question remained whether the pyramid is the path of the ray of vision going out from the eye, or the path of the forms of light and colour entering the eye. In conclusion, Alhazen was able to demonstrate that all visible objects, whether they be self-luminous or dependent for their light on some other object, emit light from their surface along straight lines in such a way that between any point in the medium surrounding the luminous surface and all the points on that surface there exists a pyramid of light.

23. Joseph Needham, *Clerks and Craftsmen in China and the West* (Cambridge: Cambridge University Press, 1970) 15. The science and scientific thought of Arabic civilisation forms in one sense a unity with European science because, at the furthest extension of Islam, Arabic was the channel through which the Greek writings of the Ancients reached Medieval Europeans. All important Greek texts were translated into Arabic between the seventh and eleventh centuries and were translated back into Latin or Greek in the beginning of the twelfth century. Their influx was due to the continual Arab occupation, primarily of Spain and southern Italy. The texts brought to Spain were sent to different parts of Europe to be re-translated into Latin. Amongst these translators was Robert Grosseteste (born *c.*1175) of Suffolk, England.

24. George Sarton, *Introduction to the History of Science*, Vol. II, Part II, (Baltimore: William & Wilkins Comp., 1931) 583. Robert Grosseteste was the first chancellor of the University of Oxford, first lecturer to Oxford Franciscans (1224), Bishop of Lincoln, mathematician, astronomer, physicist, philosopher and translator from Greek to Latin. His insistence on basing natural philosophy on mathematics and experiment had a far-reaching effect not only on his famous student, Roger Bacon, but also on all of European history.

25. Straker, 101.

26. Lenn E. Goodman, *Avicenna* (London: Routledge, 1992) 49. The problem with the Arabic texts is that in their original translations they were frequently misunderstood as well as badly translated. The concepts in the originai manuscripts were elaborated on, or a number of different authors dealing with similar material were combined as was the case with Aristotle's and Plato's writings, forming a strong unified philosophy that became known as Neo-Platonic thought.

27. Straker, 101. Grosseteste had at his disposal the translated works of Euclid's Optics, Catoptrics, Alkindus's De aspectibus, the pseudo Euclidear De speculis, Aristotle's Metaphysics, and Meteorology, and Arithmatics of Boethius. These works argue effectively for the fundamental role of geometry in the study of causes. As Grosseteste argues, every natural agent acts in the same way as does a source of illumination; the agent sets out its "species" along geometrical lines.

28. M.S. Hammond, 43. In making the mathematical study of optics the foundation of all creation and all causation, Grosseteste brought a new enthusiasm to the study of optics among the natural philosophers of the 13th Century.

29. Straker, 104. Roger Bacon, according to Thorndike, "grieve[d] that the neglect of the science of optics by his age and [said] that it [had] not yet been lectured on at Paris, nor elsewhere among the latins, except twice at Oxford."

30. Bridges, 94. "Species" was the word chosen by Bacon to express the emanation

of force which he conceived to be continually proceeding from every bodily object in all directions.

31. M.S. Hammond, 44. Unlike Grosseteste, Bacon tried to find the phenomena that would best demonstrate the way in which the "species" were multiplied from "agent" to "patient." Bacon turned to the small aperture to investigate the propagation of light and to explore its action in producing heat and brightness.

32. Bridges, 101. Every kind of body is endowed with a force identical with its substance or essence. The first result is its force, resembling it in character, is its species (otherwise called likeness or image) or intention or impression. In other words, body is a centre of activity or force radiating in every direction. Species is the first result of this force, with rays extending from the body.

33. Bridges, 107-08. Bacon's text *Perspectiva* (1614) was most profoundly influenced by the writings of Alhazen, however the difference lies in the fact that Alhazen did not construct instruments for the purpose of increasing vision.

34. M.S. Hammond, 73. The astronomer William St. Cloud, who may in fact have been English, wrote in his almanac of 1292 about the camera obscura used for solar observation.

35. Helmut Gernsheim, *The Pre-History of Photography* (Oxford: University of Oxford Press, 1955) 3. Description of the fabrication of a camera obscura for solar eclipse observation.

36. Bridges, 42. It is important to realize that the scholastic philosophers from the eleventh to the thirteenth Centuries underwent a dramatic change. To pass from John of Salisbury, who knew nothing of Aristotle but his logic, to Aquinas who had studied and integrated Aristotelian attitudes and teachings into the christian doctrines was a dramatic change, not to mention the impact of the advanced concepts in mathematics of Euclid and biological studies of Galen that were previously unknown.

37. Tarnas, 186. The Realists believed that universals existed as real entities. The argument was whether the universal was real in the Platonic sense, as a transcendent ideal independent of the concrete particular, or in the Aristotelian sense, as an immanent form fully associated with its individual material embodiment.

38. Russell, 175. "Universals" is the concept that deals with naming. It divides into two possibilities. By the term universal, I mean that which is of such a nature as to be predicated of many subjects, and by individual, that which is not thus predicated. A human or man is called a universal which indicates a sort of thing, not as such the actual particular thing. It expresses that which is particular to that thing but not uniquely in that thing alone, i.e. universal.

39. Russell, 445. Thomas Aquinas (1255-1274) is regarded as the most important scholastic philosopher. His most important work, the *Summa Contra Gentiles*, was written from 1259 to 1264, and concerned itself with establishing the truth of the Christian religion by arguments addressed to a reader imagined not already to be a Christian but a man that was expected to be versed in the philosophy of the Arabs.

40. Tarnas, 180-190. In the *Summa*, Aquinas combined ancient scientific and philosophical achievements with Christian theology into a synthesis.

41. Tarnas, 191. Averroes (1126-1198) taught Aristotle's work without seeing the need or possibility to integrate it into the Christian faith.

42. Tarnas, 201. William of Oackham (1285-1349) was a British philosopher and priest born soon after Thomas Aquinas died in Surrey. He was at first at Oxford and later in Paris.

43. Russell, 462. Oackham kept the study of logic free of references to metaphysics and theology and, in this way, encouraged scientific research. Tarnas, suggested that Oackham's vision prefigures the path subsequently taken by the western mind as he believed the Church must be separated politically from the secular world in order to give both integrity and rightful freedom. (Tarnas, 208)

44. Tarnas, 208. With this new attitude came the embryonic foundation--epistemological and metaphysical as well as religious and political--which would be expressed through the Reformation, the Scientific Revolution and the Enlightenment.

45. Klein, 90. The concept of the relative, for example cosmological, model can best be expressed by the idea of a model that is based relative to the Christian text as opposed to empirical observation of the heavens and earth. Cosmos, a sixth-century monk, gave definition to a Christian cosmology in his work *Topographia Christiana* which was popular until the twelfth century. It was described as an earth-centred universe, a flat earth of conical shape, surrounded by a outer ring of fixed stars that was considered the premum mobil or prime mover.

46. Tarnas, 207. It was no accident that Buridan and Oresme, two of the most original scientific thinkers of the Middle Ages, worked in the Parisian Nominalist school (from existence of idea to existence of particular) in which Oackham had been the central influence. By eliminating the fixed correspondence between human concept and metaphysical reality, an alliance between the Nominalists and the Empiricists was made possible. This idea spread throughout the universities of the 14th Century.

47. When I use the expression "mind-space," I mean the idea of mind conceptually taking on "a place" in the same sense that the Church represented as a physical building a house for the spirit. It is in this sense that I suggest the preoccupation with this objectness of the camera obscura relates.

48. M.S. Hammond, (taken from Strong 1979) 388-349.

49. Straker, 433. In some manner or other, the form or species of visible objects has also to be received completely by the "visual spirit" of the optic nerve before vision is accomplished. The reception of these forms or species on the crystalline humour contributes only partially to vision; they must also pass beyond, up the optic nerve.

50. Hubert Damish, *The Origin of Perspective*, translated by John Goodman (London: M.I.T. Press, 1994) 168. Piero della Francesca used the concept of the lines of propagation as force; as related to species, becoming lines and angles to produce perspective.

51. M.S. Hammond, 101-105. The disregard for geometry in relationship to the notion of the camera obscura was in fact the problem of light and not of aperture. The idea of how a round image comes from a square hole became at this time a problem of philosophy and not of mathematics. This eventually led to an intellectual cul-de-sac.

52. Gombrich, 144. Instead of using the method of picture writing, he could create the illusion as if the sacred story was happening right in front of his very eyes. The friars exhorted to the people in their sermons to visualize in their mind the stories of the bible and, in that sense, put the story into the immediate present.

53. Erwin Panofsky, *Perspective as Symbolic Form* (New York: Zone Books, 1991) 16. Panofsky claimed that antique painters did not overlook Euclid's Eight's Axiom (which deals with parallel lines that never meet and which, however, are not dealt with in their entirety but rather regarded as segments that can extend as far as is necessary in either direction (Klein, 144)) and arrived at linear perspective "because that feeling for space which was seeking expression in the plastic arts simply did not demand a systematic space." The question remains: what was the circumstance that gave impetus to this feeling? See Hubert Damish, *The Origin of Perspective*, and Martin Kemp, *The Science of Art* (New Haven and London: Yale University Press, 1990).

54. Kemp, 9. Giotto, near the end of his life, was responsible for the first steps towards a geometrical system. This is supported by a highly-developed pattern of convergences for the ceiling of the painting *Confirmation of the Rule of St. Francis*, *c.*1325.

55. Kemp, 9. It is generally claimed that Fillipo Brunelleschi (1377-1446) was the inventor of perspective. Brunelleschi, as architect seeking a new architectural vocabulary, is reputed to have travelled to the old Roman ruins in Italy in an attempt to understand their building techniques and aesthetic spirit. For this purpose he needed to take measurements to create plans. One can only speculate that this tedious method and the attempt to work out new formulas for spanning large surfaces led to his speculations about a shorthand for accurate pictorial representation of measurable objects in space. He was certainly familiar with the concept of the camera obscura as he designed and

installed an aperture in the apex of the Duomo of Santa Maria del Fiore in Florence. I believe these two circumstances contributed to the invention of perspective.

56. Tarnas, 212.

57. M.S. Hammond, 111. A quote from Da Vinci's notebook illustrates his passion and belief in mathematics:

> Mathematical sciences are those which, through the senses, have a final degree of certainty. There are only two of them, of which the first is arithmetic and the second geometry. One deals with continuous quantities and the other with discontinuous ones. From them the perspective arises, which deals with all the functions and delights of the eye, with varied speculations, when one of the three mentioned: that is arithmetic and geometry and perspective is missing nothing can be achieved [...] is born of astronomy, which by means of the visual rays, with numbers and measure, establishes the distance of and size of celestial as well as terrestrial bodies.

58. Shigeru Tsuji, "Brunelleschi and the Camera Obscura," *Art History* Vol.13, No.3 (September 1990) 276-292. Antonio di Tuccio Manetti is the primary source on the life of Brunelleschi.

59. Tsuji, 289.

60. Panofsky, 66-67. Panofsky suggests that perspective is the result of a psycho-physiological space converted into a mathematical space. With the separation of man from God, he must have also become aware of the space he himself occupied and, in that way, became aware of the distance between himself and others and other material reality. The formula suggests that as soon as perspective ceased to be a technical and mathematical problem, it was bound to become all the more an artistic problem presenting an opportunity to self-determine the nature and the potential in this connective space.

61. Parrinder, 156.

62. Panofsky, 16. According to Christopher Woods, by suggesting that perspective is a concrete expression of epistemology or natural philosophy, a problem of philology arises. There is a lack of consistence between the degree of historical analysis and art, therefore creating an inconsistency. It is interesting to speculate on this idea as this thesis also is only a first attempt to bring the camera obscura out of the chronological closet into a broader field which, at this stage, surely suffers from many of these discrepancies.

63. Gombrich, 78.

64. John R. Spencer, trans. *Leon Battista Alberti on Painting* (New Haven, Connecticut and London: Yale University Press, 1966) 12. Leon Battista Alberti (1404-72), through his *Della Pittura*, influenced generations of artists, critics and historians from Piero Della Francesca and Leonardo da Vinci to Vasari taking up his cause, to the Du Fresne translation in Paris in 1651 which became the "authority" at the Paris Academy, finally reaching England in the 18th Century and noticeably influencing Hogarth, Reynolds and the Royal Academy.

65. M.S. Hammond, 85.

66. How I interpret this statement that Damish makes about perspective is the very essence of the formation of the camera obscura body, built around the opening. The opening is the desire for control of terrestrial materiality, it had become man's property to do with as he pleased. Perspective is the reconnaissance, the surveying and recording by truth, a legitimizing measure. It gave permission to the appropriation and bonding of the external and internal body.

67. Tarnas, 218. Nicolas of Cusa (1401-1464), Cardinal, Neo-Platonic philosopher and mathematician of the mid-fifteenth Century, proposed a moving earth as part of the centreless or omnicentred infinite Neo-Platonic universe. This was later expanded on by Copernicus.

68. Ioan Gadol, *Leon Battista Alberti, Universal Man* (Chicago: University of Chicago Press, 1973) 204-205. Cusa, in his book *Idiota*, discusses the measurements of the empirical world outside. In *On Learned Ignorance*, written in 1440 and republished in John F. Wippel and Allan B. Wolter, *Medieval Philosophy* (New York: The Free Press, 1969), Cusa considers the measurement of mind: "We consider that number is the mind's measurement of a multitude by a unit common to all, it would seem as though God, who is the unit, were multiplied in things, since his understanding is His being; and yet we know that any multiplication of that unit, is the infinite maximum unity, is impossible." (462) He discusses the contradiction between being nothing and being from God and concludes: "By contrast to go in our state of nothingness we are forced to admit our ignorance." God's unity embraces all things. He is plurality, He is what they are, like truth in an image. It is as if a face were producing its own image. With the multiplication of the image we get distant and close reproduction of the face (I do not mean distance in space but a gradual distance from the true face.) In the many different images of the face one face would appear in many different ways, but it would be an appearance that neither the sense nor the mind could recognize or understand.

69. Gadol, 205. Alberti, in *De re Aedificatoria and Ludi Mathematica*, describes ancient measuring devices recovered mainly from Vitruvius, but in his reconstruction of them you can feel the quickening of the mechanical mode of thought.

70. Russell, 53. Most sciences, at their inception, have been connected with some form of false belief which gave them fictitious value. Astronomy was connected with astrology, chemistry with alchemy, and mathematics was associated with a more refined type of error. Mathematical knowledge appeared to be certain, exact and applicable to the real world; moreover it was obtained by mere thinking and, consequently, it was thought to supply an ideal from which empirical knowledge fell short. Theology from its exact form takes its style from mathematics, and religion is derived from ecstasy, and both are found in Pythagoras. Mathematics is, I believe, the chief source of the belief in the eternal and exact truth as well as in a super-sensible intelligible world.

CHAPTER 2

Light: Carrier of Messages

Let there be light: divine will, divine source, divine home.

> Light fills our universe. In the deepest of night, in the farthest of space, light is there. Yet we are strangely unaware of its presence. It may be that, for humans, light is so central to our perception that nature is forced to make us aware of it. Processing light beams from all directions at all times would overload the circuits of the human brain. We interpret. We see not light but objects, constructed by the brain from information passed along the optic nerve. We construct shapes, colours, textures and motion....Often it is only the peculiarities of light's behaviour--the distorted views of objects underwater, the left handed image in a mirror, or the play of sunlight on water, that call our attention to the existence of something between an object and our consciousness.[1]

If Michael Sobel, professor of physics, described the contemporary conception of light, in terms of human perception, as that between material object and our consciousness--or connector of the material to the immaterial--Pythagoras's beliefs were diametrically opposite. The latter was concerned with:

> ...the value of the unseen unity of God [which] condemned the visible world [created by light] as false and illusive, a turbid medium in which the rays of heavenly light are broken and obscured in mist and darkness.[2]

Light, for Sobel, became the carrier of information about the material object or world to our consciousness. To Pythagoras, nothing was known of optics and the mechanism of the eye. Instead, he quantified the audio sense of sound through mathematics and made the harmonics of music, not light, the connective value to material

consciousness.[3] Instead of seeing the interdependence of light and matter in relationship to human consciousness, Pythagoras saw two separate realities that are exclusive of each other and are a case of matter versus light, like thought versus sense. These were the parameters within which western consciousness anatomized and constructed the nature and meaning of light significantly mediated through the camera obscura assemblage. A paradigm, and I mean it in the all-encompassing idea that Thomas Kuhn, in his book *The Structure of Scientific Revolutions*, suggests: a constellation of beliefs, values and techniques and, secondly, as models or examples in relationship to problems as a co-habitation of both the objective and subjective values.[4]

The camera obscura as subject has unfortunately suffered a Pythagorean ruptured fate at the hands of historians, with the exception of Svetlana Alpers and Jonathan Crary.[5] The materiality of the body denoted as machine or mechanism in the traditional sense is separated from the organ of light as optics, physics or art. In this chapter, I deconstruct and re-constitute the complex nature of this light that acts as both a conduit, through the opening of the camera obscura body, and as an intrinsic part of its assemblage as opening: organ and body.

Light, in the Aristotelian-Ptolemaic cosmological model (Illustration 5, figure 1), created a context for the senses between the heavens and earth. In this schema the earth was at the centre, surrounded by rings of water, air and, beyond that, fire. This "Celestial Sphere" was further extended by planetary rings and filled with a single

incorruptible element, having imperishable forms and perfect circular motion. This element, or almost tactile ether, filled the vaults of the heavens to the interior edge of the perfectly circular *premum mobil*; it engaged the stars and planets to move in circular motion. This circularity was the first cause of motion determining an orderly physical-ethereal finite universe ruled by eternal ideas or universals and which could be apprehended from sensory perceptions. Beyond the outer edge of the *premum mobil*, nothing existed but a void.[6]

Roger Bacon, in *Opus Majus*, observed and rationalized the circularity of light of the projected image through an aperture in accordance with its natural behaviour, the circular motion of the first cause:

> If it should be said that light entering through a large triangular opening...or another polygonal figure does not fall in spherical form, but does so when it enters through a small opening, we must state that the small sides of the small opening are not far apart and therefore the light in a short distance is able to regain its figure; but when it passes through a large figure, it cannot do so easily, but will do so at some sufficient distance, if obstacles are removed.[7]

The origin of the speculations inherent in the rotundity of light had not been explained from the metaphysical point of view. The difficulty lay at the juncture of the three possible primary origins of light in the cosmological model of the Middle Ages: the omnipresent divine light created before any luminous bodies of the cosmos,[8] the sun that was located on the fourth planetary ring, and the sphere of fire immediately surrounding the sphere of air connected by water to the earth. Seeing the sun through the fire must have created theological and cosmological conflicts, if not unexpressed

confusion, for early astronomers. It is for these reasons that I believe Grosseteste's divine light[9] and its proclivity to circularity can be associated with celestial organization and motion. The sun, on the other hand, became at this early date an example for the nature of light and not its only source.

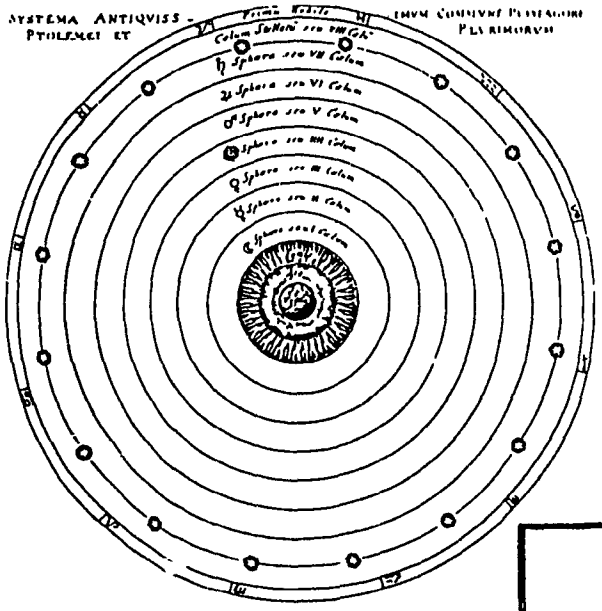
The ancient tactile cosmological space, united in the Middle Ages with the western tradition of the Book of Genesis, *Let There Be Light*, became the Neo-Platonic tradition of Augustine. Consequently, Christianity moved from a primitive tradition to an intellectual mysticism based on the metaphysical relationship between God and light.[10] The speculations surrounding the nature of this light became one of the preoccupations of the search for the rational cause of origin.

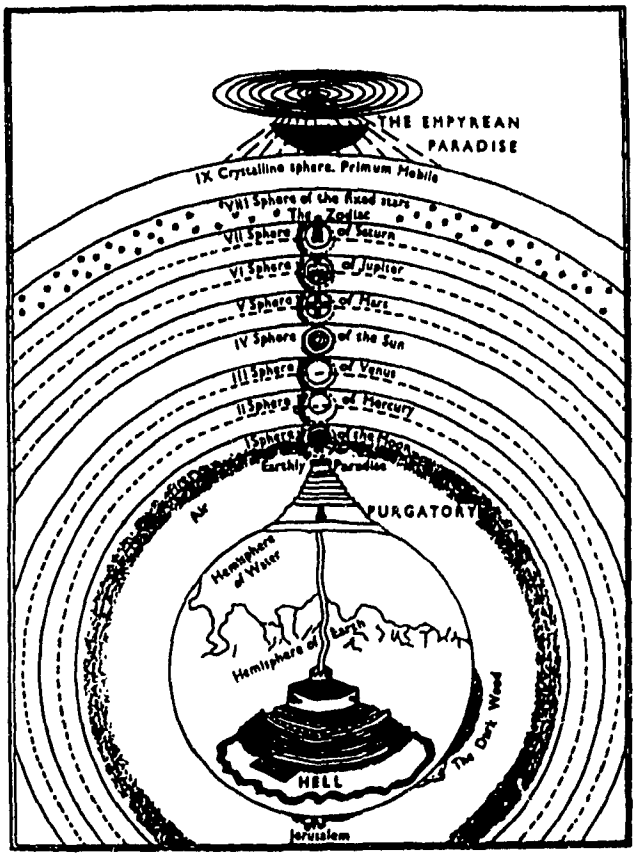
The first step towards a new rationalization was the modification of the Christian Medieval cosmological model by Anselm, Archbishop of Canterbury in the eleventh century, who introduced a superior, outermost ring that he named the Empyrean.[11] (Illustration 5, figure 2.) It consisted of the purest fire and was the place where God dwelt. Anselm essentially took fire, one of the four corruptible elements of Greek metaphysics,[12] and, associating it with divine will by displacing it from the immediate vicinity of the earth to beyond the outer edge of the *premum mobil*, extended in this way the transcended worldly material of fire to demarcate the finiteness of the heavenly universe. This is a beautiful and significant metaphor for the physical body

Ill. 5

Fig. 1 The Aristotelian-Ptolemaic cosmological system.

Fig. 2 Dante's cosmological system according to *The Divine Comedy*.





rising as a cause of elemental change. In this way, the seat of the worldly creator became materially connected to the earth.[13]

Anselm's decision to move the ring of fire out to the edge of the *premum mobil* created a clear path between man and the sun. However, the question of the origin of light was still not completely resolved. Dante's cosmology,[14] which he constructed for *The Divine Comedy*, was designed after Anselm. For Dante, the divine light became the "sun" of the Empyrian paradise at the outer edge of the crystalline sphere of the *premum mobil*, giving specificity to divine light as the new sun overlooking and able to penetrate through the clear "lens" of the *premum mobil*.

Roger Bacon's second speculation on the rotundity of light in the *De Multiplicatines Specierum* chose not the divine light as subject, but rather the more empirically accessible light of the planetary sun. To this natural source he introduced Grosseteste's concept of the propagation of species which made light into the purest and most perfect expression of natural agent, exerting its proper power of movement and its ability to change, to bind and to disappear.[15] Bacon more specifically suggested that the circularity of light was a direct expression of origin as the sun and the roundness of the sun as roundness or circularity was the first cause of motion. In this sense, light became the paradigm of activity itself.

> Through an oblong or multi-cornered aperture is incident in a shape conforming to the shape of the aperture, especially if the aperture is rather larger, since it is too small the light is incident in a round figure....Although in a small distance the light does not assume the

> required [circular] shape, it does acquire this shape in a sufficient distance. For the larger the aperture the greater the distance [required] for it to assume this shape, since the large dimensions of a many-sided aperture are more elongated from the circle and sphere....The species of the sun would become equal to the portion of the sun multiplying the species....For the angles of the two triangles, which have as bases the cord of the portion of the sun multiplying the species and the cord of the species falling on the wall, are equal since they are vertically opposite; and by hypothesis the sides of those triangles are equal. Consequently the bases which are the cords of portions of the sun and of the species of those portions, are equal.[16]

This tract demonstrates how the rational geometric axioms were integrated to prove metaphysical beliefs in the natural expression and origin of light and locates the sun as the source--something visible, measurable and finite.

After Bacon, both Witelo and John Pecham[17] continued to understand the origin and the origin of species and circularity in this way.

Anselm's metaphysical beliefs were strongly influenced by the rational methods of dialectics[18] which he had learned at Oxford, the leading European centre of mathematical studies in the Middle Ages. It seems appropriate that he applied this thinking to the mechanical prototype of the *premum mobil.* With causal logic, he conceived of the Empyrean outer ring of fire as the action of heat, creating movement for the *premum mobil.* I also say this because Bacon, as we have seen in the previous chapter, simultaneously studied light and heat as forces moving through matter. Anselm, I believe, set up a relationship inside the Empyrean cosmological model as a mechanically elemental cause of motion for the *premum mobil* and designated it God's seat, thus

establishing a very prophetic relationship in terms of light as divine will and identity, as divine home and earthly materiality, and as divine source and causal mechanical action.[19]

I would like to suggest here that the teleology of light, captured through the aperture by Grosseteste in the twelfth century and subsequently contemplated by others through the opening of the camera obscura body, was also charged at this early date with values other than natural behaviour and that its optical characteristics were stratified by geometry. In fact, these values created the assemblage of the camera obscura through light:

1) The opening: divine will and identity.

2) The organ: divine source and mechanical action.

3) The body: divine home and earthly materiality.

These light values are pivotal to the unfolding of the camera obscura potential as a paradigm.

It is in this spirit that I would like to discuss the concept of divine light as the carrier of messages in the McLuhanistic sense of the notion of "hybrid energy": light carrying identity through the opening, depositing mechanical action onto the organ and constituting the body with earthly material reality.[20] In the eleventh century, this concept "having been put out, now has to be thought out"[21] through the camera obscura.

I have associated these three messages in light with the most important events related to light and the camera obscura:

1) the formation of the "image" or pictorial identity as opening;

2) the re-evaluation of "celestial motions" or mechanical action of the organ; and

3) the relationship of the camera obscura to the "eye", earthly materiality of the body.

But first, I would like to introduce light in the camera obscura through the parable of Plato's *Cave*.

I have long been fascinated with this text, paraphrased below, as a parable because it brings together many elements of the camera obscura. It is at once a place and a home, an inside and an outside and, in fact, becomes meaningful only because the two are connected by an opening and their value is in relationship to each other. Low light, brightness, the fixed gaze, the darkness, the problems of mimesis, the dilemma of illusion and reality and Platonic perceptions of the world, light as divine and light as knowledge are all characteristic of the camera obscura experience.

The Parable (paraphrased):

> Men are sitting as prisoners at the bottom of a cave, their heads and bodies fixed by chains. They can only look ahead. Light comes from fire above the cave where other men are walking, talking and carrying artifacts back and forth. The

shadows from these objects and men above are the prisoners' only reference to a dimly lit visual reality. They are the convention of knowing. One of the prisoners is allowed to leave the cave. The bright sun at first is a painful experience. In the full light of the day he can at first only recognize shadows, then the outline of faces and in time all and every detail of reality is perceived through the light of day. Knowledge as memory eliminates the night. Despite the first harsh pain of light, the ex-prisoner would endure anything rather then be forced to live in the underworld of the shadows and its illusion again.[22]

Although many interpretations of Plato's *Cave* have been given, I would like to single out two. The first one is by Santillana, a scientific historian who related the parable to the study of light as optics:

> It starts from the Platonic analogy of God, with the sun that is set forth in the myth of the Cave. It pursues the analogy to suggest that, as God is the life of the soul, so the physical world is held together and animated by the force of light and heat, which should turn out to be, as it were, the ultimate constituent of reality....There are minds to whom the geometrical virtues of the light ray, its sovereign diffusion and instantaneous transmission, are symbols of its closeness to creative omnipotence, and intimations of its mysterious role as a prime element.[23]

This interpretation is in relationship to Ancient and Christian perceptions of light.[24]

The second analysis, by Luce Irigaray, a psychoanalyst, relates the cave to the perceptual and psychological condition in the profile of the prisoner as subject, captive to the manifestation of reality through light and shadow:

A Fire in the Image of A Sun.

> They have been given light, however it comes from a fire burning at a distance behind them. A light but artificial and earthly. A weak light, and one that offers the eyes poor visibility, far from ideal conditions for seeing and for being seen. Its distance and particularly its position in relation to the prisoners control the play of shadow in a specific way. Light that gives little light, that produces only shadows, reflections fantasies, all of which are bigger than the objects figured in this way. Given the lights situation to the object and the prisoners gaze. A fire...at a distance...like natural daylight from afar...but meant to be only a reproduction and artful reproduction of sunlight inside this translation. A fire lighted by the hand of man in the image of the sun. A topographic mime, but one whose process of repetition, reproduction, is always already multiplying doubled up, divided scaled down and demented, with no possible recourse to a first time, a first model. For if the cave is made in the image of the world, the world is equally the image of the cave. In "cave" or "world" all that is but the image of the image. This cave is always already an attempt to represent another cave. The mold which silently dictates all replicas, all possible forms and between forms all replica.[25]

Santillana speaks for the persistent interest in light as origin through optics (Witelo, Pecham and Kepler). Irigaray, on the other hand, speaks primarily for the visual artist. Those visual artists most associated with the camera obscura are Vermeer, Canaletto and Da Vinci.[26] The specific circumstances of the camera obscura assemblage created a particular psychological and perceptual condition for light. The painters' interest in the camera obscura image also reflected their inquiry into origin as expressed through mimetic nature or the propagation of light as the projected image.

Opening: image, identity, divine will.

Light as conduit of meaning enters the body of the camera obscura and deposits an image at its point of resolution. The receptive surface or plane of consistency becomes the organ of the body, first through the meaning or stratification in light. Epicurus provided the earliest stratification of image formation:

> There are solid molds corresponding to all solid bodies, preserving the same shape and arrangement as these bodies which emanate from them, and are conveyed through space with incredible velocity. These may be called images. Their flow from bodies is continuous so that they are not separately perceived. (Epicurus, 306 BC)[27]

The stratification of light through the camera obscura opening had both internal and external consequences. Its externalized manifestation as image became perspective. Hubert Damish argues that, although the perspective image and the camera obscura image rely on similar reasoning (which I posit is due to their ontological relationship), they are fundamentally different.[28] Damish appreciates the projected image as shadow rather than as projected light. He states that the camera obscura is different from the perspectival image since one is projected shadow, the other uses direct light. One exists in darkness, the other in light. I believe they are different but connected through the same opening: an inside and an outside. Also, the upside-downess of the image is connected to our convention of seeing, just as the image projected down on a table is located in a different visual plane and has no upside-downess to it. The image can also be projected on a ceiling where there is no up or down. It is only when it is brought into the reference of the easel view that, without a lens, the image is upside

down. The lens does become an important part of the body to right the easel image. I think the division between the camera obscura and perspective is reactionary, typical of the conditioned attitude that one has to chose one over the other. I cannot completely agree with the ambition of this separation, especially since they share the same opening through which perception, ideology, psychology and circumstance pass in both directions. I cannot agree with the value of separating the object from its construction since I understand its construction as its value. I do agree, however, that the image inside the camera obscura is different from the perspectival resolution of a painting. I suggest that the visualization of this internal reality of the image is completely interlocked, similar but different, with its external counterpart.

Alberti's analogy of the perspective image as the plane formed at the point where the double cones of light intersect has some echoes here.[29] In the case of perspective, the canvas acts as the memory mediated by vision and the mind. The image is fixed two-dimensionally and exists without the visibility of its constructional support. It is the organ freed of the body, existing without time. In the case of the camera obscura image, its temporal quality as a photonic image exists in a permanent body in time. The invisible body and the separated organ of perspective and the temporal organ and the visible body of the camera obscura are mirror reflections of each other belonging to an extended body that incorporates them both. In fact, they are the double cone or double articulation of light in which perspective is just one of its many potential quantitative manifestations.

The double cone extends equally to the relative notion of vérité. An astronomer, viewing the projected image of the sun, moon or bright stars, would consider the image not as an illusion of the real thing but rather as the closest material confrontation with the object of his inquiry. This observer would appropriate the image by the quantification of light with abstract values, for example, degree of eclipse or movement as speed in time.

The observer has a very different relationship to the image when terrestrial reality is projected. The problems inscribed in compressing the materiality of the real to that of pictorial representation carry those truths that describe the qualitative phenomena of the real world in the nature of light into the camera obscura. The observer's experience of the real object brings to the projected image material and psychological experiences, desires and expectations. These have to be de-coded and re-invented through the material metaphor. This is the double conduit and articulation represented by the double cone of light as quantification and abstraction and as de-coded or re-invented visual metaphor--a combination of Structuralism and Gestalt Theory.[30]

Leonardo da Vinci was the first painter to take a profound interest in the nature of the camera obscura image for its own sake. Da Vinci was equally interested in the nature of the image as perspectival constructions. The inquiry into the external and internal nature of the camera obscura image was intended to contribute to the fulfilment of the desire for and manifestation of the perfect mimetic moment.[31] Da

Vinci wanted the observer to mistake his paintings for the real. He made a relationship with the mirror image which, to the uninitiated, would be so real that they would be convinced of its continuity on the other side of the silvered surface. Da Vinci looked into both sides of the double cone of light and this internal and external nature became metaphorically expressed in his paintings.

Da Vinci understood the principles of linear perspective and extended these into a number of different spacial propositions. His invention of the anamorphic drawing tested the malleable potential of form on a plane, extending and compressing time and space.[32] This clearly indicates his grasp of the double articulation of space as time through movement. Da Vinci's preoccupation with the reflected image of the camera obscura was a manifestation of his fascination not only with the physiology of the eye, to which he attributed similar characteristics, but more so as an opportunity to study the phenomenology of vision connected to the relationship of objects in space and objects in image. As he separated and extended line into unconventional perceptions with the anamorphic drawing, so he separated light as a translucent coloured skin connecting all objects in space. What he observed in the camera obscura image was the unity of light as colour and coloured light as a unifier. The photonic mimetic skin that he stretched out over space and the objects in his paintings is remarkable for the veils of translucent and physically immaterial colour he observed in the camera obscura.[33]

The yet unquantifiable materiality of this photonic image convinced Da Vinci that visual perception was perhaps more accurate than theoretical (mathematical) reconstitution and so, for a time, he concentrated on empirical experiments and observations from the projected image. Its illusive transparency and immaterial materiality impressed upon him the vulnerability of light as one colour reflected into another.

> ...by transmitting the images of objects and colours of bodies illuminated by sunlight through a small round perforation and into a dark chamber onto a plane surface, which itself is quite white, ...
>
> The surface of a body assumes in some degree the hue of those around it. The colours of illuminated objects are reflected from the surface of one to the other in various spots, according to the various positions of those objects...but everything will be upside down. (Leonardo da Vinci)[34]

This is the first empirical observation of the interaction of light as colour in relationship to the objects of the real world represented in the image mediated by the camera obscura.

No doubt Da Vinci would have seen many times what I saw in my observation of the camera obscura image. There are no sharp hard edges to objects or clear separations between objects and space in the projected image, even more so before a lens would be installed. This characteristic fuzzy edge in painting, annotated by broken lines in drawings of the object, is considered by many to be Da Vinci's invention, termed *sfumato*.[35] It was, I think, more a discovery through observation than an invention. He observed blurred lines and mellow colours that allowed one form to merge with another, thus solving the problem of the painting's rigid outline and creating a more uniform pictorial space, now primarily motivated by light.

> If the outline is not quite so firmly drawn, if the form is left a little vague, as though disappearing into the shadow, the impression of dryness and stiffness will be avoided. (Leonardo da Vinci)[36]

The separateness of object from space was arbitrated by the continuous flow and movement of light.

Unlike the astronomer's joy at seeing and manipulating the projection of the untouchable, the frustrations with the camera obscura in observing terrestrial reality at the time of Da Vinci were many. First, there was a problem of monocular vision. Da Vinci understood and wrote on the concept of binocular vision[37] with which he became more involved after 1508-09:

> Painters often fall into despair...when they see that their paintings lack the roundness and the liveliness which we find in objects seen in the mirror...but it is impossible for painting to look as rounded as a mirror image...except if you look at both with one eye only.[38]

He investigated the consequences of the eye not being as mobile as a camera. I believe these investigations led him to construct, perhaps in somewhat exaggerated a manner, two divergent landscape views which he placed effectively as background to the *Mona Lisa* in an attempt to create a greater perceptual sense of real depth.

The second problem with the projected image was that it was not quite as sharp as ordinary vision due to the lack of a lens or of a good lens. Also problematic for Da Vinci was the problem of left/right and upside-down reversal of the image--a small

coincidence, irony, or intention considering that he wrote his notebooks in mirror handwriting. Da Vinci's desire to improve the image motivated him to apply the lens in front of the opening. Unfortunately, at that time lenses where convex and either of very bad quality glass[39] or made from glass containers filled with water that gave unfocussed, blurred and distorted results. For these reasons he abandoned the study of "eye" or camera obscura and went back to his former beliefs, concentrating on geometry and mathematics in search of certainty:

> Mathematical sciences are those that through the senses have a final degree of certainty. There are only two of them, of which the first is arithmetic, the second geometry. One deals with discontinuous quantities, the other with continuous ones...without arithmetic, geometry and perspective... nothing can be achieved...is born astronomy, which by means of the visual rays, with numbers and measure, establishes the distance and size of the terrestrial as well as celestial bodies.[40]

Organ: celestial motion, mechanical action, divine source.

During the Renaissance, stars and celestial bodies, their movemental behaviour and the nature of their surfaces were being more accurately quantified by observations in the camera obscura--sun spots, lunar and solar, as well as planetary motion and eclipses.[41] It seems almost unbelievable today that it could have been dark enough and clear enough to see bright stars projected in the camera obscura. The Danish astronomer, Tycho Brahae, wrote in 1600:

> The moon is not as splendid and does not shine as notably as the sun...which in the instrument by means of the pinnule or central illumination [through the aperture] of the pinnule can be discerned with

> little doubt...is more difficult to observe than the sun or even than some stars which are observed precisely enough through the dioptral slit.[42]

Inevitable discrepancies were noticed between the rational quantification from observation by astronomers and the desire to sustain ideological coherence of the theological cosmos. In the beginning, these two ongoing developing models became almost imperceptibly unsynchronized. This was primarily because theological and secular vision were transmitted through the same ideological filter. However, in time, the two cosmological conceptions reached critical disparity and distance.

The fact that theology had put into question the earth's centredness, the consequence of Oackham's Razor, and the growing disparity observed in astronomical calculations were perhaps paradoxically causal to the tremendous astronomical activity determined to prove that the earth was still at the centre of the universe. This was evidenced by the persistence of the old Ptolemaic cosmological model.[43] The more effort put forward in gathering proofs from the naked eye as well as from camera obscura image observation, the greater the discrepancies between the idealized and the emerging empirical models.

John Tolhpf (1440-1480), a German astronomer, presented his problems in 1476. If the universe revolves around a stationary earth, why were the moon and the sun simply not moving in concentric rings? Why did the major planets stop and seem to retrace their paths in an elliptical, eccentric fashion?[44]

The heavens as the mechanical prototype were no longer harmonic. Astronomer Nicolaus Copernicus was aware of these problems and decided to create a sun-centred cosmology. The heliocentric system was designed as a hypothetical concept for aesthetic and Neo-Platonic rather than factual reasons. Copernicus is reputed to have been more interested in the experience of the senses and observation since he also painted.[45] This intuitive mechanical and aesthetic rationalization was only later confirmed by Galileo but not accepted until Kepler.[46]

The heliocentric or sun-centred celestial model of 1521-1514, created by Copernicus, was significant for its correspondence to light as the new cosmological centre. It became the new relative measure of the location of the earth, the singular planetary source of light. The necessity of remaking the old *a priori* mechanical model of the *premum mobil* provoked great consciousness of the earth moving around the sun, in Kepler's words, "moving around it in adoration."[47]

For this reason, light, up to then associated with the divine, was beginning to be invested with secular potential and referred back to pagan beliefs connected with the worship of the sun.[48] This new light also marked a new period of historical vision. While the Medieval historical concept saw history divided into before-Christ and after-Christ, the Renaissance saw itself as a separated, third, modern addition.[49]

This break of divine and secular light created a rupture in the coherence between the secular mind and Christian truth. Tarnas describes this as:

> Hence the world could now be apprehended and analyzed not according to its assumed sacramental participation in "static" divine patterning in the Neo-Platonic and Scholastic thought, but according to distinct material processes, devoid in direct reference with God.[50]

If there was very little activity in the fifteenth century regarding the camera obscura, the sixteenth century, re-invigorated by its orientation towards the secular sun, was tremendously stimulated by the invention of the Gutenberg press. Texts became more readily available to an ever-broadening public. Publications on optics and the camera obscura became more widely accessible. Treatises of Alhazan's *Perspectiva*, Risner's *Opticae Thesaurus*, Witelo's *Perspectiva* and John Pecham's *Perspectiva Communis*[51] which was particularly dedicated to image formation, stimulated inquiry in the field. Discussions of the camera obscura as applied to image formation, astronomy and human vision with its theoretical and experimental consequences, became central to new independent secular groups of scholars and professional practitioners.

Giovanni Battista della Porta, a sixteenth-century Neapolitan nobleman, published an account of the camera obscura in his *Magia Naturalis Libri IIII* (1558) and popularized it as a quasi-magical event. As well, Daniello Barbaro (1514-1570) was trained at the University of Padua as a Euclidean scholar and had been exposed to the Aristotelian-Averroist[52] philosophy of vision. As a humanist he was able to compile and translate original documents. In his optical speculations regarding vision, he made an

indirect connection between human vision, the lens and the camera obscura and described in great detail the most ideal opening or aperture and the most ideal type of lens to be placed at the opening of the camera obscura to improve image resolution in his *La Practica della Perspectiva*. In della Porta's second edition of *Magia Naturalis*, he incorporated both a mirror and a lens:

> Now I will declare what I ever concealed till now, and thought to conceal continually. If you place a lenticular Crystal glass to the hole, you shall presently see all things clearer, the countenances of men walking, the colours and all things as if you stood by; you shall see them with so much pleasure, that those that see it can never enough admire it.[53]

The lens changed the camera obscura from an open sign to a quantifiable sign. The aperture without a lens permitted light to travel through it in both directions. Light entered, but also allowed vision to exit. The double conduit of light was unimpeded. The addition of the lens as the mechanism that manipulated and controlled the behaviour of light changed the nature of the double conduit. Light, with its own mechanical potential stratified by the material characteristic of the lens, was no longer naturally directed towards its subject but was, at the same time, artfully or artificially controlling the resolution of the image. The double conduit of light was then clearly between the artificer and the projected image and the presence of the latter became more and more a part of the path and direction that the conduit of light would take.

Da Vinci had made experiments tracing the path of light through transparent, dense, spherical objects related to the liquid humours of the eye in

relationship to the camera as an eye. In the latter part of the fifteenth century and all through the sixteenth century, these became common experiments in private workshops and laboratories. The works of Daniello Barbaro and Giovanni Battista della Porta are examples of this. *Magia Naturalis*[54] is full of observations and experiments of this kind with diverse glasses and mirrors. The refractive properties of light travelling through mediums was beginning to be mapped and geometrically understood. Della Porta wrote about it in *De Refractione* (1539) and described the point of convergence and divergence of the lens. Also important to note was the first appearance of an engraving illustrating a room camera obscura, published by Gemma-Frisius in 1544 in *De Radio Astronomica et Geometrico*.[55]

Most important, however, were the physical modifications to the camera obscura body. The introduction of the lens and the mirror solved some of Da Vinci's frustrations as the lens and mirror positioned the image right-side-up and improved the quality of its resolution, making it sharper and brighter and therefore closer to the experience of human vision.

Body: eye, earthly materiality, divine home.

It was at the end of this frantic period of activity surrounding the camera obscura that Kepler made the first concrete relationship between the structure of the eye and the camera obscura. In order to make a true relationship to the eye, Kepler had to

consider the effect of three actions: the nature of light, the ability to stimulate vision, and the definition of the optician. This was also the first quantitative relationship established through light between the camera obscura, the created object as a mechanism of vision, and the mechanism of vision or the eye of the observer. This marks an important moment when the identity of self as observer merged with the secular mechanism of vision. A brief physiological and optical history which preceded Kepler will help to contextualize this dramatic moment as disseminated through his *Dioptrice* of 1611.

Euclid, in his *Emission Theory*, considered vision to be rays going out from the eye, scanning objects and, in this way, receiving visual information about the world. Grosseteste, in his study of optics, inverted the origin of the ray and suggested that vision was created by light coming from a point on the surface of the object to the eye. The ray consisted of a pyramid shape that had its base in the real world and its apex, or top, in the eye where it focused its beam. He posited that all rays that come to the eye in this manner are perpendicular to the crystalline humour, or liquid, in the eye. The problem of what occurs to overlapping pyramids of vision as the observer moves from one point to another, seemingly causing confusion, was answered by Bacon.[56] Only true perpendicular rays directly lined up with the eye would succeed in penetrating the crystalline humour and have sufficient force to enter the optic nerve. Those rays, coming at the eye obliquely because of defraction, were cancelled out, making them too weak and ineffective for vision.

After Bacon, Pecham concentrated on the perpendicular ray, saying that it was the "prince of vision" becoming the "only one ray" concept.[57] This one, or axial, or centric ray scanned the entire surface of the object. Alberti constructed his artist's perspective on this concept of vision. He placed the conical base of this monocular ray on the surfaces of the real world and located the apex of the ray in the observer's eye. The concept expressed was that points seen would directly stimulate points in the eye in order to achieve clear vision. The Renaissance had a one object, one point, to one ray of vision concept:

> Pyramid of radiation manifests the object to the eye....For although the whole pyramid is perpendicular to the centre of the eye, that is the glacial humour, it is not perpendicular to the whole eye. Therefore only the perpendicular [ray] called the "axis" which is not refracted, manifests the object. The closer other rays are to this one the better able they are to manifest the object. (Pecham, *Perspectiva Communis*)[58]

In order to explain vision "in the eye," a screen had to be located. For a number of reasons, the crystalline humour was suggested to be the possible "seat of vision" in the visual organ of the eye. However, it was impossible to rationalize this satisfactorily with the existing theories.

Kepler, who had been using the camera obscura to measure the degree of an eclipse, found that there was a discrepancy between naked-eye and camera obscura observations. This disparity motivated him to investigate the underlying principles of the mechanism of the camera obscura. The only difference he discovered between the camera obscura and the naked eye was the larger the opening in the human eye, the

better, up to a point, the vision. The image in the camera obscura, however, worked paradoxically; the bigger the opening, the less clear and fuzzy the image. Also, to understand the relationship between the ray of light coming through the opening and the formation of the image, Kepler drew on his experience of having made panoramic drawings of terrestrial landscapes in his camera obscura tent.[59] He made associations between the projected image as though pencilled point-by-point with nature. Kepler made an analogy with a pencil point of nature and equated each point in the real world with a point in the projected image. The image was therefore the result of a simple rectilinear propagation of light. With this understanding, Kepler set out to learn about the organ of vision through contemporary anatomical studies.[60]

Kepler's study of the anatomy of the organ began first with disassociating himself from the metaphysical notion of the pyramid and cone action that implied only certain rays, such as articulated in the pyramidal theory of Bacon, and went for the point-to-point rectilinear propagation of light as experienced in his own observation with the camera obscura. With evidence found in the studies of anatomy he concluded that since vision was not impaired when the crystalline humour was damaged, this humour could therefore not be the screen of vision. The only other logical place after examining detailed drawings of the eye was the retina[61] as it was attached by a profusion of nerve connections to the optic nerve. With the retina as the screen, he recognized that the vitreous humour acts like a lens which focuses the image to a point and places that point onto the retina. In this way, point-to-point rectilinear propagation of vision was achieved

and a direct luminous mathematical point replication of the image of the real world resulted. The opening of the camera obscura as related to the pupil of the eye now made sense and vision gained status as an apparatus of quantification, without mystical properties.[62] The physician Johanne Brengger commented on Kepler's conclusions:

> The mean of vision you explain skilfully and elegantly in which you surpass by your diligence all those who have written on this topic before you. From what I had seen earlier on the use of the camera obscura by Jo.Bapt. Porta (which you have recalled to me and is certainly a most beautiful spectacle) I had always convinced myself that vision was accomplished by the reception of the species of visible things on the retina. It held me in some doubt however since all things would be received there inverted, whereas vision is accomplished directly.[63]

Kepler's experiments provided the explanation. Light, as it passes into the humour, goes through the process of refraction. As it leaves the humour, it settles on the curved surface of the retina where it gets re-inverted and reversed from left to right.

It must be remembered that Kepler was motivated to examine the camera obscura and the optical nature of vision as a means of finding more accurate measurements in the development of better astronomical instruments of observation. Kepler's findings also gave new direction and understanding to the optician. Where previously the lens was thought to slow down or speed up the visual ray in the medium of the crystalline humour, it now appeared to be a matter of correcting any imperfection with the focusing capacity of the humour which Kepler considered to be like a lens.[64]

The camera obscura assemblage as an instrument of observation performed a new function with the lens. This assemblage had broken through the *premum mobil* of the Middle Ages and brought the celestial infinity onto the plane as astronomy, and it had done so with terrestrial reality. With the lens closing the camera obscura body, the captured, controlled light seemed to offer an opportunity to examine its controversial nature. Somehow, light had brought images of distant and nearby objects onto the same plane. However, the question as to the nature of its movement or, indeed, the constitution of its materiality, had never fully been answered. If Kepler more clearly understood the concept of vision that had been understood before him, his attempt to apply physical motion to optics was less successful. The problem was that he believed that light itself was an immaterial entity and, like Descartes, he supposed that light simply had a tendency to motion, not motion itself.[65]

Sir Isaac Newton, although he adopted Kepler's concept of linear propagation of light, concluded however that light was corpuscular, like bullets in motion.[66] He believed that the bending of light rays through the prism was caused by the interaction of light particles and the edge of the aperture. This action was known as defraction. Unlike Descartes whose understanding of light was grounded in geometry, Newton's speculations on light were force oriented because corpuscular light had mechanical properties, decreeing this force the Divine Will, a mechanism that worked automatically without further interference. Newton became the last proponent of the classical particle model which he published in 1704.[67]

Having passed through the camera obscura assemblage, both Kepler and Newton made it possible through their conclusions to quantify the agent and the patient: the light projected from the sun and the light received on the retina. What this meant specifically for the camera obscura image was its potential as the optical apparatus of vision to give parameters to the investigation of the mechanism of perception within the frame of quantification and certainty. For the painter, the new material concepts in light as well as the prismatic separation of light into its spectral component colours by Newton gave light a tangible structural and repeatable reality for the first time. This new structure, in relation to its connection with the visual organ of the body, extended the concept of territorialization of the visual field into the body of the observer as perceiver and as home.

The observations and speculations of light from cosmological order and origin to the arrival within the visual organ of the observer precipitated a whole new dynamic of meaning for light. The quantifiable unity of light and matter had broken the spell of Pythagoras. From observation to perception, a new conception of the visual world was initiated and what had been the natural philosophy of the Renaissance became the philosophy of nature in the Age of Enlightenment.[68]

Notes to Chapter 2.

1. Michael I. Sobel, *Light* (London: The University of Chicago Press, 1987) 1. Contemporary wave theories of light, starting with Newton.

2. Russell, 51-52. Russell speaks of all the systems that Pythagoras inspired as otherworldly. Pythagoras attributed semi-divine characteristics to himself.

3. Miles V. Klein, Thomas E. Furtak, *Optics* (New York: John Wiley & Sons, 1986) 1. Euclid wrote *Optics* in 280 BC and Pythagoras lived from 582 to 508 BC. It can be assumed that, since Pythagoras developed the first proofs of geometric axioms, there would not have been a theory on Optics before him. Thus his attitude towards vision and light.

4. Thomas S. Kuhn, *The Structure of the Scientific Revolution* (Chicago: University of Chicago Press, 1970) 175. A paradigm usually describes a less complex idea, such as simple example or pattern. I want to extend the meaning in relationship to multivalent aspects of the camera obscura assemblage.

5. Crary, 2. I mean this also as a general position that he takes in his book, not just a single comment. In this study of the modernization of vision, Crary places the camera obscura in relationship to the observer as an extension and part of the observer's condition of seeing--an archaeological perspective.

6. Edward Harris, *Darkness at Night* (Cambridge: Harvard University Press, 1987) 19. According to Aristotle's cosmological concept, earth and its sub-lunar regions consist of the four corruptible elements, fire, air, water and earth, having perishable forms and jerky, imperfect motion.

7. M.S. Hammond, 45. This was Bacon's first attempt to deal with the question of circularity and aperture. Bacon did not consider the concept of multiplication of species along rectilinear paths in this speculation. He came to this conclusion by observing close and far distances between screen and aperture.

8. Straker, 100. *The Book of Genesis* can be cited as relating the creation of light (divine light) itself before any of the luminous bodies of the cosmos.

9. Straker, 101. Grosseteste believed that divine light, its action and its behaviour revealed the nature of causation and was, itself, the source of all created being.

10. Tarnas, 85. We are talking here about the intellectual mysticism originating with Pythagoras and adopted by Plato. After Plato's death, the metaphysical and religious aspects associated with the concept of The One placed a new emphasis on "flight from the body."

11. *Concise Oxford Dictionary*, 1964: "Empyrean, the highest heaven, as the sphere of fire, or as the abode of God [of] the visible heavens. Gk, pure fire."

12. Harris, 19.

13. I am setting up the expansion of the original Neo-Platonic model adopted by the Church in which the materiality of fire, as later also believed by Newton, displaced the up-to-then immaterially-defined realm of the *premum mobil* and made a link for the first time with the materiality of earth in the heavenly realm.

14. Harris, 30. Dante's system was usually represented as hell, earth, purgatory, earthly paradise, planetary spheres (including the sun on the fourth ring), the sphere of fixed stars, the crystalline sphere of the *premum mobil* above the sun and the divine light of the Empyrean paradise.

15. Straker, 107. The mathematical theory of propagation of luminous bodies and light for optical studies became the paradigm theory of nature and natural action.

16. M.S. Hammond, 46.

17. M.S. Hammond, 56-63. Bacon's impact and study of optics can be found in the works of his contemporaries, such as Witelo's *Optica* and John Pecham's *Perspectiva Communis*. It is also reported that Bacon, Witelo and Pecham were in Italy at the same time for a number of years where they could have met and exchanged information.

18. Wippel and Wolter, 153; and Tarnas, 176. Anselm (1033-1109) believed in the use of reason to examine and defend articles of faith. He applied the discipline of logic to clarify and defend Christian revelations. He is frequently considered the father of scolasticism, and the champion of the twelfth-century dialecticians.

19. Ernest A. Moody, *Studies in Medieval Philosophy, Science and Logic* (Berkeley: University of California, 1975) 189-192 and 287-306. Aristotle had already developed concepts of laws of motion, relating movement to distance, velocity, change, rectilinear local motions, "natural" or violent friction of medium, density of medium and "natural" motion of the body. The laws of motion were re-examined by Medieval scholars. The *premum mobil* was subject to the law of motion of the Divine Will. Since the Church was setting itself up as the sole agent of metaphysics in theological terms, the material nature of the *premum mobil* dealing with earthly concepts and materiality was, in fact, a philosophical proposition. It was the beginning of the empirical philosophy that used the conduit of divine light as connecting the metaphysical to the empirical.

20. Marshall McLuhan, *Understanding Media* (London and New York: Ark Paperbacks, 1987) 49. What McLuhan is essentially describing is the formation of knowledge as an institution without an official structure, that knowledge or institution presents itself through the gesture and, once presented, then has to be anatomized. He

also suggests that compound agents, in this case divine light, are particularly favourable to deconstruction.

21. McLuhan, 49.

22. G.M.A. Grube, trans., *Plato's Republic* (Indianapolis: Hackett Publishing Company, 1974) 168-69.

23. Straker, 100. Quoting Santillana, 53-54: "From [such minds] spring the persistent interest in Optics from Alhazen to Witelo the Pole and Johannes Kepler."

24. Straker, 101. As Grosseteste later explained, every natural agent acts in the same way as does a source of illumination; the agent sends out its "species" or virtue" along geometrical lines, for the straight line is most effective, the strongest and the most perfect route of natural action. A point of light was seen as the fundamental unit of propagation of power and was taken to be the elementary model for the "multiplication of species".

25. Luce Irigaray, *Speculum of the Other Woman*, translated by Gillian C. Gill (Ithica, New York: Cornell University Press, 1985) 245-46.

26. John Hammond, 45-46. According to John Hammond, Canaletto is one of the disputed cases regarding the proven use of the camera obscura. He is said to have done a lot of work outside which was not the practice of his day. There was, however, widespread use of the camera obscura in the 18th Century and it is possible that it was used for preparatory sketches only since the final paintings show more than could be seen from any one point. He apprenticed, however, as a scenographer and it was common practice to use the camera obscura for creating panoramic views. Vermeer will be discussed in the next chapter.

27. Bridges, 95.

28. Damish, 14-16.

29. E.H. Gombrich, Julian Hochberg and Max Black. *Art, Perception and Reality* (Baltimore and London: John Hopkins University Press, 1970) 47-49. Alberti's double cone of vision as related to perspective is the cone coming from the surface of the object to the plane represented also by da Vinci's glass plane and, from the glass plane to the eye, positioning the painting at the intersection of the double cone.

30. Gombrich et al., 50. Two classical perceptual theories: 1) Structuralism can be identified as empiricist theory by individualized deduction. This proposes viewing perceptual experiences, composed of individual isolated sensations of light, shade and colour sensations, as prior images or memories; 2) Gestalt is a "field theory," an alternative way of accounting for relevant processes. For example, light falling on the retina causes processes to occur in the brain as overall causation, therefore, stimulus distribution.

31. Rupert C. Lodge, *Plato's Theory of Art* (New York: Russell & Russell, 1953) 11-69 and 167-187. Hellenistic art theory is the foundation of concepts of creating order out of chaos--a reflective thinking to evolve along the lines of transitoriness of everything. Plato saw the final solution of the riddle of existence in everything and therefore perceived its absolute goal: transcendental principle of ideality and value, and the idea of good, which is teleological. The ideas of interconnected rhythms, patterns, waking/sleeping, life/death, are a universal law. Art as divine in origin, ideal inquiry, becomes genuine knowing. Artist as mediator of beauty as knowledge becomes an extension of communal necessity. Patterns and norms in human art are, in a sense, original with men but cosmic forces act on the human organism. The general concept of mimesis has connection to the concept of propagation of species through light; the less physically engaging the art, the higher form of art it is.

32. Kemp, 51.

33. Kemp, 105. Kemp suggests that Leonardo Da Vinci had a heightened awareness of optical factors, elusive light, veiling shadow, fleeting motion, ambiguous translucency and detached highlights.

34. M.S. Hammond, 149-50.

35. E.H. Gombrich, *The Story of Art* (New York: Phaidon Press, 1971) 219.

36. Gombrich, *The Story of Art*, 219.

37. Gombrich et al., 141.

38. Straker, 246. Leonardo Da Vinci on monocular vision in painting.

39. M.S. Hammond, 150. The development of the lens was slow in Europe. Lenses had been instrumental in Bacon's work and were used for reading since the thirteenth century. However, because the anatomy of the eye was not understood and the technology for making good quality glass was not yet developed, the drawing of the eye as a camera is possibly the result of a direct experiment with a glass of water behind the aperture.

40. M.S. Hammond, 111-112.

41. From the thirteenth century to the discovery of perspective, there is no mention made of using the camera obscura for other than astronomical observations and calculations or the observation of the phenomenon of the image. This is not so much to do with astronomers not being able to draw, but rather as a function of their own purposes and a certain understanding of the convention of drawing. Kepler was an exception. According to Henry Wotton (*c.*1620), Kepler actually drew a very convincing panoramic landscape inside the tent camera obscura by copying the image, .

42. Straker, 322. Tycho Brahe, Danish royal astronomer and nobleman was inspired to study astronomy after watching a predicted eclipse. He was astonished at the capacity to predict the eclipse: "As something divine that men could know, the motions of the stars so accurately that they could long before foretell, their places and relative positions," 21 August, 1560.

43. Tarnas, 79-84. Ptolemy (366-285 BC) was a geographer/ astronomer who, with Euclid, Appolonius, Archimedes and Hipparchus, produced scientific advances and codification that would become the paradigm of astronomy for many centuries. The development of mathematical astronomy was particularly consequential.

44. George Sergeant Snyder, *Maps of the Heavens* (New York: Abbeville Press, 1984) 45-46.

45. Daniel J. Boorstin, *The Discoverers* (New York: Vintage Books, Random House, 1985) 297. As an astronomer, Copernicus was an amateur. He studied mathematics in Cracow where he also studied painting. As well, he studied canon law in Bologna and medicine in Padua and it was during this time in Italy that he attended some lectures in astronomy. *Commentarolus* or "Sketch of his Hypotheses for Heavenly Motions" was circulated only by a few handwritten copies during his lifetime. The book was not officially published until after his death. The first description of his heliocentric system was disseminated by a young disciple for political reasons.

46. Raymond J. Seager, *Galileo Galilei, His Life and His Works* (Oxford: Pergamon Press, 1966) 33-37. Although Galileo had established certain proofs for the Copernican system, the inquisition forced him to refute his beliefs in a heliocentric system. (Harrison, 47.) Kepler combined the heliocentric system of Copernicus and the magnetic philosophy of William Gelbert as his own version of the immovable sun in a magnetic field of motion.

47. Tarnas, 210.

48. Aubrey Burl, *Prehistoric Avebury, The Ancient Apollonian Greek Religion Worshipped the Sun* (New Haven: Yale University Press, 1979) 45 and 95-96. Ancient prehistoric Stonehenge and Avebury are witness to the Druid culture of sun worship. They constructed stone circles like large time-mechanisms in relationship to light which are in fact related to the camera obscura teleology.

49. Tarnas, 292- 308.

50. Tarnas, 281.

51. M.S. Hammond, 155. Pecham's *Perspectiva Communis* went through nine publications during the 16th Century. Even a commentary of Johannes de Sacro Bosco's

thirteenth century astronomical treatise *Tractus de Sphera* appeared in 1531 and included a description of the camera obscura as an observational tool.

52. Tarnas, 191. Averroes (1126-1198) was a monk-scientist and secularist philosopher who taught Aristotle's work without coordinating his scientific and logical conclusions with the Christian faith.

53. M.S. Hammond, 180.

54. Straker, 442-43. In their experiments, they also pointed out that it was possible to see the form of the ray in moist air; the convergence of rays through refracting mediums, placing a globe above the rays, or spherical section of globe in order to isolate parallel beams. The image cast on the other side of a refracting mirror became recognized.

55. John Hammond, 17. This was the first published example of a camera obscura. Gemma-Frisius, a Dutch physician and mathematician, observed an eclipse of the sun at Luvain in January, 1544. He produced a drawing to illustrate his book, *De Radio Astronomica et Geometrico*, published in 1545.

56. Bridges, 111. Bacon's solution consisted of lines of force impinging vertically on the sense organs. These rays were so much more effectual than those which fell upon the eye obliquely, and became neutralized.

57. Straker, 438.

58. Straker, 438.

59. M.S. Hammond, 266-267. Hammond describes Kepler's drawing made in a camera obscura tent. The reference is quoted at length in the third chapter.

60. Straker, 455-61. Kepler emphasized that his theory of vision differed from that of others in that he does not refer to the image or the species, but rather to the world painted or depicted by the rays.

61. Straker, 457.

62. Until this time, numerous speculations had been made both about the eye as an organ of vision and about the process of vision in the eye. Even though there was not yet a correct reading of the lens, the basic concept was nevertheless quantifiable. A true relationship could then be set up between the organ of vision and light.

63. Straker, 463.

64. Straker, 479. Kepler delineated the territory for the optician. The law of "optics" and the "equipment of the optician" proceed only as far as the white wall at the back of the eye, the retina.

65. Klein and Furtak, 7. To René Descartes, ideas about light were consistent with his impression of the real world. He believed all things were related to geometry and motion, the fundamental powers in nature. Motion could be communicated from one body to another only by impact. His concept on matter encompassed its ability to be infinitely divisible and incompressible and, therefore, a void was considered impossible. Descartes compared light to a mechanical particle. He believed light had a tendency toward motion, not motion itself.

If light were not an immaterial surface, Kepler argued, but were instead a corporeal body, then it would be affected in its motion by the corporality of matter as in reflection and refraction. It is clearly not affected in this way as light is continually bent or slowed down in its passage through the transparent medium.

66. Klein and Furtak, 14-15. Newton's description of light was accepted as the most accurate in his time. Newton thought that the light ray consisted of a stream of particles that moved through an all-pervading ethereal medium. He thought the size of the particles related to different colours, concluded from the spectral separation. Newton also believed that perpendicular forces acted on the particles of reflection and refraction.

67. H.S. Thayer, ed., *Newton's Philosophy of Nature* (New York: Hafner Press, 1974) 135. Newton described his investigation through a series of questions: Do bodies not act upon light at a distance and, by their action, are they not strongest at the least distance? Do bodies and light not act mutually upon one another: bodies upon light in emitting, reflecting, refracting, and inflecting, and light upon bodies for heating them and putting their parts into a vibrating motion wherein heat consists?

68. Thayer, 9. Newtonian science, with its concept of motion, gravity and light, demonstrated that the Will of God was the Divine Will, decreeing a mechanism that worked automatically without further interference. This was paralleled by social philosophies that pointed to similar human affairs as autonomous order for conducting the life of a man. It is in this understanding of autonomy that the concept of philosophy changed from the natural philosophy of observation to the new philosophy of the autonomous mechanism in nature.

CHAPTER 3

Body: oneness to multivalence

> A human being is a purely physical object, a biochemical machine completely and exhaustively described by known laws of physics. There are "no" mysterious "vital" forces. More generally, it requires us to regard a "person" as a particular [very complicated] type of computer program, the human "soul" is nothing but a specific program being run on a computing machine called the brain....All living beings are generated by programs coded in DNA molecules....The human body by itself is a marvellous complex machine, more complex and more in accord with reality (fitted to survive) and more beautiful than any creation of the human mind. Since we know that natural selection acting on random mutations can be and has been more creative then the human mind, it seems perfectly plausible that the human mind can create ideas and be itself created by the same mechanism....We are machines, but we in contrast to machines we have built, possess true free will.[1]

Frank J. Tipler, professor of mathematics and theoretician in the field of global general relativity, in his book *The Physics of Immortality*, has taken on the formidable task of deconstructing the Judeo-Christian theological theory of immortality through contemporary physics and modern biological evolutionary theory and placed the human body and its constructed theological belief firmly in this material mechanistic field. He does not separate the mind from the body and conceives of the entire unit of the body as a whole which has come into existence through evolution from a primary physical unit, the electron, making physics and metaphysics indistinguishable from each other.

What fundamentally distinguishes Descartes from Tipler is the former's concept of origin. Descartes believed in the biblical idea of God creating a fully-formed human being. This representation of human origin lasted until Darwin's formulation of the Theory of Evolution in the nineteenth century. Despite Descartes's apparent holistic view joining the body and the soul in divine unity, he separated the body into two exclusive empirical entities: first, the material nature of the body as extension and object which he associated with the concept of mechanical motion; second, he determined the soul as perception and subject. The body was quantifiable as the relationship of optics and eye. The soul was quantifiable as the internalized image, immaterial but connected by the brain to the senses which, in turn, could also be quantified. With new knowledge unavailable to the Ancients, Descartes redefined the dualistic problems of Pythagoras who, as seen in the first chapter, believed thought and sense to be exclusive of each other. With Descartes, sense and thought were inescapably associated. This separation from Pythagoras placed the soul in the body, as seen in the second chapter, and was made possible by Kepler's correlation of the eye to the camera obscura. This became the new quantifiable mechanism and, with it, a complex equation of the mind/soul/sense/ perception and the body/materiality/extension. This was the new dualistic critical discourse.

The separation relates to the camera obscura assemblage in equating the image with the sense of sight as soul (or the subject) and the housing of the camera obscura as material/body (or object). This also divides the body into the material and the

immaterial. The body and its extension as object is the material and the image and its soul as subject is the immaterial, but significantly quantifiable. How Descartes rationalized the legitimacy of these positions is important and is demonstrated in his words:

> If God has free will he can choose to create man in a certain way, we are created by this perfect God who would not deceive us....To believe in Him is also therefore to believe in [His] reason and choice. An Atheist, denying the existence of God, must therefore necessarily be the prey of an absolute scepticism: he cannot have any assurance of anything whatever--not even of mathematics--and, for him, to believe in "reason" would be utterly unreasonable....[As believers] we can confidently proceed with the critical examination and evaluations of our mental faculties, such as memory, inference and so forth and our ideas as to "measure" their validity according to standards of clearness and divine veracity. So we find that not only our clear and distinct ideas have validity, but even those that can perhaps only be given speculative validity, our sense perceptions and our passions. Absolute truth is the idea of union between body and soul. However, the soul is a purely spiritual being, and exercises our consciousness and does not include the idea of the body, and conversely the body does not and cannot include consciousness. It is neither less nor more than the extension; and an extension can only be an object of thought not its subject.[2]

The evolution of the modifications of the camera obscura body carries this necessary paradox of interdependence and separation between the body and the soul or the housing and the image.

In this chapter, I discuss the evolution of the camera obscura machine in process. Its symbolic housing or body engages in a choreographed event with the organ of light as the symbolic image of the soul. The object of this event is the housing of the camera obscura assemblage and the body of the observer. The subject of this event is the image in the camera housing and the soul of the observer. The opening is the conduit

of light linking the inside to the outside or the extended outer skin of the body[3] to the projected reflection as image/soul (as a mechanical reproduction).[4] The subject or soul, by its inscription as a photonic parallel or sign of the terrestrial or celestial world, modifies the shape of the body. The body in turn starts to amplify the potential resonance of the image/soul, making the presence of the image independent of the presence of the body. Both are equally vulnerable, and both are equally conditioned to change in the moment. In time, the objects have to be re-invested with new souls or images and the subjects have to be re-invested with new objects.

In Renaissance thought, the concept of body and soul was defined by the philosopher Pomponazzi from Padua:

> An individual soul can only be conceived of as such if it is thought of as a form of an individual body. In fact, one can say that what we call the animation of a body consists in nothing other than in this its complete individualization. Through this, the body is distinguished by mere "matter"; through this it becomes the organic body which, in its individual determination, becomes the vehicle of a definite, concrete and individual life. The soul therefore is not added to the body, as an external principle of movement or animation; rather it is the very thing that forms the body in the first place; it is that which makes it a whole, differentiated within itself and articulated within this differentiation.[5]

The adaptability of the machine in this state of individuation as the separation of units of a compound organism, of body and soul, is the technique of the observer as well as the process of discovery and invention. It precipitates the observer's deconstruction of his own paradigm which makes possible the building of ever-more sophisticated machines to which he remains the extension of purpose and meaning--a

machine that leads to the collective constitution of body and soul. In this sense, the camera obscura is one of its constituent parts.

The housing, the body, the object.

I would like to introduce the body of the camera obscura with one of its oldest known examples, the Egyptian Temple of Ptah[6] at Karnak in the Middle Kingdom (1500-1000 BC). In one of its chambers, an aperture was positioned in the roof and the projecting surface was the body of the statue of a god. The light that fell to cover this object was given the properties of the soul. The illusory consequence of this light travelling from above was used to give life to the inanimate body of Ptah:

> Perhaps the most unexpected optical effect produced by the Egyptians can still be seen in a small dark chamber in the temple of Ptah. The chamber is lit from the ceiling by a small opening (in the usual truncated pyramid shape) in the centre of the ceiling, admitting a cone of peculiarly bluish light that enveloped and illuminated the statue of Ptah beneath it. In 1916 Legrain, an archaeologist, observed that this was indeed a very strong incredible optical illusion and in fact the room is a camera obscura.[7]

This animation of the figure which, through the reflection of white clouds, appeared to be coming forward and, in bluish light from the sky, appeared to be receding, created an illusion that convinced the believer of the presence of and communication with the god Ptah. In Egyptian mythology, this god was the first being to rise out of the primordial chaos. In the uttering of his first words, he brought order

into the world of objects.[8] Apparently, these camera obscura-type chambers were quite common in Egyptian temples.

In Medieval European temples of God, the church was the first permanent structure of a camera obscura as described by the fourteenth-century astronomer, Nicolas Oresme, who wrote that William St. Cloud installed a camera obscura in the roof of the cathedral of Notre-Dame in Paris in 1296:

> The experience that whenever the sun shines through an aperture high above the ground, as in the Cathedral of Paris, when that light appears to jiggle as if the sun were moved discontinuously by shaking or trembling, and the explanation of this is its variation of refraction, on account of changes in medium (through which it passes)...from which it is evident that something which is moved regularly may appear to twinkle on account of alteration in motion namely refraction.[9]

In this cathedral, however, although the phenomenon of light played an important role in the Christian Church,[10] the camera obscura was not specifically intended to convince the believer through its illusionary possibilities. Rather, through its mechanical possibilities as quantification of astronomical observation, it was intended to convince the believer of the union with God.

The most important such instrument of quantification was the cathedral camera obscura installed in the Vatican's Tower of the Wind, constructed in 1582.[11] It was designed by Egnatio Dante, papal astronomer to Gregory XIII.[12] The aperture was poetically located in the mouth of Father, Wind of the South, in a fresco painted on the

ceiling. The sun projected through this opening and fell on the markings of a scale located on the floor:

> ...a perforated bronze plate, placed so that the sun's beams struck the pavement along a graded strip cemented to the floor. It turned the Dome into the greatest [camera obscura] and astronomical instrument ever built. The beam was 240 feet long, and it allowed Toscanelli to effect his solstical measurement of the inclination of the eclipse.[13]

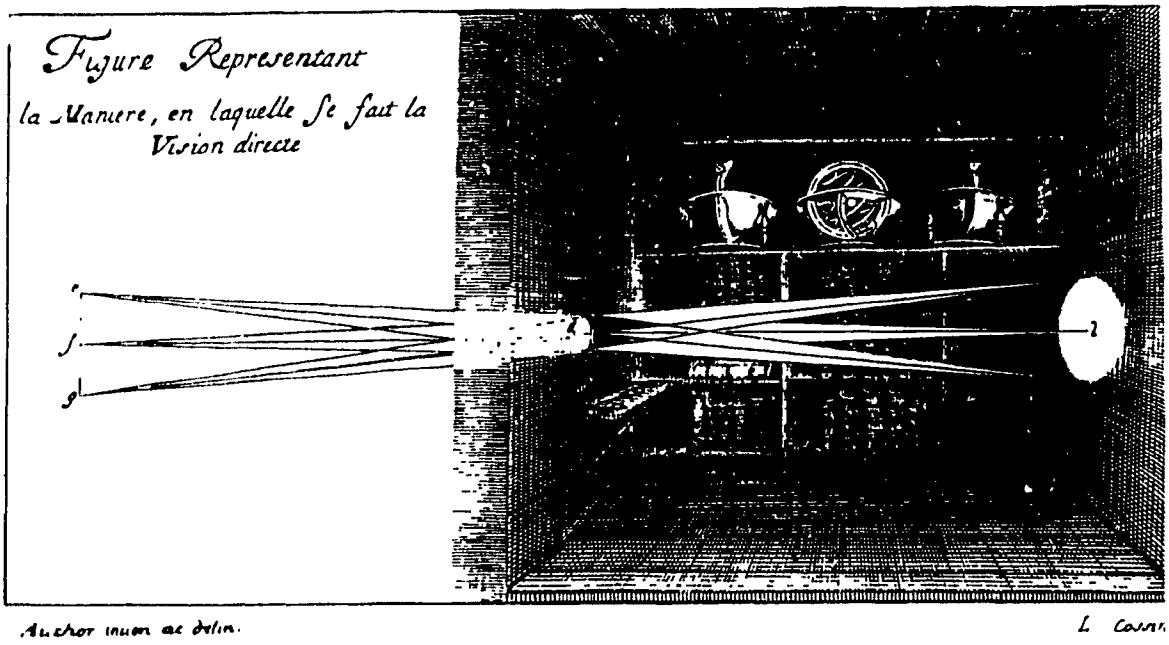
Measurements taken from the astronomical readings of this giant machine were mathematically calculated and led to the devising of the Gregorian calendar, replacing the Julian calendar which, by this time, was ten days in error. The synchronization of the Christian calendar with heavenly movements created a harmonious model of time and space between the heavens and theology.

The camera obscura time-machine as calendar is also pre-dated by, amongst others, the megalithic configuration of Stonehenge, one of the oldest solar observatories or time-machines that associated religious ceremonies with solar celestial configurations, dividing the year by solar solstices. Through solar observation, the Christian ritual was able to determine the exact time of Easter and to calculate the Christian year.[14] The Church camera obscura was the theological body of ritual which, as calendars, like clocks, McLuhan writes, fundamentally helped to create a belief in cosmic determinism: "The clock [calendar] creates the image of a quantified, mechanically powered universe."[15]

The mechanically-powered universe was also observed from secular astronomical camera obscuras first described by William of St. Cloud who, as mentioned in the previous chapter, was believed to have been an English astronomer and the founder of the astronomical school of Paris. In his almanac of 1292, he published the first description of the conversion of a house into an astronomical camera obscura.[16] St. Cloud suggested using an attic or simply a darkened room as a camera obscura, thus making the home an observation machine in the same sense as the castle was a war machine. (Illustration 6.) The opening had to be positioned in relationship to that part of the sky where the astronomical event, the eclipse of the sun for example, would appear.[17] The observer was positioned inside the machine and controlled its mechanism.

The information gathered from secular and non-secular observatories of the Middle Ages and the Renaissance, as we have already seen, contributed to the restructuring of the cosmological mechanism as a secular heliocentric system. The celestial charting of the sun was precipitated with the help of a more accurate theological calendar which defined the world body in a decentred non-spheric infinite space. The eternal Christian soul, having lost its hermetic centre, was now connected only by time and held in its relative position in space by its mechanical motion. The observer himself was positioned at the "centre" of the double articulation of time and space, becoming part of its motion.

Ill. 6 A camera obscura combined with a seventeenth-century private library or study. Illustration from *La Dioptrique Oculaire* by Cherubin d'Orleans (1671).



In the fourteenth century, the concept of motion came under discussion at the University of Paris. Buridan, rector of the University of Paris in 1328, speculated on the natural cause of the heavenly motions which concerned both the Church and the astronomers. To find a rational explanation, he appropriated aspects of Aristotelian logic and concepts of motion and added these to Christian theology.[18]

> If God created the world and he set the heavenly bodies in motion at their present rates of rotation, since they have no resistance, they will continue to move at their initial speed and direction and require no secondary intelligence or angels as movers of the heavens. It is said that if his predecessor absorbed Aristotle's physics into Christian theology, Buridan reversed the procedure and absorbed the celestial habitation of the gods into the realm of the aristotelian nature.[19]

It took two hundred and fifty years of astronomical calculations, made possible through the continual improvement and extension of the camera obscura apparatus for Copernicus, Galileo and Newton, to transform Buridan's intuition into a genuine mechanics of the universe through the extension of the body of the observer and the body of the camera obscura.

While there are many quoted examples of early camera obscuras with their parasitic bodies of simple openings, no refinements were made to the apparatus other than the speculations of Da Vinci until the sixteenth century. The first specific modification of the aperture, other than to the size or shape of the opening, is described by the Italian architect Cesariano who published a source book for architects mentioned by Vitruvius

in 1521. In this book, he relates the experience of two students of architecture of a camera obscura at a monastery near Milan:

> ...a beautiful law of optics may well be mentioned which was found out and verified by the Benedictine monk--architect Don Papnutio. If a circular concavity about two inches in diameter is cut with a lathe in a piece of wood about 4 or 5 inches in seize, and in the centre of the concavity a small and very short tube (speculum) or aperture, (which is also called a sight scopos) is placed and properly fixed to the door or window...and everything passing through is represented on the white paper...you will see everything contained in the earth or in the sky...according to the pyramid formed through the aperture, with their colours and forms.[20]

A refined aperture modified by a tube and encasing the conduit of light is the first mechanical adaptation noted. The subsequent physical modification to the aperture is the lens, recorded and described in Girolamo Cardano's *De Subtiliate Libri XXI*, published in Nuremberg in 1550. In *Book IV* of this publication, subtitled "De Luce et De Lumine," Cardano writes:

> If you want to see the things which go on in the street, at a time when the sun shines brightly, place in the window shutter a bi-convex lens (orbem e vitro). If you then close the window you will see images projected through the aperture on the opposite wall, but with rather dull colours; but by placing a piece of very white paper in place where you see the images, you will attain the eagerly awaited result in a wonderful manner.[21]

The lens could have been an orb or glass filled with water which was at this time the popular aqua-magnifying glass.[22]

The beginning of the body as the eye.

To really refine and develop the lens, it was important to have a knowledge of both mathematics and optics. Daniello Barbaro had studied both in Bologna. Clearly understanding some of the optical principles, he undertook to install a lens in front of the aperture but equally important was his comprehension and application of a diaphragm which was a method of either enlarging or closing down the opening by which light passed through the fixed lens. In Barbaro's edition of *La Practica della Perspectiva*, he wrote:

> If you wish to see how nature shows us the various aspects of things not only outlines of their whole but also their parts as well as their colours and shadows, you must make a hole of the size of the spectacle lens in the window shutter....Then take a lens from the spectacles used by old men, that is to say a lens that is fairly thick at the centre and not concave like the spectacles for younger men who are shortsighted, and fix this lens in the hole you made...by moving the sheet of paper towards or away from the lens you will find the most suitable position. Here you will see the images on the paper as they are, and the variations colours, shadows, movements, clouds, the rippling of water, birds flying, and everything that can be seen. For this experiment you should choose the glasses which do best, and should cover the glass so much that you will leave a little of the circumference in the middle, which should be clear and open, and you will see a still brighter effect...[23]

The innovation of a diaphragm, that is, masking the lens to have a smaller diameter or smaller aperture in order to make the image "brighter," was not yet understood by Barbaro. In fact, the image was not brighter but sharper, giving the illusion of brightness. Giovanni Battista Della Porta, in *Magia Naturalis Libri XX*, included the description of a mirror already discussed by Bacon that he used to correct

the inverted image. By 1585, the camera obscura was modified by lens, mirror and diaphragm and was, with all of these refinements, fairly well known in Italy. However, it was still housed as part of an already-existing permanent structure.

The eye can focus.

If the modifications were essential in getting better image resolution, a methodology for apprehending and mathematically quantifying the projected image was also essential to maximize the usefulness of the instrument for the astronomer and, as I will discuss, the artist. The first published methodology for accurate observation was set down by Gemma Frisius, a Dutch astronomer, in *De Radio Astronomico et Geometico Liber*, published in Antwerp in 1545. He describes the necessity of having the "tablet" or surface of projection at the right position in relationship to the sun (perpendicular), but also of accurately measuring both the distance from the opening to the table and the diameter of the sun before or after it is eclipsed. The measurements he took of all the different relationships in the camera obscura body were of ultimate importance. Frisius set down the parameters for observation by considering the internal relationship for quantification.

The eye's internal construction takes form.

> ...inside some room through a narrow aperture, the ray is received on a flat tablet. There certainly the degree to which the sun is eclipsed can be

> seen without any visual difficulty as perfectly as if you were present in the heavens yourself...either before or after eclipse received on the same tablet equally distant from the aperture through which the ray is admitted...and thereafter divided that very diameter into 12 equal parts with a compass, then you will see how many 12ths of the sun is eclipsed....Thus we observe a solar eclipse exactly. By this method, therefore observations of the sun, the moon, and even the motion of other stars and the longitudinal position can be set down correctly. (Frisius, Luvain, 1544.)[24]

This publication also carried the first published image of the camera obscura as a classically designed room or perhaps even a separate building.

The eye becomes an autonomous body.

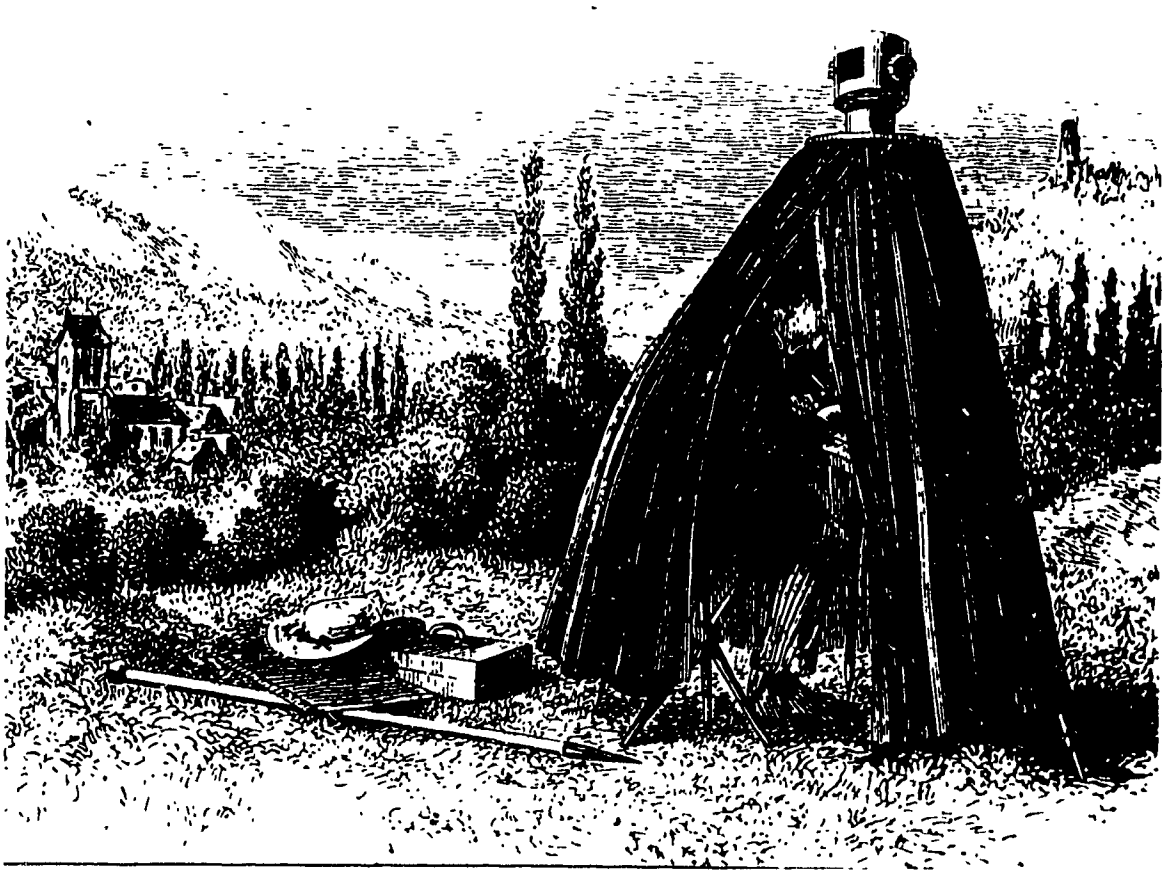
The first portable camera obscura was constructed by Kepler during his assistantship to Tycho Brahe in Graz. In its original form, it was an adaptation of Tycho's dioptre, a wooden instrument with a large base, a pivoting rule and two pinnules or sight guides. Kepler placed this instrument in the large market square of Graz for the observation of the solar eclipse of 1600. The aperture was made in the thin metal upper pinnule of the instrument for projecting the image and the entire structure was covered with a heavy black cloth so that he could observe the projection on a white tablet attached to the sliding bottom pinnule. However, he was not totally satisfied with this arrangement and eventually designed a more stable and vertical portable tent-type camera obscura. (Illustration 7.) The only description of the tent was handed down to us in a letter by Henry Wotton to Francis Bacon in the year 1620:

> He hath a little black tent which he can suddenly set up where he will in a field, and it is convertible (like a windmill) turning to all quarters at pleasure, capable of (holding) not much more than one man...exactly closed and dark, save for one hole, about an inch and a half in Diameter, to which he applies a long perspective-trunk, with the (a 45 degree mirror reflecting the surrounding landscape into a) convex glass fitted to the said hole, and the concave glass taken out at the other end, which extendeth to about the middle of the erected tent, through which the visible radiation of all the objects without are intromitted, falling unto a paper which is accommodated to receive them. And so he traceth them with his pen in their natural appearance, turning his little tent round by degrees until he has the whole aspect of the field...[25]

<u>The eye is in motion (mobile).</u>

This event of the camera obscura observing machine with the observer situated at the centre of space, capable of bringing the entire panoramic view of the exterior world into full view of the observer in the confines of the tent, has inscribed in it a symbolic cosmological parallel. The significance of this moment in the camera obscura body is linked to the decisive reaction expressed against the unitary view of the cosmos still generally held in the early Renaissance. The Medieval Christian Church argued against the possibility of multiple infinite worlds which were not unknown to the Medieval mind. The Copernican Universe, a neutral, centreless, non-unique moving earth, multipopulated and perhaps infinite space,[26] made it hard to support the unity of the Aristotelian cosmos which the Church supported for religious and ethical reasons. By its very nature, the Christian model also sacrificed the idea of the unique value of the individual to maintain the idea of oneness.

Ill. 7 The tent camera obscura. The turret could be revolved to present a different scene. From *Natural Philosophy* by E. Atkinson (1900).



For this reason Giordano Bruno (1548-1600), an Italian Neo-Platonic philosopher, intuitively considered that it was necessary to re-assert the notion of infinity and, with that, suggested that the individual must find the heroic fervour of self-assertion within himself. One must believe in the limitless unfolding of the self. In this way, man is not lost or blind in the infinite universe. To define and to name this centre within man, he formulated the concept of the Ego as intellectual and moral dignity of the "person," putting the emphasis not so much on the universe as on the Ego that must produce the vision of the universe within itself. Man, like Kepler in his tent, finds his true Ego by drawing the infinite universe into himself and, conversely, by extending himself to it.[27]

The eye is the Ego as an autonomous body.

The camera obscura, with this gesture as a rotating tent attached like a garment to the observer,[28] draws into it, as an autonomous mobile structure, the image of the world in which it is placed as centre. The tent camera obscura as the symbolic body is the collecting centre for terrestrial and celestial images, eliminating their distinction in the projected image. The internalized image inside the mobile unit is the most personal of human extensions. It is both the place of the ego and of the soul.

The eye and its conduit the Ego extend both into space and into the brain.

The tube that extended inside Kepler's tent with its various lenses was, in fact, the beginning of the concept of the telescope. The difference lies in the telescope's focal length. The telescope, placed close to the eye, requires a short focal length and a narrow field of vision, whereas the image projected in a tent requires a longer and wider focal length--the distance between the lens at the uppermost part of the viewing tube right to the surface of the paper on which the panoramic "landskip" is traced.

All the preoccupation with the lens and the camera obscura for celestial observations precipitated the invention of the telescope. In the summer of 1609, the Italian astronomer Galileo heard of a magnifying instrument called the Dutch Tube which apparently was capable of righting the image and magnifying it many times.[29] Galileo worked out his own design of it and improved its magnification. However, as the astronomer Johannes Fabricius discovered in 1611, it was very dangerous to observe the sun through such an instrument of magnification. The consequences of this rebounded in a number of different modifications made to the camera obscura body.[30]

In *Refractines Coelestes*, a work published by the astronomer Christopher Scheiner in 1617, Scheiner claimed to have observed sunspots in 1612 by projecting the image through a telescope onto a tablet placed directly opposite. The telescope was suspended horizontally in a wooden structure directly in front of the opening of the

camera obscura. This instrument, like Kepler's dioptre, became known as a helioscope. In 1630, Scheiner published a massive work on solar observation, *Rosa Ursina*, in which he gave detailed illustrations of the instrument and suggested seven ways in which to observe sunspots. From this time on important astronomical observations were made with the combination of a camera obscura opening or aperture into which the telescope was inserted. This configuration became known as the telescopic camera with a system of sliding tablets to which a perpendicular rod was attached to a tablet for the projection surface and paper. French astronomer and atomistic empiricist Pierre Gassendi (1592-1655) observed the transit of Mercury across the sun in this way in 1631 and, on November 24, 1639, Jeremiah Horrocks also used a telescopic camera to observe the transit of Venus across the sun.[31]

The roaming eye and Ego penetrate space.

The telescope placed directly in front of the eye was, in fact, the extension of the human organ of vision that permitted man to visually penetrate space beyond his organic capacity and to observe from greater distances the physical world of the sky. If the *premum mobil* had been conceptually broken with the new cosmology, it was now visually possible to go beyond the boundaries set up by the Medieval Christian model. The limitation was the power of magnification of the optical apparatus and no longer that of the eye. This extension was also turned inwards by the gesture of the telescopic camera and the internal vision of the world was extended beyond the conventional

limitations of the interior conceptualization of the body and the mind and, in fact, to the limits of its interior extension.

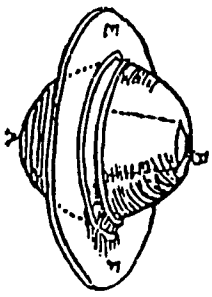
Anatomical verification of the eye and the Ego.

In the seventeenth century, the eye was paramount to the understanding of this new central identity of Bruno's Ego. Astronomers, mathematicians, opticians, artists and philosophers interrogated vision. Descartes, thirty-three years after Kepler, wrote about dissecting dead men's eyes or, failing that, an eye of a large animal or ox:

> Take the Eye of a newly dead man...ox or large animal; carefully cut away the three enveloping membranes at the back, so as to expose a large part of the humour without shedding any; then cover the hole with some white body, thin enough to let daylight through, a piece of paper or eggshell. Now put this eye in front of an opening of a specially made window...no light must enter the room except through the eye....I dare say with surprise and pleasure, a picture representing in natural perspective of all objects outside I will appear.[32]

The eye was actually reconstructed as the *oculis artificialis telediopticaesive telescopium*. This model eye camera obscura was a large wooden ball with a hole bored through the axis and a lens placed at each end of the opening. The ball swivelled and rotated in its socket within a specially designed frame that fit into the window shutter of a dark room. This entire unit became known by a shorter name, "scioptric ball." Telescopes of different focal length could be used with this mount thus permitting true perpendicularity--movement of view and images. (Illustration 8.) Telescopes with longer focal length could be projected through an interior window into

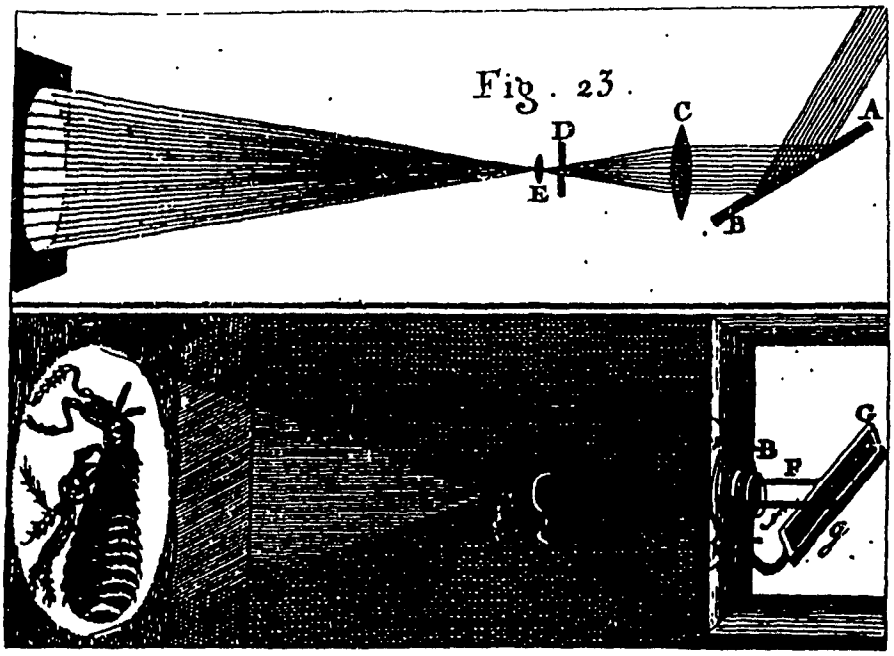
Ill. 8 J. Helvelius (1611-1687), a Danzig Astronomer, first to use an inverted telescope for celestial observations. From *Machina Coelestis*, published in 1673.



the next room. The aperture of the camera obscura was truly now like the prototype of the movable adjustable eye and the telescope connected to it became like the optic nerve, the conduit for light extending deeper and farther into the body and into consciousness.

This inward-turning eye continued with this configuration well into the eighteenth century for astronomical observation but, by the middle of the century, a different arrangement of lenses and mirrors in the camera obscura body succeeded in turning the power of its extension inwards. It was in this way that in 1745 the camera obscura became the first solar microscope invented by Jean Antoine Nollet.[33] (Illustration 9.) What had previously been macrocosmic vision became a microcosmic internalized vision of the earth's organic and inorganic material reality. The world and its universe moved towards transparent certainty. The Aristotelian world of fixed places and measurements shifted to a world where certainty was achieved by "the separation of the parts of the soul."[34] Its norm was no longer the whole but the *a priori* parts that embraced its completeness, bestowing on every part the right to represent perfection.[35]

Ill. 9 The first (solar) microscope designed in 1745 by Jean Antoine Nollet (1700-1770).



Notes to Chapter 3.

1. Frank J. Tipler, *The Physics of Immortality* (New York: Doubleday (Publishers), 1994) 3-29. Tipler bases his concepts of man as a machine on the concept that mechanisms are organic evolutionary entities. He incorporates these ideas into his Omega Point Theory which also includes the resurrection theory which he describes as pure physics. There is nothing supernatural in the theory, there is no appeal anywhere to religious faith. The genealogy of the theory is actually atheist scientific materialism--the line of research which led to this theory was simultaneously discovered by Marxist John Bernal, computer scientist Hans Moravec and philosopher Nozick. The conclusion is that from the point of view of physics, theology is nothing but cosmology based on the assumption that life as a whole is immortal.

2. Alexandre Koyré, introduction to *Descartes, Philosophical Writings*, by Elizabeth Anscombe, Peter Thomas Geach, eds. (London: Thomas Nelson and Sons, 1970) xlii-xliii. Descartes's position to the creation of man is underlined in his own words: "The Lord has made three marvels: things out of nothingness, free will, and the Man who is God." Descartes as man and God, through reason, set up a system of proof that was initiated through a systematic belief of doubt. It was from this basic denial of reality that he reconstructed what he could understand and know through empirical reason and proof.

3. McLuhan, 123. If clothing is the extension of our private skin to store and channel our own heat and energy...housing as shelter is an extension of our bodily heat-control mechanisms--a collective skin or garment. Cities are an even further extension of bodily organs. It is in this sense that the camera obscura assemblage, as an extension of man's own body and soul, becomes identified with it.

4. Crary, 2:

> What is the relation between the dematerialized digital imagery of the present and the so-called age of mechanical reproduction? The most urgent questions, though, are larger ones. How is the body, including the observing body, becoming a component of new machines, economies, apparatuses, whether social, libidinal or technological? In what ways is subjectivity becoming a precarious condition of interface between rationalized systems of exchange and networks of information?

These questions, deeply rooted in McLuhanistic analogies, are the questions I am trying to become familiar with in this thesis in relationship with the camera obscura.

5. Ernst Cassirer, *The Individual and the Cosmos in Renaissance Philosophy*, translated by Mario Domandi (Philadelphia: University of Pennsylvania Press, 1963) 136-137. It is this correlative relationship of the soul, not just a *forma assistent* (a

promoter of forms), but also an informer giving genuine form (*forma informans*). Therefore, the function giving form can only be accomplished through a definitive physical substratum without which the function would lose not only its entire support but also its entire meaning.

6. Cyril Aldred, *The Egyptians* (London: Thames and Hudson, 1987) 84-85. The new land reclaimed by Menes, who joined Upper and Lower Egypt in the Archaic Period (31000-27000 BC), is believed to have given form to the concept of the "demiurge" or the creator of the material universe, Ptah. He caused the primeval mound to rise from the waters of Chaos, in which he existed before the "First Time." By taking thought and uttering a word, he caused the earth, as mound, to rise. Ptah's utterings brought forth from the new-risen earthmound all the clay, earth, seeds, stones, metals and minerals from which the works of men, as well as nature, were formed. Ptah is also credited with the creation of towns.

7. Kim Levine, *Light in Art*, Thomas B. Hess and John Ashbery, eds. (New York: Collier-Macmillan Ltd., 1969) 29. Because most roofs in Egyptian temples no longer exist, it is difficult to know how light entered the temple chambers, if indeed it entered through the doorways. There is strong evidence, previously overlooked, that it did. Raised relief was used for interior surfaces but on the front faces of interior doorjambs, between chambers, sunken relief covered in gold leaf was used, possibly to reinforce the effect on the sunlight or to substitute for it. Light from the roofs would have affected the volumetric illusion of the carved figures and promoted the reflection of light and shadow to promote illusion.

8. See note 6.

9. M.S. Hammond. This is a quote from the almanac of William St. Cloud given by Nicolas Oresme.

10. Levine, 3. According to Plotonius, the eye is a microscopic sun. It is this concept that inspired John the Evangelist to identify the Logos with light, hence Medieval artists depicted the Divine Word in the form of a ray of light travelling towards the recipient of the Logos. An example of this is Saul being blinded by the luminous ray and falling off his horse. Unlike the Gothic ray of light that symbolized Truth, artists of the seventeenth century used the dramatic structure of light and shadow to apprehend the truth in terms of history. Eventually, the scientific concept of truth took precedence over both theological and historical interpretations.

11. Notre-Dame was not the only cathedral to be used for astronomical observation. In Italy there were the Duomo in Orvieto and San Petronio in Bologna. In relationship to the discovery of perspective, architect Fillippo Brunelleschi incorporated not only a gnome on the top of the Dome of Santa Maria del Fiori in Florence, but an aperture in the roof of the church as well.

12. J. Waterhouse, "Notes on the Early History of the Camera Obscura," *The Photographic Journal* (31 May 1901): 276. In 1573, Egnatio Dante published at Florence an edition of *Euclid's Optics* where he gave a description of the camera obscura. He showed the ordinary method of a simple opening but also suggested a mirror behind the opening to inverse the images.

13. M.S. Hammond, 79.

14. Alexander Marshack, *The Roots of Civilization* (New York: Moyer Bell Limited, 1991) 17. Harvard University professor Hawkins suggested in the English science journal *Nature* that the alignments of circular stone structures, of which Stonehenge was one, were now proven astronomical and calendrical alignments.

15. McLuhan, 145-146. As a piece of technology, the clock is a machine that produces uniform seconds, minutes and hours on an assembly-line pattern. Processed in a uniform way, time is separated from the rhythm of human experience. It was in the world of the medieval monasteries, with their need for regimented and synchronized communal life, that clocks got their start in modern development. Time did not just measure uniquely private experience but, by abstract uniform units, gradually pervaded all sensory life and as does the technology of writing.

16. M.S. Hammond, 74.

17. M.S. Hammond, 74.

18. Moody, 210. Aristotelian concepts of motion are natural movements of heavy or light bodies moving toward conditions or places of "natura rest." Aristotle posited that inequality or equality between medium and body define dynamics of equilibrium or disequilibrium.

19. Moody, 271-273.

20. Waterhouse, 273.

21. M.S. Hammond, 162.

22. M.S. Hammond, 163.

23. Arthur Wheelock, Jr., "The shifting relationship of perspective to optics and its manifestation in paintings by artists in Delft around 1650." (Dissertation, Harvard University, Cambridge, Massachusetts, 1973) 137-138.

24. Straker, 315-316. The methodology given by Gemma Frisius as a way of measuring the eclipse was simply based on the idea of making a circle, divided in advance into twelve parts. When the eclipse occurred, it was then possible to take the paper with the circle and divisions already drawn on it, and to move it back and forth

until it fitted the diameter of the projected sun. The methodically progressive reading of the eclipse was, in this way, facilitated and consequently more accurate.

25. Straker, n.p. In the preface, Straker adds:

> The camera obscura observations in the tent led to Kepler's observation of the transition of Mars in front of the sun. From these observations he formulated three new mathematical laws of planetary motion, with these new proofs the old cosmological circle was deductively broken, and created the first model of the "New Astronomy."

26. Tarnas, 266. With the comprehensive structure of Aristotelian cosmology collapsing and with no viable alternative to replace it, the atomists' universe represented an already well-developed and uniquely appropriate framework which could be placed into the new Copernican system. Giordano Bruno (1548-1600), an Italian philosopher, through his Neo-Platonic image of the universe, created an immensely expanded universe.

27. Cassirer, 189. Bruno put his position in relationship to the idealized active gaze as he asserted that it was not sufficient to observe passively or by mere sensible aesthetic contemplation. Instead, we must perform a free act and a free upward movement of the mind to raise ourselves to it. Through this act, the Ego assures itself of its inner freedom. The knowledge of subject and object becomes interrelated in that the vision of this inner universe is the polar opposite of the Ego's intellectual vision of itself.

28. McLuhan, see note 3.

29. M.S. Hammond, 210. Galileo heard about the Dutch Tube while visiting Venice in 1609. He decided to devise his own tube before having seen the Dutch Tube and did so by using a convex lens for the objective and a concave lens for the eye piece. In this way, he produced a telescope that had an erected image which, at first, had a magnification of eight and eventually refined it to a maximum of 30 magnification.

30. Waterhouse, 278. The telescope camera obscura allowed for the first observations of clear sun spots.

31. M.S. Hammond, 214-223.

32. M.S. Hammond, 234.

33. E.H. Schmitz, *Handbuch zur Geschichte der Optik*, Vol. 2 (Bonn: Verlag Wayenborgh, 1982) 373. Jean Nollet (1700-1770) was the French physicist who invented the microscope.

34. Cassirer, 124. The first fundamental accomplishment was that Greek philosophy took the concept of self-consciousness and the world out of mythical thought. The need arose to relocate and position these concepts by new relative means. The certainty of the

Aristotelian cosmos, fixed and finite, gave definite limits to self-consciousness as the unity of consciousness and the soul. By means of ever further analysis, this united harmonious whole became divided into parts by subsequent empirical knowledge.

35. Cassirer, 178-179. The unity of the universe is based on the unity of rules. Unity can only be grasped through the unity of the medium of multiplicity, and permanence can only be understood through the medium of change.

CHAPTER 4

Organ: Image as soul

The image, the soul, the subject

> Beside my father's coffin I summoned such a skill as I have as a draughtsman, to apply it directly to the task in hand. I say directly because often skill in drawing expresses itself as a manner and then its application to what is being drawn is indirect. Mannerism--in the general rather than art-historical sense--comes from the need to invent urgency, to produce an 'urgent' drawing, instead of submitting to the urgency of what is....People talk of the freshness of vision, of the intensity of seeing for the first time, but the intensity of seeing for the last time, I believe, greater. Of all that I could see only the drawing would remain....Each drawing then was nothing but the site of a departure....[In time] the content of the drawing increased. The drawing instead of marking the site of a departure, began to mark the site of an arrival...and the drawing became the immediate locus of my memories....(John Berger, 1985)[1]

> The Power of Painting is possessed by a divine power, for not only as is said of friendship, does it make the absent [person] present, but it also, after many centuries, makes the dead almost alive, so that they are recognized with great admiration for the artist and with great delight....Thus this art gives pleasure and praise to who ever is skilled in it; riches and perpetual fame to one who is master of it. (Leon Battista Alberti, 1436)[2]

I have juxtaposed the contemporary text of theoretician John Berger and that of the Renaissance theoretician Leon Battista Alberti to initiate the differences in contemporary and classical attitudes toward vision and image. John Berger makes us aware, in the most poignant, personalized way, of the experience and intensity of seeing

and the significance of the meaning of the moment of seeing time past, present and future. His personal experience lends a contemporary metaphor to his capturing and distilling, in a few mimetic lines, the object before its disappearance. A sense of loss marks the psychological emptiness of the moment which reflects back to the observer the minimal means of the drawing. The present memory of the father is erased but, as time distances the event, this same process of memory engages in the reconstitution of the father.

Alberti's quote deals with a more theoretical reflection on the significance of painting. Although he also speaks of painting as the memory of a friend, painting becomes particularly significant in terms of divine construction, giving visibility to both the invisible, divine, mythical history and to immortality or fame. For Alberti, painting is the fabrication and ordering of an imaginary "historical" reality by the ideal selection and ideological ordering of real objects in the world.

In Berger's text, the emphasis is on the appropriation of the present moment for the purpose of, or in consequence of, reconstruction. As Berger posits:

> Because the faculty of sight is continuous, because visual categories (red, yellow, dark, thick, thin) remain constant, and because so many things appear to remain in place, one tends to forget that the visual is always the result of an unrepeatable, momentary encounter. Appearances, at any given moment, are a construction emerging from the debris of everything which has previously appeared.[3]

It is in the distancing from the object that the work lives again.

In Alberti's construction, it is the distant story of history that is brought into the present as the idealized mimetic moment. For Alberti, looking is the looking on an imagined picturing of an historical event for the first time whereas Berger speaks of looking in the present moment for the last time.

In this chapter I try to show the movement from the first seeing towards the movement of the last seeing. In contemporary society the observer has developed multiple techniques of visual memory for herself which underline the final loss of the disappearance of the real moment. In the fifteenth century the only visual pictorial memory was painting or sculpture of which painting was closest to the intangibility of actual memory. The technique of the observer was relatively limited in the techniques of memory outside actual memory. Therefore, one can understand the preciousness of the relatively rare artificed duplicate and the experience of the seeing for the first time. What these texts initiate is the concept of the changes of understanding vision and how this understanding as visualization of vision has affected the visual perception of the world and the construction of the image.

The captured photonic organ as image, soul and subject of the camera obscura drew attention to these possibilities in vision and memory. The camera obscura demonstrated in the imaginary picturing of the observer's mind as soul, the potential of continuous vision. The conduit of light overlaying one image onto another as memory in continuity is also paradoxically responsible for the loss or erasure of previous memory.

This technique for picturing vision was quantified when Kepler drew a relationship between the image formation of the camera obscura assemblage and the image formation in the visual organ (the eye) which he described as continuous perpendicular rays of light coming from the object to the eye or subject.

The ability of the observer to capture and to control the potential of continuous memory as reality found an echo in the already existing desire for continuity as history in the fifteenth century. However, before these ideas could be accepted as truth, the ideological and social circumstances had to be a reflection of the camera obscura's own condition--the condition of the active constitution of the image, the organ, the mind or the soul.

In this chapter I outline the circumstances that surround the "recognition," "rejection" and "reconstitution" of the continuous projected "natural image" as it became appropriated and ideologized one slice at a time. The only constants are the observer and the reflection as nature offered it.

Recognition: of the organ or image by observation, technique and theory.

The recognition of the image as observation, technique and theory is introduced by the Euclidean scholar Barbaro who observed the duality of geometry and natural science in the camera obscura image:

> Now I will describe a most beautiful experiment concerning perspective. If you wish to see how nature shows us the various aspect of things not only the outline of their whole but their parts as well as of their colours and shadows, you must make a hole in the shutter of a window....Here you will see the images on the paper as they are, variations and colours, shadows and movements, clouds and the rippling of water and birds flying, and everything.[4]

Della Porta, the magician and naturalist, related the technique of appropriation inherent in the image as he reflected on the technique of capturing the magic:

> If one can but only make the colours, this is an Art worth learning! Let the sun beat upon the window, and there about the hole put a white paper against it, and you shall so long the men by the light, bringing them near or setting them further, until the sun cast a perfect representation upon the table against it; one that is skilled in painting must lay on colours where they are in the table, and shall describe the manner of the countenance; so the image being removed, the picture will remain on the table...it will be seen, as an image in a glass.[5]

Both these attitudes are relevant to Alberti's theory on painting which constitutes the seeds for recognition but also rejection of the camera obscura image.

Although, in *Della Pittura*, Alberti does not make a direct reference to the camera obscura image, it seems obvious that the analysis of painting nevertheless exudes not only concepts of perspective but also of observed qualities of the projected image of the camera obscura such as described by Barbaro and Della Porta. We recognize this particularly in the following three texts from *Della Pittura*:

> Painting consists of the reception of light...because all colours put in the shade appear different from what they are in the light...is a close relationship between light and colour in making each other visible.[6]

> And let the painters know that, whenever with their lines they draw contours, and with their colours they fill in the areas thus outlined, they have no other aim but to make the shape of things seen appear on the surface of the picture not otherwise than as if this surface were of transparent glass.
>
> A narrative picture will move the feelings when men therein clearly manifest their emotions. It is a law of nature-but those emotions are revealed by the movements of the body.[7]

Each describes Alberti's concept of painting relates to the camera obscura image as it refers to motion, surface and light. He deviated, however, from the "natural image" in the importance he placed on outline and, most importantly, in his ideological position on the constitution and necessity of beauty. Alberti wrote:

> [The painters] will take pains not only to achieve a good likeness of every part, but to add beauty also. For beauty in painting is both welcome and demanded....For this reason always take from nature that which you wish to paint, and always choose the most beautiful.[8]

This insistence on "idealized beauty" is underlined by his attitude to the Greek painter Demitrius "who fell short of the highest praise because he took more pains to make his work like the models than to make them beautiful."[9]

The opposition of selective, idealized beauty and the natural, framed, unselective reflected image of the projected world becomes visible in the camera obscura body. The origin of these expectations for painting in the Renaissance are tied up in the belief structures rigorously advocated by society and the artist. As I hope to demonstrate,

it is for ideological reasons that the specificity of the projected image is rejected as "banal nature" in the southern Italian Renaissance. It was at this early stage that the camera obscura image provided the technique as perspective for the observer and not yet the frame for painting. This movement from the real-idealized to the idealization of the real is, however, present in Barbaro's, Della Porta's and Alberti's texts. As we have seen, the scientist-naturalist, the astronomer and the scientist/artist/magician are all interested in the "natural image" and its inherent potential of truth and illusion.

The projected image is not an illusion in itself but an abstract sign of the world. It is when the observer projects his experience of himself and his understanding of the world back into the image that the illusory dimension is given. A typical example of this relationship to the image is exemplified by Villeneuve, a thirteenth-century miracle-worker and magician who, at this early date, staged theatrical camera obscura projections. He arranged for actors to enact a battle or murder scene in bright sunshine outside a darkened room that was effectively turned into a camera obscura. The room had a small hole in the shutters which projected an image of the scene on an interior wall. The scene was accompanied by appropriate noises and music made by another group outside the room or behind a curtain--sword clashes, screams, trumpets and animal noises accompanied the projection.[10]

In a similar manner, Della Porta gained a reputation as a magician because he took the theatrical possibilities of the camera obscura very seriously. In his notes,

Della Porta advised others that, by following the dramatic skills of a playwright and with the right scenario, they could thrill and frighten their friends and neighbours.

When considering the relationship of the nature of truth and illusion, it is the artist, as scientist-magician, who becomes the double conduit to the image or organ of the camera obscura body.

Rejection: the organ as natural image or soul is rejected from the idealized body.

The ideological field of artistic education in the fifteenth century described by the sculptor Lorenzo Ghiberti (1378-1455) emphasized a liberal education. Included in the curriculum was grammar, geometry, philosophy, medicine, astronomy, perspective, history, anatomy, theory of design and arithmetic.[11] This made the cross-fertilization of art and other disciplines possible. Ghiberti himself was an example of this. He had a good knowledge of medieval classics amongst whom Witelo, like Pecham, dealt extensively with the nature of light in the camera obscura assemblage.[12]

The knowledge transmitted to the artist relating specifically to artistic practice was expressed as a distillation of theory, technique and aesthetics to which was given, at the same time, a moral framework. The early fifteenth-century *Technical Manual* of Cennino Cennini, before the theory of perspective, showed the intensity of the ideological, practical and moral expectation of the artist. Even though this was before

Alberti's treatise on painting, it should be remembered that the camera obscura paradigm had been a major concern of the astronomer for some time and would have been known to the artists.

In Cennini's *Manual*, the definition of a potential artist was someone with a refined disposition given to him by God. This automatically linked the lifelong practice of art as a divine intention with expectations of the true love of God, the fear of God, obedience and perseverance. This was the monastic model of service. The *Manual* also prescribed a code of ethics and conduct to regulate the artist's life: hard, diligent work and moderation.

The specific artistic education constituted an apprenticeship to a master where the method of developing skill was the practice of continually copying from the work of the master as well as from nature. The technique was quite specific. Amongst other things, the Manual mentions examples of painting mountains by copying a large rock, drapery had to be modeled from dark to light and the human body had to be well proportioned. For the correct drawing of buildings, Giotto's rules were followed.[13]

What becomes important to identify with this text is that the artist has already been given a unique position by God to give visibility to Him and His creation. This position also endowed the artist with a great creative authority. However, the aesthete's choices of creation for the glory of God were nevertheless steeped in the

cultural ideology of the moment in which the theological model was its most prominent part. The other important aspects of artistic education were the following two models for artistic development in practice: the idealized model of the master (the second official creator after God) and the model of nature.

Nature, although God's creation, was given an aesthetic hierarchy, with some examples more perfect than others. Perfection in the material object as beauty became the appropriate representation of God. In this context, unmediated Nature is imperfect, like man himself, and becomes a means to, and not the end of, the divine mimetic moment.

The artist, in the service of the paternal master and the ultimate divine creator, is faced with the paradox of the recreation of the immaterial presence of God. This precipitated a conflict from the very beginning between the representation of this immateriality of God and the material necessity of the artist. By simple extension, the necessity of the visual material world of the painting gave material evidence to God's presence. Consequently, this made the material into the experience of God, contradicting the Church's separation of God from material reality in the Medieval thinking of Thomas Aquinas. Cassirer, in *The Individual and The Cosmos in Renaissance Philosophy*,[14] describes this enigmatic position of art and the artist:

> The nature of the artist is his dedication to the world of sensible appearance reaching and striving beyond it....Like Eros he is always joining things that are separate and opposed. He seeks the 'invisible' in

> the 'visible', the 'intelligible' in the 'sensible.' He only truly possesses this pure form if he succeeds in realizing it in matter.[15]

The relationship between the material and divine became understood as the aesthetic experience for the first time in the Renaissance.[16] The image as the soul and the subject then had both divine and material properties through the experience of the aesthetic, connecting the organ and the body. This new materiality, however, separated the immaterial soul of God from the dualistic soul of the earthly body. This was the first aesthetic separation from the divine.

The second separation that occurred was the formulation of "Laws of Nature" which is a separation from the "Divine Law". Alberti's perspective, mediated by the camera obscura, was considered a Law of Nature. It was this law and not Divine Law that now ennobled material reality by demonstrating its cohesion and its quantitative relationships of inner measure and harmony.[17] This underlying concept of harmony as "measure," through the Law of Nature, became part of the concepts of beauty and, therefore, truth. Piero Della Francesca wrote:

> ...painting is nothing but a representation of surfaces and solids, foreshortened or enlarged... perspective is necessary in as much as it determines as a true science the apparent size, shape position....Many ancient painters earned everlasting praise by cultivating perspective, and to be sure many painters without perspective have also been praised; but they were praised with false judgement.[18]

The Law of Nature also became the true aesthetic judge. Perspective as law paradoxically showed cohesive harmony in the ideologies of two contradictory aesthetic positions already forming in the fifteenth century. The double conduit of the Law of Nature or perspective was the division between the Neo-Platonic-idealized concept of beauty as truth advocated in Della Pittura by Alberti, and the exact empirical demonstration of the cohesion of nature as beauty and truth represented by the photonic reflection of the image in the camera obscura body. The artist's relationship to these respective values determined the extent of their artistic practice engaged with the camera obscura assemblage. This duality can most simply be observed in the two almost contemporaneous artists Leonardo Da Vinci and Michelangelo. Their work and thoughts represent both empirically humanized and ideally humanized nature. This is also the double conduit of the image, the soul or the subject.

The subject of Michelangelo's painting or sculpture was not the representation of bodies of ordinary men but rather the idealized body epitomized by the Ancients. Only these superhuman ultra-perfect bodies were worthy of the glorification of God. It is significant that he also separated himself as much as possible from the "technique of vision," believing it to be a means and not an end. Its absolute control was necessary to liberate the prerogative of the artist, that of the second divine creator.[19] These ideas are reflected by Vasari who wrote of Michelangelo: "He surpasses not only all those who have as it were surpassed nature, but the most famous ancients also, who undoubtedly surpassed her..."[20] Michelangelo, in the following quotation, speaks for

himself: "For good painting is nothing but a copy of the perfection of God....In Italy great princes as such are not held in great renown: it is a painter that they call divine."[21]

Da Vinci, on the other hand, whose relationship with the camera obscura image was discussed in the previous chapter, was essentially a humanist-empirical-scientist. Da Vinci was interested in the variety of natural and human subject matter and looked for his models in the ordinary man. Although he believed in concepts of proportions and mathematics, he was concerned with an observable, empirical, exact quantification of visual nature, and the nature of the human mind understood as the soul. Da Vinci himself wrote:

> A good painter is to paint two main things, namely, man and the workings of man's mind [soul]. The first is easy, the second difficult, for it is represented through the gestures and movements of the limbs. And these may best be learned from the dumb, who make them more clearly then any other sort.[22]

Leonardo's interest in the camera obscura image was primarily in its potential to give a more accurate objective demonstration of the natural world. The image allowed him to speculate on man's physiological and mental constructs. The image as the "mirror of the soul" revealed to him the natural soul of man. On the other hand, Michelangelo, as a young artist, reacted against this empirically humanistic attitude which advocated nature as the perfect order. This was emphasized in his attitude towards Dutch painting of his day:

> In Flanders they paint with a view of external exactness or such things as...stuffs and masonry, the green grass of the fields, the shadows of trees, and rivers and bridges, which they call landscape, with many figures on this side and many figures on that side. And all this although it pleases some persons, is done without reason to art...this will appeal to monks, nuns and nobleman who have no sense of true harmony.[23]

For the humanist-idealist, the harmony of the image of a true work of art was a soul that imposed an idealized order on the world to glorify God's creation by improving upon imperfect nature. This is an active construction which I believe also relates to the picturing of vision in the Renaissance. The idea of a ray of vision projected from the eye to the object, selecting one object at a time, as procedure for seeing suggests an energetic intention generated by the seer. Alberti gave this function to the visual ray of perspective, placing the humanist-idealist viewer in a role of actively constructing, ordering and actively observing the world. I term this method of visualizing vision the "active gaze".

On the other hand, the Humanist-scientist believed in the perfection of the visible material nature as the true order.[24] Consequently, in the activity of empirical observation, there was a desire to discover the underlying order and so there was no need or desire to reconstruct the world. The activity of the seer was in the relatively passive observation of the world. These two views can perhaps best be identified as the **active constructional gaze** of idealized vision and the **passive observational gaze** of natural vision.

For the artist, perspective, as the technique of construction and observation, contributed quantitative certainty. Paradoxically, it promoted an ever-more ideal model that divided the soul as an agent or a patient, projecting or receiving. This stratification of the image, the subject and the soul led to a new plateau of complexity and certainty.

The origin of the split in the nature of the identification of the image and its related ideologies was already visible within the two related yet separate interests of Alberti. As cartographer, he documented the world as it existed through empirical observation, utilizing perspective among other methods and, most likely, the projection of the camera obscura since it was considered a useful tool for this activity.[25] As a theoretician, Alberti succumbed to the mythology of the divine artist and the Neo-Platonic model of Greek thought for painting. This context gave form to the notion of idealized nature. But perhaps even more so was the intention of separating the craftsman's activity of surveying the land with measurements as truth from the liberal artist. The status of the painter was elevated not only through measurements of geometry, but also the concept of the literary poetic notion of idealized beauty.[26] That is why, for Michelangelo and other Italian artists, the empirical-humanist Flemish painters where considered to be neither true artists nor thought of as having a sense of true harmony and beauty.

Reconstruction: the organ or image as soul is uniting with the body.

It becomes evident that the empirical humanist soul/image could only develop fully in the terrain in which its technique was also its ideology. This was the case, as we have already seen in astronomy, magic and sciences. In relationship to painting in the sixteenth century, its most receptive field was situated in Holland and England, not, surprisingly, due to similar socio-political and ideological conditions.

By the sixteenth century, England, as a Church State separated from Rome, had a strong tradition of empirical science and liberal philosophy. As we have already seen in previous chapters, this was in large part due to Grosseteste, Bacon and Oackham. Papal domination had also, by tradition, been resisted in Holland. The separation of Holland from Rome was due to the Protestant Reformation. Luther revolted against the corruption and material wealth of the Catholic Church, used to a large extent in the material glorification of God. Holland, like England, was subject to an early form of philosophical liberalism. There was religious toleration, valued commerce, industry and, consequently, a rising middle class that set itself up, tolerating the Church but not giving it political power. Due to colonialization, private property acquired by personal labour was held in high esteem. The divine right of kings was rejected, giving every community the right to self-determination. This created the undercurrent to the belief that all men were equal. There was a strong emphasis on education which created a critical climate in relationship to the government. Protestantism asserted that the general council was not

infallible in its conclusions which determined truth (no doubt a reaction to the Inquisition), and so, truth became a personal rather than a collective social enterprise.[27]

Holland initiated, but also adopted, many reflections of liberalism expounded by the English philosopher Locke who had taken refuge in its tolerant climate to formulate his philosophical, political and social beliefs in *The Essay on Human Understanding*.[28] Holland, being a liberal haven, was also sympathetic to the reflections of another exile, René Descartes, who was looking for solitary contemplation. Cartesian philosophy, like Locke's, was orientated around the experience of the individual's self-determination to the extent of the famous Cartesian proposition: "I think therefore I am." This made the knowledge base different for each person.[29]

The ideological climate established by these individualistic and materialistic attitudes are reflections of the camera obscura assemblage. The authority of this relationship is the psychological field between the object and the subject, or the observer and the image. The humanist/scientist/artist is the organ, the image and the soul. The camera obscura assemblage is the mechanism of extension by which the measure of the mind or the soul is invested.

Cassirer talks about the Renaissance as forming, in its philosophical and scientific form, the psychological and intellectual movements from which emerge the newer, deeper concept of subjectivity. This comes out of the opposition between the path

of spiritualism in the Florentine academy that negated the value of nature when it conceives of soul and life as unity, and the view of nature as the complex of a singular and all-embracing continuity which must, by necessity, deny immortality.[30] But, in the Humanist moment of the seventeenth century, there seems to be a union between these opposing views.

> ...the lyrical mood does not see in nature the opposite of psychical reality; rather it feels everywhere in nature the traces and the echo of the soul... the landscape becomes the living mirror of the Ego....for precisely in the function of reflecting the soul, nature itself possesses only a mediate and as it were reflected reality. Nature is not sought and represented for its own sake; rather its value lies in its service to modern man as a new means of expression for himself, for the liveliness and the infinite polymorphism of his inner life.[31]

The psychological field is also the field for the technique of the observer. The technique of optics was an industry actively pursued in Holland since the beginning of the seventeenth century. The early stages of the optical industry in both Holland and England were, to a large extent, based on the need for lenses to construct new astronomical, optical and navigational instruments for the large colonizing navy. These very profitable, rare instruments were originally constructed by a number of skilful but highly secretive spectacle makers and artisans in the sixteenth century. However, enthusiasm for scientific observation promoted the making of lenses by amateurs. For example, Galileo, Scheiner and Constantijn Huygens all had their own optical workshops. This climate of enthusiasm had its opposite in Renaissance Italy. The theoreticians of both art and science argued against the use of optical instruments in both fields due to the complexity of optics in relationship to the single ray theory.[32] The theoretician, Vasco

Ronchi, expressed the following reaction to the introduction of mirrors, lenses and prisms:

> ...which bring inescapably an alteration of truth...these instruments make us see figures where the material objects are not and often make us see them enlarged or reduced, inverted, distorted, double and coloured. It is all a trick and illusion. All optical means must be illuminated if we really want to reach the truth. No one considers mirrors, lenses, particularly curved mirrors, worthy of serious and conscientious study.[33]

The seventeenth-century Dutch theoretician Hendrick Honduis, in his perspective treatise of 1620, had just the opposite sentiments about using optical devices:

> That which ravishes [enraptures] the spirit of men is an admirable effect of which the cause is unknown: Otherwise should one discover the trick half the pleasure is lost...All the graciousness consists in posing skilfully the fact, disguising the artifice, and frequently changing the ruses to give value to the pieces.[34]

In this text, the artist takes pleasure in revealing the effect but hides the method, as it would destroy the elusive "natural picturing" of the world. The idea of graciousness is the knowledge of the underlying truth, manipulating and using it to valorize the object without leaving traces of its technique which would otherwise destroy its illusion or mystery. This joyous archaeological sentiment is profoundly related to the mysterious technique of memory. The sense of wholeness, a moment in the continuum of memory, is the natural moment of observation unerased by other memories. This is the state of grace for the observer or the act of graciousness on behalf of the artist as a gift to the observer.

John Berger defines this as the point of affirmation:

> When the evolution of the natural form and the evolution of human perception co[inside]coincide to produce the phenomena of a potential recognition: what is and what we can see (and by seeing also feel) sometimes meet at a point of affirmation. This point is co-incidence, is two faced: what has been seen is recognized and affirmed by what (she) sees. For a brief moment one finds oneself--without the pretensions of a creator--in the position of God in the first chapter of Genesis....And he saw that it was good. The aesthetic emotion before nature derives, I believe, from this double affirmation.[35]

The natural image valorized by this recognition of symbiosis is the sense of underlying and overt wholeness in the ideology of the soul as beauty and truth. It is in this very spirit that the Dutch statesman and close friend of Descartes, Constantijn Huygens, who had a profound interest in mathematics, optics, philosophy, politics, art and history, exclaimed about the camera obscura:

> I have at home Drebbel's [a Dutch expatriate instrument maker living in England] other instrument, which certainly makes admirable effects in painting from reflections in a dark room; it is not possible for me to reveal the beauty to you in words; all painting is dead in comparison, for here is life itself or something more elevated if one could articulate it. As one can see, the figure and the contour and the movements join together naturally and in a grandly pleasing fashion...it is a beautiful brown picture...is really one of the masterpieces of his sorcery.[36]

Huygens's reaction to the camera obscura comes from two major sources: the first being the metaphysical aspirations of Protestant Holland which was actively anatomizing the nature of the human soul, and secondly, from his friendship with Descartes who promoted his passion for questions on optics and perception. Descartes's own study of optics was facilitated by his access to many diverse kinds of lenses. If, in

France, the optical instrument-making ability was stifled by guild restrictions which did not apply in England or Holland,[37] Descartes, through his friend Claude Mydorge, had concave mirrors available to him--lenses of every shape: parabolic, hyperbolic, oval and elliptic.[38]

Descartes's passionate study of the field of optics and vision as the image or the soul in *Dioptrics* was grounded in geometry and extended into the field of perceptual optical phenomena. This undoubtedly helped to form his aesthetic conclusions which had a major influence on the thinking of Dutch painting in general, but more specifically on Dutch landscape painting. It was Huygens who actively disseminated Descartes's ideas among the artists of Holland. Descartes was interested in the image, in vision as the experience of the senses received and interpreted by the brain as the mind and seat of the soul. Maurice Merleau-Ponty, the French philosopher, called Descartes's vision blind vision[39] because, like the blind man's experience of sight through the senses, vision becomes internalized and therefore personalized. (Illustration 10.) Descartes described this himself in *Dioptrics*:

> [If we] admit that objects of sensations actually do transmit images to the interior of the brain or soul, we must at least observe that no images have to resemble the objects they represent in all respects, otherwise there would be no distinction between the object and its image.[40]

This eliminated the need to conceive of all aspects of the image other than purely its visual appearance which is the underlying visual material truth in the projected image. It is a vision that discovers itself in terms of its material pictorial reconstruction

Ill. 10 Illustration from 1724 edition of Descartes's *La Dioptrique*, describing his concept of "blind vision."

as representative, not identical to the world. As Berger's views on art still express in the twentieth century:

> Art does not imitate nature, it imitates a creation, art is an organized response to what nature allows us to glimpse occasionally. Art sets out to transform the potential recognition into an unceasing one...[41]

It is at this moment that the Greek mimetic self-contained idealized construction of the Neo-Platonic model is transcended.[42] Descartes's belief holds that the value of painting is based upon independent artistic creation and not on preconceived rules.[43] This is the rationalization of the separation between the image and the real world or the body and the soul, marking art as a spiritual activity. In the union of the soul/nature of material visual reality, a new plastic relationship between the self-discovering soul of man and the material world around him is established. Therefore, the created image mediated by the camera obscure becomes the measure of the human soul as the divine soul.

If, in Renaissance Italy, the relationship between the material and the divine became understood as the aesthetic experience, in seventeenth-century Holland it was the relationship between the material and the human soul that was understood as the aesthetic experience.

If one is persuaded by the autonomy of the image or soul by Descartes and Huygens in the seventeenth century, there is another factor that seems to have contributed

at an earlier date to this particular authority of independent vision. Perhaps the first clue, as Alpers suggests in her book on Dutch Art, *The Art of Describing*, might come from the fact that the Dutch did not differentiate between the outline as drawing and the filling-in as painting (there is no outline in a projected camera obscura image). These terms were often interchanged. Drawing was considered "imitating things after life even as they appear."[44] It was also hinted that painting would not hinder, but help, drawing.[45] The idea of painting coming before drawing suggests a different way of perceiving the visual world. Alpers mentions the possible source for this potential difference. It seems that the Dutch artist, at a very early time, associated perception and vision. Alpers suggests that this might be related to a different interpretation of the principle of *perspectiva* as the act of seeing.

The earliest northern European tract on perspective, *Artificiali Perspectiva*, was written in 1505 by the French priest, Jean Pelerin, known as Viator. It appears that he assumed from the very beginning that representation replicates vision which he defined in terms of "the moving eye reflecting the light it receives like a burning mirror."[46] The image is of the concave mirror. This allowed him to picture the reception of an image on the eye like in a mirror. This was in contrast to Alberti who was not concerned about the nature of the organ of the eye in vision. A diagram of Viator's theory of perspective demonstrates his idea (Illustration 11). In it, we see that "the centre point in perspective and the two distant points are all located on the same line at the level of the eye...."[47]

Ill. 11 Viator's perspective demontration, a woodcut of his living room and three diagrams illustrating the development of perspectival projection.

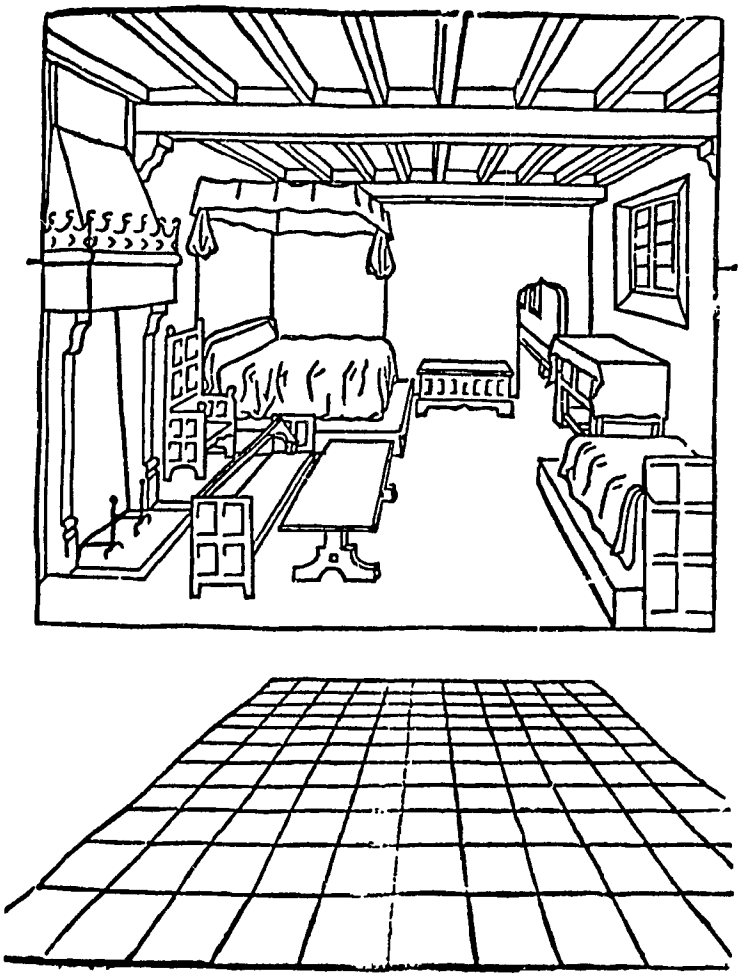


FIG. 23. WOODCUT OF VIATOR'S LIVING ROOM

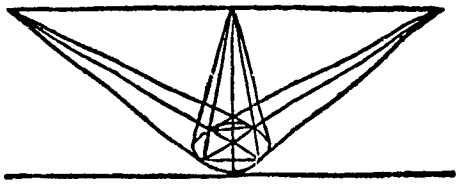
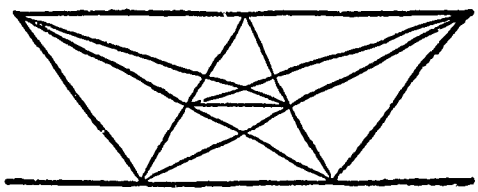


FIG. 25 VIATOR'S SECOND DIAGRAM



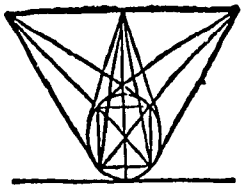


FIG. 24 VIATOR'S FIRST DIAGRAM

This suggests a flattening out of the space since perspective points arrive on the same plane as the eye point. In Alberti, this becomes a single vanishing point in the distance.

Alpers posits a belief that this is a different picturing of vision and a different conception of space. Viator's perspectival illustration for his treatise is also equally intriguing. It is a woodcut illustrating a perspectival view of the author's living room. This is a voluntary penetration into the author's private space. Had Alberti illustrated his book, it is unlikely that it would have reflected either his personal or domestic environment. It would rather have been an example of classical architecture or architectural setting.

This domestic image as the example of picturing vision is in rapport with vision impinging on a private space of the body. This idea, as I have tried to show, was the consequence of much speculation in the sixteenth century, concluding with Kepler's demonstration and understanding of perpendicular rays of light travelling from a point on the object to a point in the eye, from the object to the subject, forming an image on the retina. In the beginning of the sixteenth century, Viator's way of picturing vision initiated, for the Northern observer, this passive observational gaze: simply open your eyes and the world will impinge itself with pictures. In this passive gaze you do not build visual pyramids, you simply turn your head to receive another picture or view.

If one follows this reasoning of vision, placing oneself into the position of the Southern idealized, actively constructional gaze, then imagines the difference in visual responsiveness to the Northern (Dutch) observational passive gaze, the list that Alpers has compiled of the topographical differences for the Northern and Southern painters is remarkably in tune with the ideology and technique of vision of their practitioners.

OBSERVATIONAL GAZE	CONSTRUCTIONAL GAZE [48]
Attention to many small things	Attention to a few large things
Light is reflected off the objects	Objects are modelled by light and shadow
Objects and textures with emphasis on colour rather than legible placement in space	Placement of objects in legible space
The unframed image (the natural frame)	The framed image (the idealized frame)
The viewer is not clearly situated	The viewer is clearly situated
Texture versus form	Surface versus objects and space

Whether or not the original concept of the projected image of the camera obscura directly or indirectly impinged its own paradigm on the image through perspective belief structures and concepts of vision is, perhaps, not any more important than its very demonstration of interdependence. What is clear is the difference of the ideological connection between the active seeing that constructs and the passive gaze that observes. The passive gaze is the Humanist Moment when the individual accepts, but

also legitimizes, the privilege of the position of the observer-voyeur who, with a Theosophic view, observes the soul of man in the soul of the world.

The seventeenth-century Dutch painter, Jan Vermeer, epitomizes the observation of the soul with this passive gaze, putting the observer as voyeur into the private homes and the private moments of the people who inhabit them. This argument is grounded in Alpers's analysis. Whether it is in the painting *Lady Reading at an Open Window* (1658), *Maid Servant Pouring Milk* (1660), *A Painter in his Studio* (1666), or *The Love Letter* (1670), we are moved into the collective social body as the private space of the soul. This privilege puts the observer into a non-judgemental position. We, as the observer, have no identifiable place. We are so engaged in the complex textures, colours and surfaces captured in light that we lose the consciousness of our own presence in the intimacy of someone else's private thoughts, conversation or observation. The progression of rooms and of suggested spaces in the mirror reflections in Dutch interior views draws our curiosity further into this private body, towards a reality that we believe exists very much like the underlying belief in the order of the natural image. We are, after all, the passive observer held by the material and psychologically-charged density of the private soul. We are arrested on the threshold that we do not cross. We are observing, absorbed beings in the "moment" of being, or "Dasein,"[49] grounded in temporality. We take our place as the observer in the continuity of the visual. There is no need for us to meet the event since the event has already entered us.

Where else but in the camera obscura or in the vastness of a landscape does one have the focus and the anonymity of one who can let go and be so unconsciously absorbed as a passive observer in the colour and textural, patterned density of light? It was just this quality of light, the density of the colour and rendering of forms without outlines, the sense of voyeurism and the strange beginning of the cultural panopticum that link Vermeer with the camera obscura. In fact, speculations of Vermeer's possible use of the camera obscura can be deducted from certain optical effects observed in his paintings that cannot possibly have been perceived with the naked eye.

Daniel Fink, in his article "Vermeer's use of the Camera Obscura--A Comparative Study," examines twenty-six of Vermeer's paintings in order to identify possible optical phenomena caused by the use of a lens:

> Ten points of correlation were discovered between data from the paintings and data gathered during laboratory experiments: 1) Principal plane of focus; 2) precise diminution of circles of confusion; 3) halation highlights; 4) precise treatment of reflections; 5) closeness to point of view of the window wall; 6) precise convergence of parallel lines located in a plane perpendicular to the viewing axis; 8) use of curtain to darken viewing room; 9) relative detail in still-life portions of the paintings; and 10) dimensional precision in rendering objects.[50]

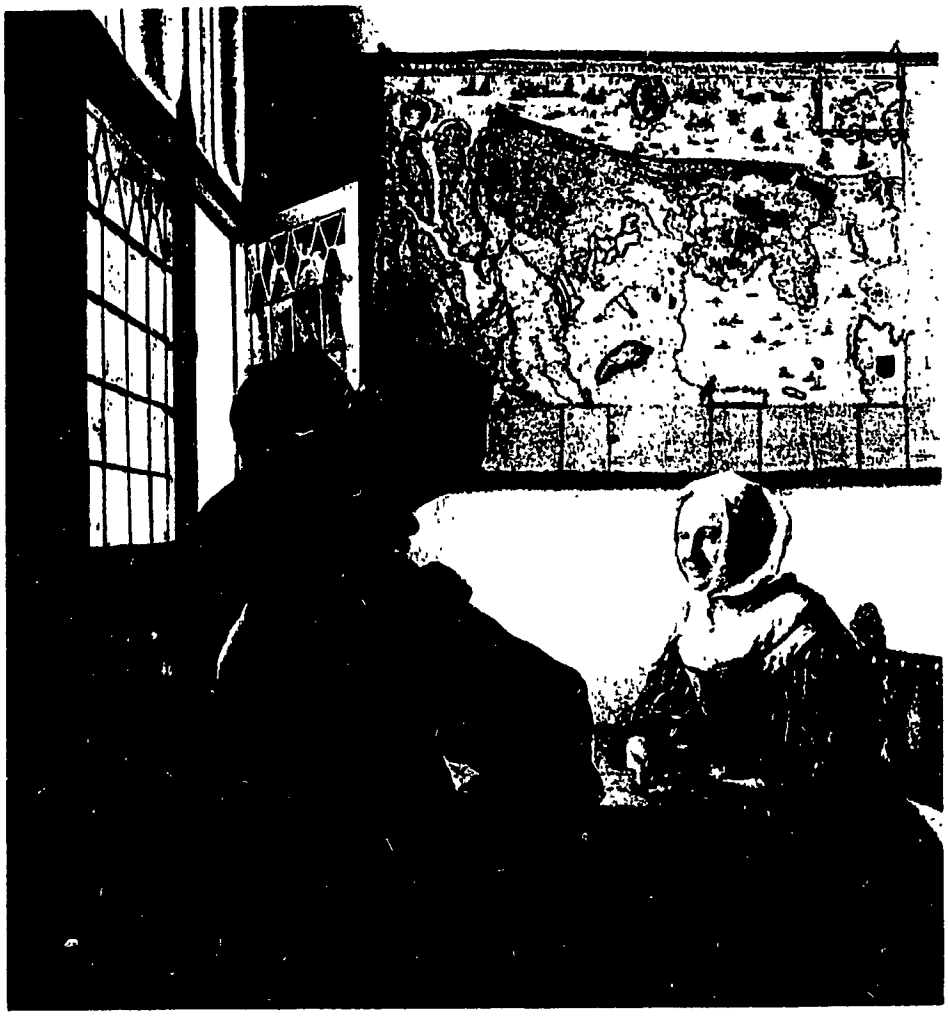
Although the intention of this text is not to give a detailed analysis of Vermeer but rather to suggest the original circumstances and origin of his context, the following analysis is intended as an extension of the camera obscura paradigm.

In the painting *Soldier and Laughing Girl* (Illustration 12), two planes of focus exist. It is suspected that Vermeer focused separately on the far wall and on the officer sitting near the frontal plane because out-of-focus images would have diminished their value. Also, the larger relative size of the officer in relationship to the girl is an optical effect of the projection of the image through a lens. Halations and highlights, ordinarily not perceived by the naked eye, occur when there is a refocussing from one plane to another. Vermeer demonstrates an incredible understanding of mirror image formation in his paintings of mirror reflections.

Contrary to the practice of other artists at the time, Vermeer painted still-life material in more detail than was customary. However, this could also have been because his father had a textile business. The heavily-patterned curtains and covers so readily available to Vermeer might have also instilled in him a fondness for their complex patterns and beautiful colours. Certainly, the detail would reproduce magically in the projected image. If this is only a very brief indication as to the possibility of Vermeer having used the technique of the camera obscura to make his paintings, the most convincing proof comes from Philip Steadman, a contemporary English architect.

Steadman reconstructed Vermeer's painting *The Music Lesson* (1670) (Illustration 13, figure 1) in three dimensions. In Martin Kemp's book, *The Science of Art*, Steadman gave part of the explanation for this proof. First, he evaluated the relative

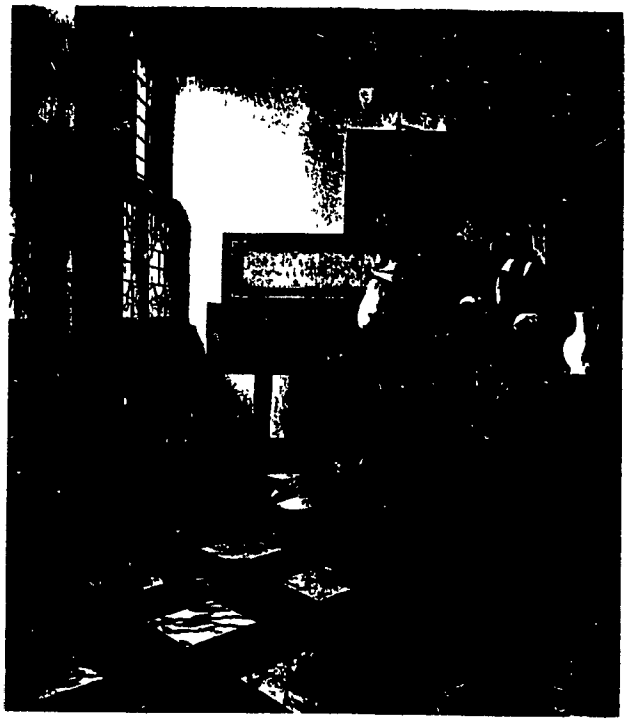
Ill. 12 Jan Vermeer, *Soldier and Laughing Girl* (c.1660), New York, Frick Collection.



Ill. 13

Fig. 1 Phillip Steadman, *Model of the Music Lesson*, photographed as though from Vermeer's point of view.

Fig. 2 Top left. Jan Vermeer, *The Music Lesson* (c.1670), London, Buckinham Palace. Collection of Her Majesty the Queen.



size of the objects in the room by using the measurements of a map that was in another painting, *Soldier and Laughing Girl*, set in the same room. He then worked out the number of windows from reflections of windows in a brass globe in another painting, thereby establishing the size of the room which is normally never visible in its totality. He reconstructed all the objects to scale that are in the painting of *The Music Lesson* (Illustration 13, figure 2) and placed them in the appropriate position in the room. He simulated the correct light falling through the windows into the model and onto the furnishings. When he took a photograph from the estimated position of the painter, he found a remarkable parity between the shadows cast in the model and those in the painting. Perhaps the most convincing proof, however, came after Steadman located the approximate position of the optical apparatus near the end of the room which he and others believed to have been blocked off by a heavy, dark curtain or wall. Through an aperture and lens, light entered into the blocked, dark space. From there, the room was projected onto the projection surface whose distance would have been within the possibilities of the extremities of the room. Using lenses that would have been available to Vermeer, Steadman calculated the size of the actual reflected images of the room. He discovered that the relationship of the size of the projection, considering the relative position of the painter in the room in relationship to each painting, correlated, within a very small percentage, the actual size to the projection of the camera obscura image.[51]

Providing absolute proof of the use of the instrument by Vermeer is not as important as establishing a relationship between all the elements that construct a

paradigm with which, in turn, we construct our lives. Each paradigm is a model of this process. Both Genre painting and Landscape painting became possible through the collective cultural circumstances represented in the ideologies of economic strategies, attitude, philosophy, religion and the general knowledge base. The picturing of vision is supported by the understanding of the apparatus. All this contributed to the perception and acceptance of the idea of the frame of vision as philosophical and psychological concepts of identify through the technique of the camera obscura image. It is the frame of the passive observational gaze and not the re-ordered idealized constructed frame that stratified, at this time, the plane of consistency of the camera obscura image. Berger reflects on several aspects of the possible stratification through Vermeer's *View of Delft*:

> If for the diagrammatic convenience, one accepts the metaphor of time as a flow, a river, then the act of drawing, by driving upstream, achieves the stationary. Vermeer's View of Delft across the canal displays this as no theoretical explanation ever can. The painted moment has remained (almost) unchanged for three centuries. The reflections in the water have not moved. Yet this painted moment, as we look at it, has a plentitude and actuality that we experience only rarely in life. We experience everything we see in the painting as absolutely momentary. At the same time the experience is repeatable the next day or in ten years. It would be naive to suppose that this has to do with accuracy: Delft at any given moment never looked like this painting. It has to do with the square density per square millimetre of Vermeer's looking, with the density per square millimetre of assembled moments.[52]

Although the view of Delft has long since changed, the potential nature of the gaze has not. We experience this view every time we look at it as a new place of arrival, the renewal of the same moments of observation and conservation of memory recaptured. Jan Vermeer was situated in a cultural climate of reverence for mathematical

certainty and objective observation of nature by the most precise instruments, optical and mechanical, of the time.

His technique for observation was simultaneously paralleled by Athanasius Kircher, a German Jesuit who believed in magic, the occult and astrology. In his publication *Ars Magna Lucis et Umbra* (1646),[53] he described two set-ups for using the camera obscura as a drawing and copying device. (Illustration 14.) Mary Sayer Hammond relates:

> Kircher introduced what he called a "Conclave," a device he had seen used in Germany, to copy objects and to produce likenesses. It consisted of a large box mounted on top of two long poles. The artist entered through a trap door at the bottom of the box. Lenses are placed in the middle of two opposing external walls of the box. Inside thin paper was stretched across wooden supports, creating an internal "box" parallel to the walls. The artist was inside the paper box where he saw the still inverted but left to right corrected images. It is possible that there were four lenses with four views that the artist could simultaneously copy, conceivably a panorama.[54]

As the lenses were being refined, housings were also being adapted to every kind of practice. Their application, whether portable or permanent, varied from portraiture and landscape drawing to cartography and anatomical drawings such as William Cheselden's medical illustrations in *Osteographia or the Anatomy of Bones* in 1733.[55] (Illustration 15.)

Although the use of the camera obscura by amateurs is well known, there are only a few confirmed examples of its use by professionals. (Illustration 16.) This

Ill. 14. Kircher's double camera obscura, from *Ars Magna* (1646). It was unlikely that the room was twice the height of the man; this was just a way of demonstrating its use.

Ill. 15 From *The Forces of Nature* by A. Guillemin. A camera obscura for enlarging objects for the purpose of drawing, also termed a megascope.

Ill. 16 Giafrencensco Costa included a small tent camera obscura on a stand in his engraving of a canal in about 1750.

is not surprising as it seems quite in character with the time to have kept the technique of the specialist a secret, whether they where lens makers, dyers or artists.

There were many instances where the use of the camera obscura was suggested as a method for learning to draw. In 1755, Charles Antoine Jombert, in *Méthode pour Apprendre le Dessein*, wrote:

> It can be noticed regarding the camera obscura, that several Flemish painters (according to what is said about them) have studied and copied, in their paintings, the effects that it produces and the way in which it presents nature; because of this several people have believed that it was capable of giving excellent drawing lessons for the understanding of light that is called chiaro-oscuro.[56]

Although Jombert argued that colours in the camera obscura were condensed and were therefore more intense than normal, stronger and brighter, as was perceived in the paintings of Vermeer, he argued not against the use of the camera obscura for drawing but against the heightened sense of coloured reality that so appealed to Constantijn Huygens. If it appealed to the Dutchman whose individualistic spirit was also underlined by the political event of the independence of Netherlands's ten provinces from Spain in 1648, it would seem that the assemblage of the camera obscura, so popular in Europe during the seventeenth and eighteenth centuries, would also have had some appeal to the new Republican spirit of their American counterparts. In fact, Lisa Fellows Andrus, in her dissertation entitled "Measure and Design in American Painting, 1760-1860," makes a direct parallel with the America born during the Enlightenment:

"...a time when men attached great importance to the close observation of fact and to reason, logic, and order."[57]

The American eighteenth-century intellectual framework also came from John Locke's empiricism and Sir Isaac Newton's principles of natural philosophy. Painting, in America, generally served a pragmatic purpose whether it was the painting of signs, walls, the recording of likenesses, social situations or landscape views. This practical approach also influenced the working method of the artist. The unavailability of art education was compensated by the importation of drawing manuals and aids from Europe which gave instruction on the art of accurate drawing and painting. It was American landscape painting that raised the craft of painting to an art. The first landscape painters, Andrus suggests, aimed for topographical accuracy in representing expansive views from high vantage points, specific townscapes or stately homes. Drawing tools, which included the camera obscura, were used for this purpose.

As in Europe, not many direct mentions of this instrument are made by professional artists. One exception is the nineteenth-century American painter John Neagle who, in his notebook on landscape painting, simply noted that for the purpose of drawing the landscape, "the study of the camera obscura I highly recommend." Neagle's contemporary, the painter Frank Guy, also owned a camera obscura tent for drawing townscapes, landscapes, portraits or other objects.[58] As further support for the use of the camera obscura at this time, Andrus also indicates that:

> ...there were enough advertisements in newspapers, periodicals to indicate that there was a market for aids; many of the drawing manuals gave instructions for making graphs, camera obscuras, and perspective machines.[59]

Sometimes it was only possible to know whether artists used a camera obscura if it were listed in their inventory at the time of their death, as in the case of Thomas Cole (1801-1848). As Andrus suggests, if a relatively destitute itinerant painter like Cole had a camera obscura in his possession, it would seem that the camera obscura was a fairly commonly-used instrument.[60]

In the context of nineteenth-century Canadian painting, a portable camera obscura was listed in the inventory of the Quebec painter Joseph Légaré (1795-1855). This tent is now in the archives of the Musée du Séminaire de Québec. (Illustrations 17, 18 and 19.) Légaré, a self-taught painter, was Canada's foremost native-born pioneer landscape painter. For him, a camera obscura would have been an important and appropriately instructive tool.

Although the camera obscura usage in American painting must have had some influence over Légaré, eighteenth-century Quebec also had its practical connections with the camera obscura as a tool. This connection came through the English military topographers stationed at the Citadel of Quebec City. Their knowledge of the camera obscura came from their training at the Military Academy in Woolich, England, under Paul Sandby (1725-1809). Sandby and his brother Thomas (1721-1798) were well-known

English water-colourists, employed by the British government as official topographers at the Drawing Office of the Tower of London. It is well documented that Thomas Sandby used a camera obscura for many of his topographical drawings. (Illustration 20.) Paul Sandby's primary association with the camera obscura came through his very well known watercolour of 1775 of Rosselyn Castle in which a woman is illustrated using a camera obscura.[61] (Illustration 21.)

It is known that Paul Sandby extended his courses beyond the basic military needs to give comprehensive instructions in watercolour landscape painting. According to J. Russell Harper, author of *Painting in Canada: A History*, many of the young officers under Sandby's tutorship blossomed into accomplished amateur painters. Harper suggests that there were at least fifty British topographers who served in the four Atlantic Provinces, in Quebec and in Ontario. Three of the most important military topographer-artists, Thomas Davies, who painted between 1757-1812, George Heriot, at the turn of the century, and J.P. Cockburn who painted in the 1820s and 1830s, were all students of Sandby.[62]

The camera obscura was used by J.P. Cockburn while he was posted as Lieutenant-Colonel to the Citadel at Quebec City in 1827. This apparatus has been mistakenly identified by Harper as a camera lucida, a more recent device than the camera obscura that consists of a prism which, when placed in front of a draughtsman's eye,

appears to him to project an image, thereby assisting him in copying. In fact, the description given by Harper is clearly that of a camera obscura:

> Through a pinhole this "slow motion camera" projected a reverse view on a sheet of paper inserted into the back. The artist rapidly traced the salient features in pencil. This required considerable skill but a practised hand could sketch landscapes and even slow moving processions. As Cockburn once drew a funeral procession in this way. He reversed the pencil sketch in completing a watercolour.[63]

Harper also confirms that this instrument was used by other visiting topographers.

It is documented that Cockburn frequented Montmorency Falls on picnics with the governor's household. The governor's wife revealed in a letter that he had an enormous collection of his own drawings from all the places in the world that he had travelled to, "some coloured from nature."[64] Cockburn could certainly have introduced Joseph Légaré to the camera obscura because it is well-known that Légaré, according to John Porter, author of the National Gallery of Canada catalogue entitled *The Works of Joseph Légaré 1795-1855*,[65] made drawings and paintings for the British officers stationed at the garrison in Quebec City.

Perhaps it was not only from the watercolour topographers that Légaré heard of the camera obscura but also from James Woodley, an English miniaturist portrait painter who helped Légaré in the decoration of the new Theatre Royal.[66] Travelling artists frequently used a camera obscura or a camera lucida to make quick, accurate portraits.[67] It is therefore evident that drawing aids, including the camera obscura, would have been well-known in Canada.

It is interesting to note that Légaré's outdoor subject matter often included sites that had been depicted by military topographers. One of these sights was the view of Quebec City from Point Lévis. A painting of this site by Légaré titled *Quebec City at Sunset* was acquired in England in 1958 for the Musée de Québec. John Porter believes that this painting might have been sold by Légaré to an English customer during the artist's lifetime. It is for this reason that Porter connects this painting to a series of small oil on paper sketches that were also sold to an Englishwoman. A similar set was offered to Jacques Viger, mayor of Montreal. Légaré wrote, in a letter to Viger, that these works measured 6 to 7 inches by 5 inches, and adds: "I have made a similar set for a Lady in Liverpool."[68]

These small drawings provide the tangible connection to Légaré's use of the camera obscura. This has been verified by re-enacting Légaré's method of projection with his actual camera obscura. Using Steadman's methodology with Vermeer in determining size correspondences, the use of Légaré's actual instrument proved pivotal. Its optical configuration consists of a prism arrangement that acts like a lens and mirror that projects the image of the exterior view onto a drawing surface. The projected image has a diameter of 7 1/2 inches. Taking into consideration the size of this projection, it becomes evident that there is a direct relationship between the 5 by 6 1/2 inch oil sketches and this camera obscura.

As noted, the maximum size of the circular projection is 7 1/2 inches in diameter. The maximum horizontal landscape format that can be superimposed on the circular projection is 5 by 6 1/2 inches. (Illustration 22.) This is exactly the format of the drawings identified by Légaré in his letter to Viger and also matches others still in existence.

With this verification of the size of the small works, a comparison can now be made to the larger works on paper, usually executed in oil, gouache and charcoal. These, on the average, are three times the size of the small works. (See Annex 2.)

Porter described one of Légaré's large oil sketches, *The Huron Village of Jeune Lorette*, as being squared or gridded for enlargement. As its actual size is already three times the size of the small oil sketches, it is more plausible, given the above evidence, that the grid indicates that it has already been enlarged from the smaller version.[69] The proportions in the large landscape oil paintings on canvas also correspond directly to those in the small works.

Aside from the coincidence of size, there is a specific optical phenomena observed in Légaré's paintings that can be associated with the camera obscura. One of these is the relative proportion of foreground to middle or background. (Illustration 23.) The foreground is proportionately enlarged in a similar manner as already observed in Vermeer's *Soldier and Laughing Girl*. This optical distortion can be identified in a

number of Légaré's landscapes, one of which is *The Huron Village of Jeune Lorette.* (Illustration 24.) Porter interprets this optical abberation as Légaré's aesthetic decision:

> The layout of this sketch is very daring. The grey sky is confined to a thin strip in the upper part of the work. This enables to highlight the wild strength of the falls whose waters are massed [in the foreground] in contrasting planes.[70]

This is equally true of *The Saint Charles River Falls at Jeune Lorette* (n.d.). (Illustration 25.)

Porter also mentions that Légaré might have copied other engravers when portraying well-known monuments or sights, such as Niagara Falls.[71] Although it is perfectly within Légaré's methodology to have copied directly from engravings, it is even more probable that he used the camera obscura *in situ*. In fact, the camera obscura was in common use, this site specific copying technique inevitably led to an accurate portrayal of subjects by a number of different artists, thus giving the appearance of having been copied from engravings.

One final deduction can be made for Légaré's possible use of the camera obscura; it relates to the particular qualities of light unique to the projected image. In the small sketches, the optical effect of highlights is obviously present. This phenomenon can only be observed when the image is projected through a lens. However, when Légaré enlarged *The Saint Ferréols Falls* (c.1842), the highlights were no longer present. (Illustration 26.)

Porter also observed a quality of light in Légaré's work which is not found in some of the more conservative landscape renderings of the time. Three examples are given. Of the painting, *The Huron Village of Jeune Lorette*, Porter writes:

> [It] is bathed in a vibrant light which catches the buildings, the rock slopes, and the rushing waterfalls. These roaring falls painted with an impressionistic touch and with a sureness of hand approaching mastery cannot but arouse admiration.[72]

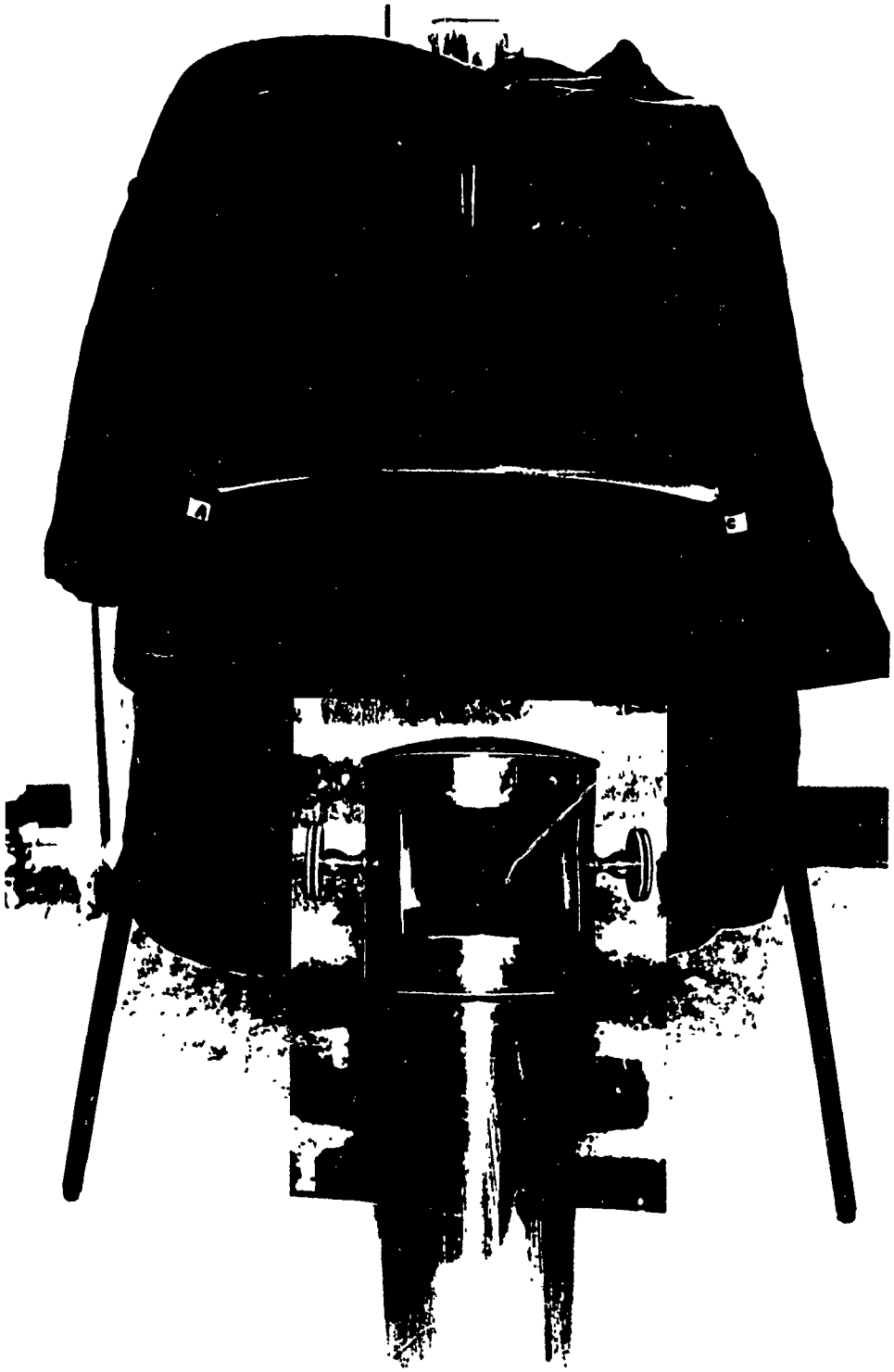
The painting *Quebec City at Sunset* (*c.* 1835) is also described: "...at the time of day the sun sinks behind the town, giving it a highly romantic luminous quality....The buildings of its lower town and quays, disappear into the shadow of the cliff."[73] The most dramatic and convincing example is Légaré's *Montmorency Falls*, a graphite gouache and oil on paper which Porter describes as having "...[an] exceptionally luminous quality about it. Painted in bold brushstrokes with an almost impressionistic touch, it presents a limited range of colours in which orange predominates."[74] The particular intensity and luminosity of Légaré's colour, which Porter has acknowledged, can be directly related to the quality of the projected image in the camera obscura.

Joseph Légaré's works were often praised for their faithful reproduction. His major contribution, however, has been to open up the entire field of Canadian landscape painting. This is particularly relevant considering the specificity of the Canadian natural landscape which did not conform to the European cultivated and tamed countryside. Légaré's use of the camera obscura assemblage and his ability to relate to the image is in keeping with his progressive endeavours as pioneer of the first Canadian private gallery and museum, as political activist and as liberal thinker.

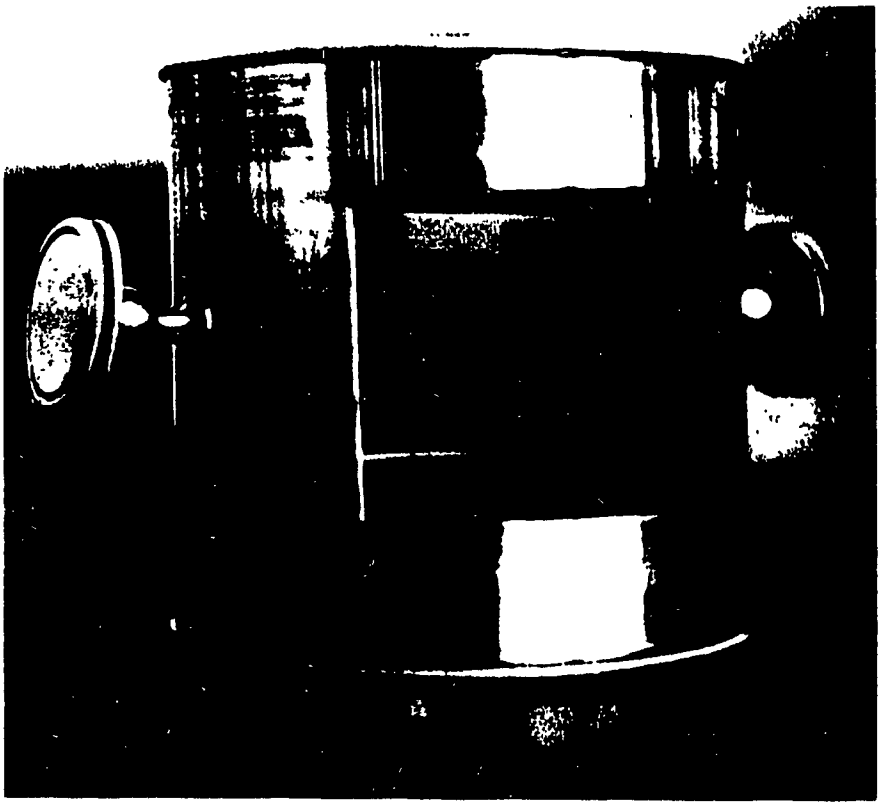
In Légaré's painting, there is a different elemental, underlying natural order that also stirs a different response in its observer. This implies his use of a camera obscura. This natural order differs, however, from the passive observational gaze of the Dutch sixteenth-century landscape painter and the eighteenth-century American romanticised landscapist. Légaré's gaze is not so much about the density of moments of detailed looking, or of the reflective surface that mirrors the soul of the observer, but rather the density of the reflective energy as light, not binding but breaking the surface. This constructs an identity in the surface of the psychological, not historical, field. Légaré's paintings encompassed a psychological space between the obvious elemental natural image and the observer. This projected energy, from the semi-hostile but invigorating natural atmosphere, invested Légaré and his paintings with a sense of self-assertion. If, under these circumstances, the intensity, magic and apparent accuracy of the image, by now accepted as experiential reality, could provoke anything, it could mediate a certainty of facts. This opened up the expressive possibility of the emotive moment in the face of the natural moment and constitutes the point of departure and the moment of a new arrival.

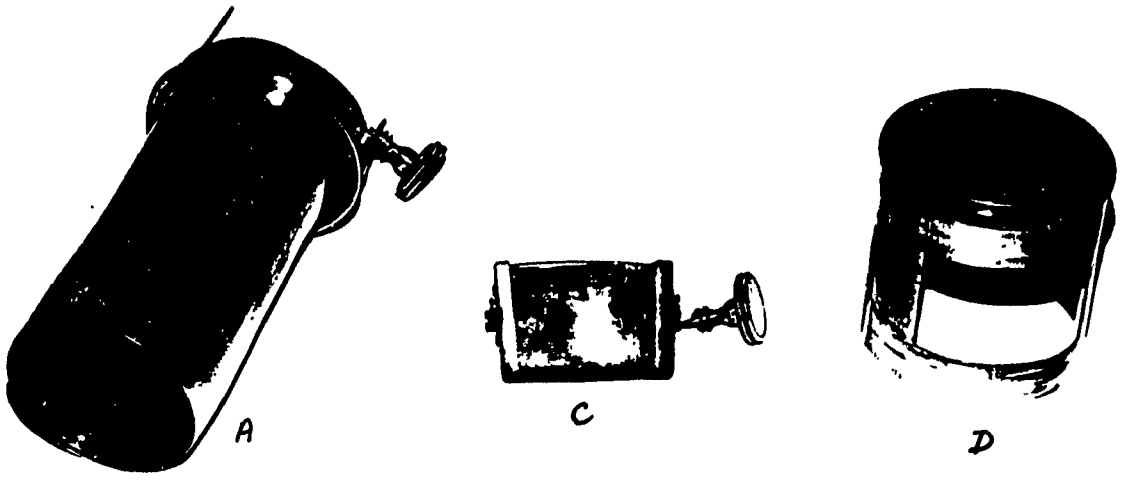
European ideologies could not capture the Canadian wilderness. Nature, as it opened up the spirit, also opened up the surface to the material essence of being. The continuity of the divine light, quantified in the Middle Ages and mediated through the body of the instrument and the soul of its observer, manifested itself in North America through the landscape paintings of Joseph Légaré.

Ill. 17 Joseph Légaré's (a) tent camera obscura, with (b) head.

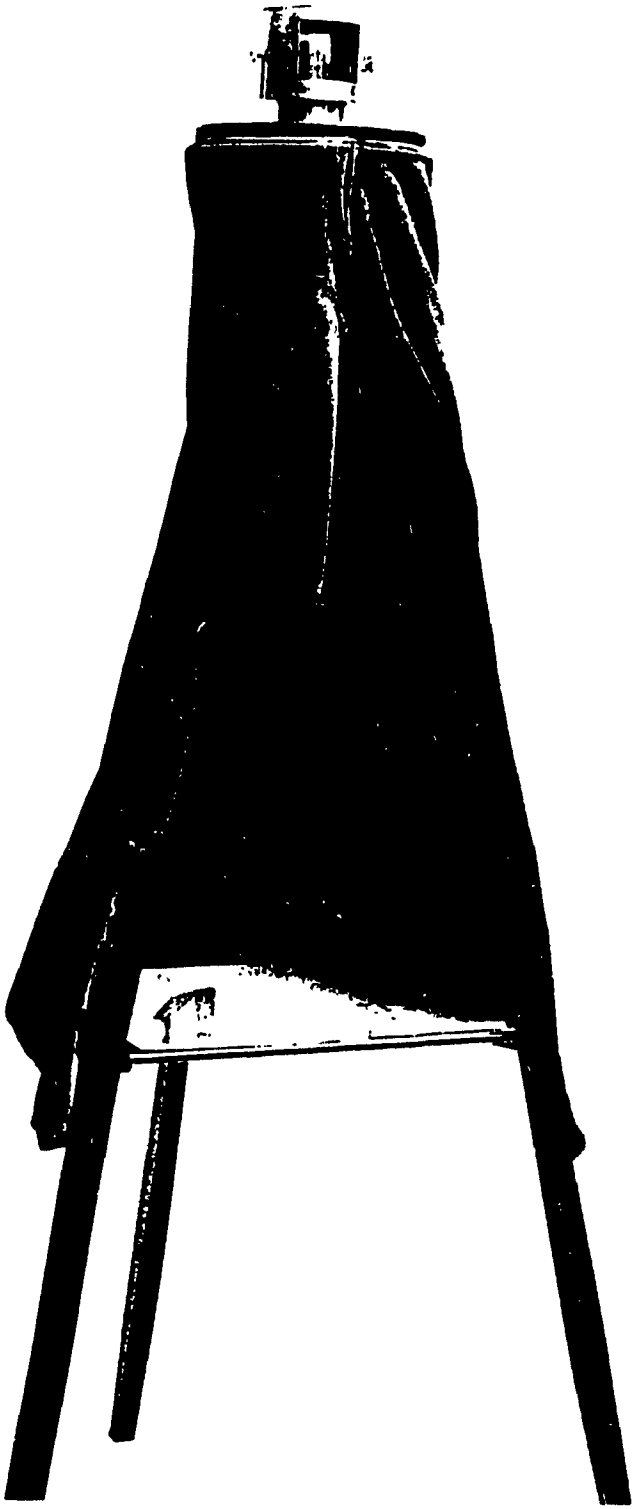


Ill. 18 Head of Légaré's camera obscura: a) brass head cover; b) shaft with lens; c) glass prism that acts like combination of lens mirror; and d) interior housing to hold prism.





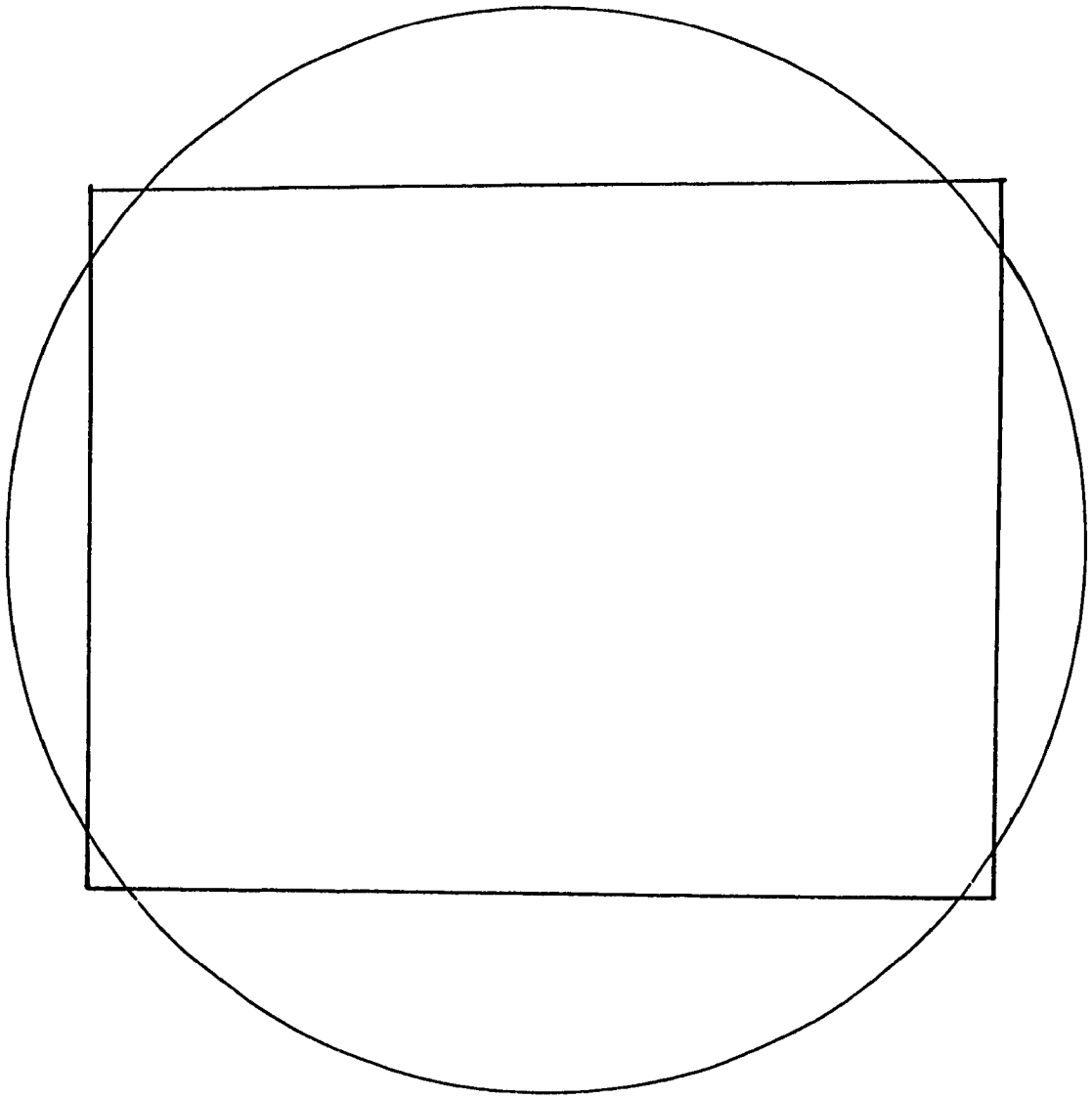
Ill. 19 Charles-Louis Chevalier: tent-type camera obscura, an eighteenth and nineteenth century development of Kepler's tent camera obscura, also remarkably similar to Légaré's tent.



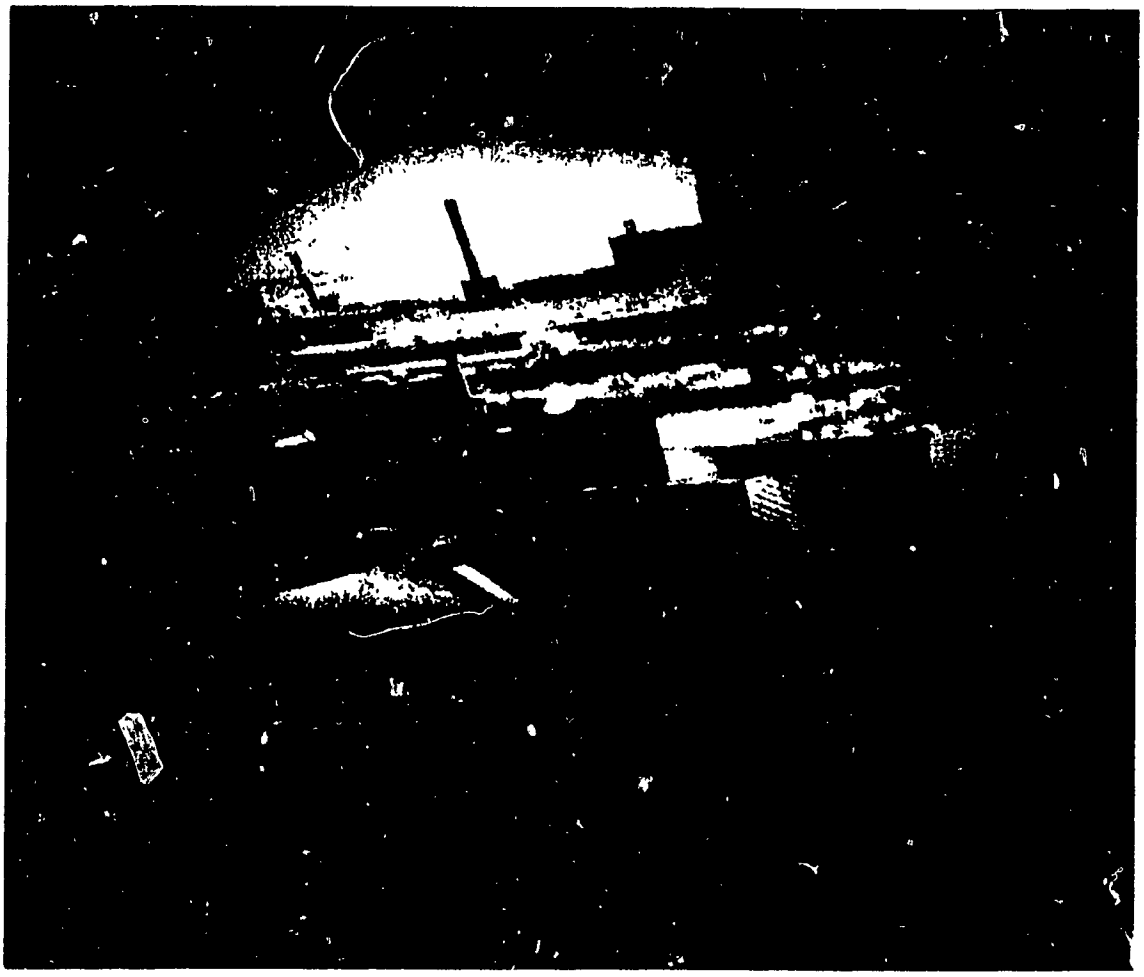
Ill. 20 Thomas Sandby, *Windsor Castle from the Gossels* (1770). Windsor, Royal Library.

Ill. 21 Paul Sandby, *Rosselyn Castle* (with a lady using a camera obscura) (c.1775) New Haven, Yale Centre for British Art.

Ill. 22 The 7 1/2" diameter circle of the projected image of Joseph Légaré's camera obscura superimposed with the diagramatic size of the small oil sketch of 5 by 6 1/2 inches.

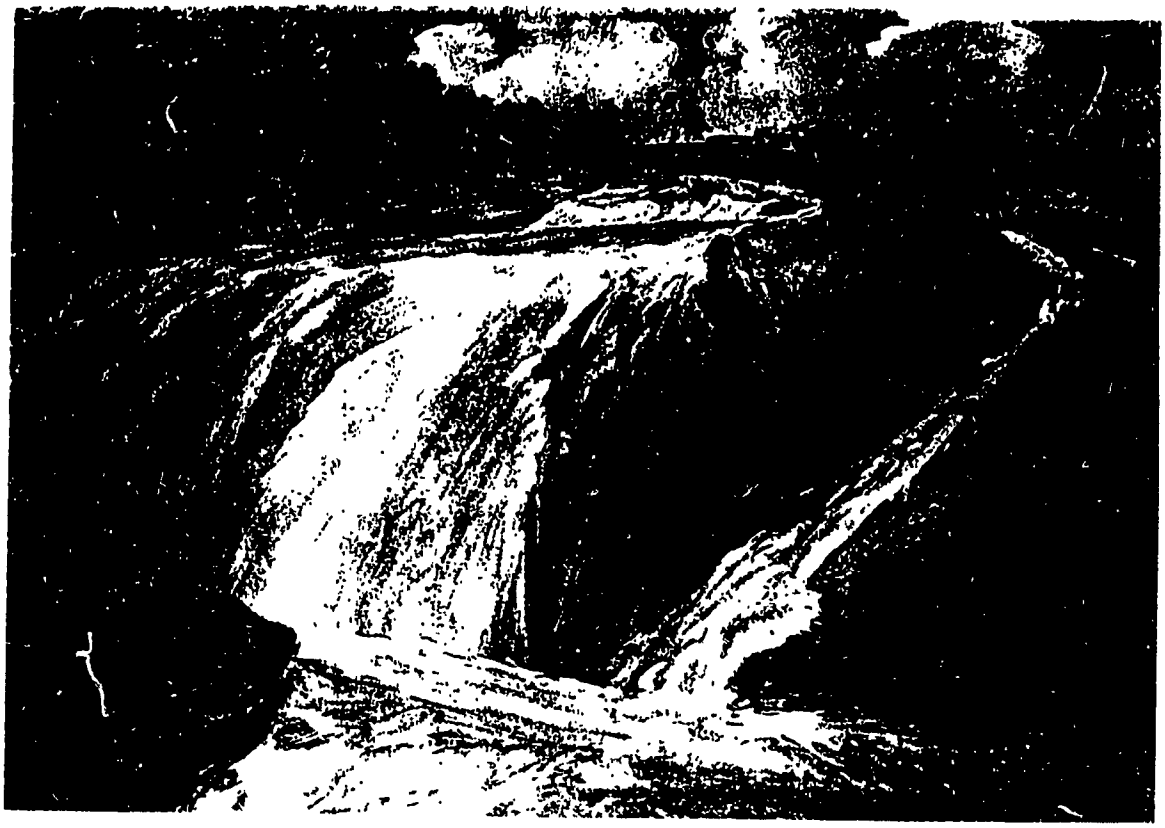


Ill. 23 A view of Quebec City from inside Joseph Légaré's tent camera obscura. the eliptical distortion of the projection circle is due to the camera angle in relationship to the projected image. Nevertheless, the enlargement of the frontal plane or the optical distortion is still quite evident in this view.



Ill. 24 Joseph Légaré, *The Huron Village of Jeune Lorette* (1874), 35.6 x 50.5 cm. Séminaire du Québec, Quebec City. (Archives, Portfolio 159-G, p. 9.)

Ill. 25 Joseph Légaré, *The Saint Charles River Falls at Jeune Lorette* (1874), 38.4 x 53.4 cm. Séminaire du Québec, Quebec City. (Archives, Portfolio 159-G, p. 9.)



Ill. 26 Joseph Légaré, *The Saint Ferréols Falls* (c.1842), 12.1 x 16.5 cm. Monastère des Ursulines de Québec, Quebec City. (Archives, Abbé Maguire album, p. 37.)

Notes to Chapter 4.

1. John Berger, *Sense of Sight* (New York: Pantheon Books, 1985) 146.

2. Leon Battista Alberti, *On Painting (Della Pittura)*, translated by John R. Spencer (New Haven: Yale University Press, 1966) 67.

3. Berger, 146.

4. M.S. Hammond, 171-172.

5. M.S. Hammond, 181.

6. Alberti, 49.

7. Robert Goldwater and Marco Treves, *Artists on Art* (New York: Pantheon Books, 1972) 3-4.

8. Alberti, 94.

9. Alberti, 94.

10. John Hammond, 9-10. Hammond also explained that the further the distance of the screen from the hole, the weaker the image.

11. Goldwater, 28. Lorenzo Ghiberti wished to compose a complete treatise on art by uniting what he knew from his own experience and what he found in books.

12. M.S. Hammond, 82-84. Bacon, Pecham and Witelo were all concerned with image formation in the camera obscura. Their geometry had been correct for size of aperture but was counter to all sensible reason or experience.

13. Goldwater, 21-30. Cennino Cennini, a Tuscan painter, worked and lived in Padua. He was primarily known, however, for his *Book of Art* which accurately described the technique art among other things. He was a pupil of the godson and pupil of Giotto, so it is assumed that he gave an accurate description of the techniques.

14. This book describes the fundamental relationship and differences between the Middle Ages, the Renaissance and the Reformation in terms of history and philosophy.

15. Cassirer, 135. This consciousness emerges in the multiplicity of and in its division into the basic activities of knowledge, violation and aesthetic creation.

16. Goldwater, 13. The dualistic soul of man can also be understood as the antique

influence of art and classic aesthetic theory, and the scientific interest in the natural properties of matter and their natural laws.

17. Cassirer, 162. This Law manifests itself in complete freedom and under its own condition. These laws are not invented or created, they are discovered. In this sense, the theory of art and the scientific theory of exact knowledge run through the exact same phases of thought. Therefore, they mutually inform or ennoble each other as well as the material reality that is part of their practice. Although one cannot ultimately grasp material reality in its entirety, we can however mutually discover the underlying principles.

18. Goldwater, 44. Piero della Francesca considered art and science to be two aspects of the same thing.

19. Goldwater, 13. Michelangelo, under the influence of Neo-Platonic theory, considered that only the end of art was worth discussing since the means were negligible--one has the feeling that the rules and formula were to be replaced by genius.

20. Goldwater, 98.

21. Goldwater, 68-69.

22. Goldwater, 52.

23. Goldwater, 68.

24. Tarnas, 211. Humanism was inspired by a desire for self-reflection. It was an investigation of the depth and complexity of personal consciousness. This joined with the scientist whose impulse it was to equally investigate the material nature of the world for the sake of discovery rather than for its own sake and not for another idealized purpose.

25. John Hammond, 13. Alberti's box, or perspective box, had a mirror or a sheet of glass opposite the peephole. The artist painted the object projected on the sheet of glass; this would have been an extremely useful tool for cartographers.

26. Gadol, 189. This view of fifteenth-century Florence from the hill is the perfect view for a cartographic rendering using a camera obscura. In this view of the city, one sees only what the view offers, unlike that of a plan or aerial view. As we have seen in the previous chapter, Barbaro suggests the use of the camera obscura for cartographic purposes.

27. Russell, 579. During the Middle Ages and into the Renaissance, what was true and what was good was ascertained by collective wisdom and not solitary thought. This control of the social institution of the Christian Church, a synthesis of dogma, law and customs, was broken by Protestantism which considered truth a personal matter.

28. Russell, 583-584.

29. Russell, 579. The starting point for each person is their own existence and not that of other individuals or of the community.

30. Cassirer, 141. The problem of the reciprocal exclusion lies in the fact that the opposition is still conceived of in a purely substantival manner. As long as nature and spirit are thought to be two parts of being, the question which encompasses the problem can never be resolved.

31. Cassirer, 143-144.

32. Arthur K. Wheelock, Jr., *Perspective, Optics, and Delft Artists Around 1650* (New York: Garland Publishing, 1977) 110-111. The roots of distrust of the validity of the visual sense, however, also extend into the social and philosophical climate of the early 16th Century in Italy.

33. Wheelock, *Perspective, Optics, and Delft Artists Around 1650,* 111.

34. Arthur K. Wheelock, Jr., "Constantijn Huygens and Early Attitudes Towards the Camera Obscura." *History of Photography*, Vol. 1, No. 2 (April 1977): 95. Dutch artists did not readily communicate artistic techniques that enabled them to achieve their distinctive results. Hendrick Honduis noted that a special effect could be achieved by tilting the glass frame, but he kept this and other things *fort secrette.*

35. Berger, 8. Yet we do not live in the first chapter of Genesis--we live, if one follows the biblical sequence of events, after the Fall. We live in a world that does not confirm our Being, a world that has to be resisted. It is in this situation that the aesthetic moment offers hope.

36. Wheelock, "Constantijn Huygens and Early Attitudes Towards the Camera Obscura," 93.

37. Maurice Daumas, *Scientific Instruments of the Seventeenth and Eighteenth Centuries and their Makers* (London: B.T. Bratsford, 1972) 93. The survival in France on guild restrictions and the unfavourable French economic climate made it impossible for the French to withstand English competition.

38. Wheelock, *Perspective, Optics...*, 22-23.

39. Alden L. Fisher, ed., *The Essential Writings of Merleau-Ponty* (New York: Harcourt, Brace & World, Inc., 1969) 252-253. Maurice Merleau-Ponty argued that the belief in science as it applies to the notion of the concepts of nature, the absolute relationship between the senses and vision is in the understanding the of "nature" as a constant. This holistic conception assumes that the proposition is always appropriate. The question of circumstances in which something might or might not work does not

arise. However, it also refers to Descartes's relationship to the nature of seeing, comparing it to the experience of a blind man seeing with his sense of touch only. (Descartes, *Dioptrics*, 241.)

40. René Descartes, *Philosophical Writings*, edited and translated by Elizabeth Anscombe and Peter Thomas Geach (London: Thomas Nelson and Son Ltd., 1954) 243.

41. Berger, 9.

42. Eric Larsen, "Descartes and the Rise of the Naturalistic Landscape Painting in 17th Century Holland." *Art Journal* XXIV I: 15.

43. Larsen, 16. For the first time in the history of modern thought, and a century before Baumgarten who generally receives credit for this innovative and radical new aesthetic approach, Descartes posed the question of the autonomy of art as a spiritual activity.

44. Alpers, 38.

45. Alpers, 38-39. Coloured drawing called attention to the double aspect of a pictorial representation. There is finally an absence of any drawings at all by a number of Holland's leading artists, namely Hals, De Hooch and Vermeer--an absence shared by many Northern artists. This suggests that representation takes place directly in colour and, therefore, in paint.

46. Alpers, 53.

47. William M. Ivins, Jr., *Rationalization of Sight* (New York: Da Capo Press, 1973) 27. The typical working diagram for Viator's construction is his third woodcut which, it has been suggested, was a construction that might have been representative of the method used among French masons.

48. Alpers, 44. The oppositions established by the North and the South are, in fact, two possibilities that pose the question of whether the perspective system is taken as a visual truth or a convention.

49. Martin Heidegger, *Being and Time*, translated by John Macquarrie and Edward Robinson (New York: Harper & Row, 1962) 488. The existential-ontological constitution of Dasein's totality is grounded in temporality. Hence, the ecstatical projection of Being must be made possible by some primordial way in which ecstatical temporality temporalizes. The continuity of vision and the continuity of the image form the double articulation of the temporality of Being.

50. Daniel A. Fink, "Vermeer's Use of the Camera Obscura--A Comparative Study." *Art Bulletin*, Vol. 53, No. 4 (December 1971): 493-494.

51. Kemp, 194. The reconstruction of the room permits Vermeer's viewing position to be found for six paintings. It can readily be confirmed that Vermeer used techniques, geometrical or optical, to create entirely credible spaces according to the canonical rule of perspective.

52. Berger, 150. For each glance, a drawing assembled a little evidence but it consists of the evidence of many glances which can be seen together. There is no sight in nature so unchanging as that of a drawing or painting.

53. M.S. Hammond, 281. Kircher's *Ars Magna Lucis et Umbra* was a massive work which included such topics as comets, eclipses sundials, optics, colours, phosphorescence and astrological influences.

54. M.S. Hammond, 282-284.

55. M.S. Hammond, 325.

56. M.S. Hammond, 359-360.

57. Elizabeth Fellows Andrus, "Measure And Design In American Painting, 1760-1860." Dissertation, Columbia University, 1976: 7.

58. Andrus, 210. Documentation by American landscape painters is relatively scant. The same applies to the European counterpart in the use of mechanical aids including the camera obscura.

59. Andrus, 211.

60. Andrus, 211. There is no evidence to suggest that he ever used a camera obscura in his work, but it seems unlikely that he would not have used it considering his scientific frame of mind.

61. J. Russell Harper, *Painting in Canada: A History* (Toronto: University of Toronto Press, 1966) 42.

62. Harper, 47. Cockburn travelled throughout Ontario and Quebec and made numerous drawings and watercolours, including several of Niagara Falls. He reportedly made drawings of the Falls from every conceivable angle.

63. Harper, 47.

64. Harper, 47. Some, coloured from nature, indicates the possibility that the work was done directly from a camera obscura.

65. John Porter, *The Works of Joseph Légaré, 1795-1855*. Catalogue. (Ottawa: National Gallery of Canada, 1979).

66. Harper, 94.

67. Harper, 117. There were regular newspaper ads inviting the public to have their portrait done. Gillespie of London-Edinburg used a camera lucida to make thousands of portraits across Canada.

68. John Porter, 48. The view of Quebec from Lévis was considered one of the finest landscapes in the world and British watercolourists visiting Quebec City never failed to paint it.

69. Porter, 68. *Huron Village* is presumed by Porter to be a painting executed on the spot. It could have been a painting on the spot that was first drawn out or enlarged from a smaller version, then carried back to the spot to paint it.

70. Porter, 69.

71. Porter, 141. Porter mentions that Légaré might have copied prints and tourist sites. I believe he travelled, like Cockburn, to Niagara Falls, especially since the work is the size of the camera obscura image.

72. Porter, 69.

73. Porter, 48.

74. Porter, 58. It is also known that Légaré frequently made day excursions around Quebec City.

CONCLUSION

The opening: The double conduit of oppositions or multivalence

> ...just when the modern mind [the male mind] believes it has most fully purified itself from any anthropomorphic projections, when it actively construes the world as unconscious, mechanistic, and impersonal, it is just then that the world is most completely a selective construct of the human mind. The human mind has abstracted from the whole all conscious intelligence and purpose and meaning, and claimed these exclusively for itself, and then projected onto the world a machine.[1]

Richard Tarnas, author of *Passion of the Western Mind* published in 1991, reflects on the consequences of man's search for origin and identity through the empirical process of philosophy and mechanical quantification. Before the world was mechanically quantified, this identification was the result of mythical anthropomorphism but, as more precise measures were constructed, a new relationship of mechanical quantification appropriated simultaneously the anatomized human body and the body of the world. The Camera obscura participated in the process of both anatomizations but also, through the opening of its assemblage, in a mechanical quantification which, in turn, constructed a new opening as part of the continuum. In the conclusion of this thesis I would like to locate the impulse and mention some of the many double conduits, at times seen as oppositions, that moved through the opening.

The opening of the camera obscura assemblage is an extended point in space and time through which both the subject and the object became stratified. The paradox of the opening is that it became an idea or place separated from the continuity of unstratified space of which it was formerly a part. As the body manifested its presence, the identity of the opening came into being. The identity of the opening first came from the separation of metaphysics and philosophy. It is this separation that legitimized the empirical impulse of the observer.

With the arrival of Aristotelian philosophy in the thirteenth century, metaphysical questions were suddenly no longer the property of the Church but the property of all thinking beings. With this came a fear that stimulated the consideration of a clear demarcation between the proper domains of theology and philosophy with respect to purposes and methods. The outcome of this separation was that all forms of knowledge which essentially could not be proven or rationalized fell into the domain of religion, such as the metaphysical questions concerning the existence of God and the immortality of the soul. This stripping of philosophy from metaphysical speculation left philosophy with deductive questions which resulted in the inevitable outcome of philosophical empiricism,[2] of which the camera obscura was one of its early prime mediators. This empirical philosophical attitude as the observing body rationalized human knowledge grounded in the experience of the five senses of which sight connects it to the camera obscura. The opening became, in this sense, the sight of the observer with its internal connection to the soul or mind.

The ideas that passed through this opening of sight where profoundly connected with Oackham, and, later, with Berkeley's and Humes's[3] notion that an idea could only represent an object to a perceiver if that object were already known to him in some other way. Therefore, causal relations could not be established by inference but only by observation.[4] This made the opening "the connection" of internal and external human reality.

Through observation, man connected an uncentred self to an uncentred universe and constructed, out of some internal necessity in the new empirical context, an identity with appropriate new parameters, one of which was the entry through this opening into the secular body and soul of man and his world.

The image observed by Vermeer and others in the camera obscura made possible the conviction that there was a difference between the world of objects and the perception of those objects in the mind of man as declared by Descartes. The fact that the image projected through the opening was visually identical and yet was materially different was the point of opposition, connection and departure. This understanding opened up was the possibility of consciousness of an abstract sign of the world that was not about the reconstruction of its molecular anatomical reality. For example, in painting, this understanding was the anatomy of the reflection of light as the skin to the secular body of the soul in the moment of observation which, I believe, was the intention of Vermeer. Descartes was followed by the phenomenology of Kant which confirmed

and extended this belief of which photography, as initiated by the daguerreotype, was one of its visual branches. Légaré's use of the camera obscura came at a time when daguerreotypes were profusely advertised in the papers of Quebec. For Légaré, the photonic image was the starting point of the mechanical truth and certainty that liberated him to respond to nature's tactile energy, the camera's optical phenomena and his emotive response to the projected landscape.

For the painter, the opening had the potential of equating human perceptions and sensations with material reality without the need to directly re-connect it to the mechanical anatomical frame of the body. Paint, for the painter, became the new skin of a conceptual body of consciousness. This new body, liberated from the servile constraints of oppression, declared not only "I think therefore I am" but also "I claim my own consciousness as my right for self determination." This, on the one hand, became the impetus for new nations and modernism. On the other hand, all the different oppositions that became the double articulations from the point of the opening, such as mind/body, idealized nature/nature idealized, the active gaze/the passive gaze, mind/sense, internal/external, metaphysical/empirical, deduction/induction, and reality/illusion, made visible the stratifications to which the assemblage of the camera obscura contributed. These stratifications, among others, are in fact the initiators of the breakdown of belief structures that lead to cultural investigations and to the process of deconstruction which is a continuity of the empirical observational impulse as contemporary critical analysis of contemporary culture. This is, for example, articulated

by Jean Baudrillard when he discusses the gaze as the ritual of transparency in the Ecstasy of Communication.[6]

This thesis however, would not be complete without mentioning the singular nature of its gender. The fascination of the male-orientated and orchestrated process of the search for origin, while at the same time denying his origin (women being mere matter and not having a soul (Thomas Aquinas)), is nowhere more poignant than in relationship to the body of the camera obscura which unites the soul of man with earthly materiality. In the desire to search for absolute certainty, man reconstructs a female body. Through the opening, into a closed dark chamber, man observes the reflections of the world in order to understand himself. It is libidinal and obvious since women have historically, in a patriarchy or monocular culture, been the captured vessel or the reflecting pond.[7] But what has been reflected back is not the singularity of the intention and strategy of the observer, but rather a non-dualistic and participatory action. This was recognized by Goethe and Hegel, among others.[8] The potential multiplicity and multivalence of the nature of the human being reunites, from the point of departure of the hierarchical visual pyramid of vision of the Renaissance to the ground of its being, with the reflected image. It is at this moment, as Tarnas suggests, that "the human mind does not produce concepts that correspond to an external reality, nor does it impose its own order on the world, rather the worlds truth realizes itself within and through the human mind."[9]

The paradox of this masculine quest for origin through the process of empirical stratification, as seen, for example, through the camera obscura assemblage, creates, in the discovery of oppositions, uncertainties and multivalence, a recognition of personal affiliations which is a different psychic starting point.[10] It is a reality that gives birth to the feminine which is becoming, in our time, the new opening.

Notes to Conclusion.

1. Tarnas, 432.

2. Moody, 296. Two lines of defense were set up against the inroads of philosophy on the domain of Sacred Doctrine. Although it was suggested by Peter Abelard in the 12th Century, it was Thomas Aquinas who set up the clear-cut demarcations between theology and philosophy. It therefore became necessary to show that the metaphysical doctrines of Greek and Arab philosophers conflicted with Christian theology.

3. George Berkeley, *A New Theory of Vision and Other Selected Writings* (London: E.P. Dutton & Co., 1929) 15. It is evident that when the mind perceives any idea, not immediately and not of itself, it must be by the means of some other idea.

4. Moody, 298.

5. Tarnas, 345. Kant believed that the only world that man knows is the empirical world of phenomena (of "appearances") and that world only exists to the extent that man participates in its construction. Knowledge is restricted to the sensible effects things have on us and these appearances or phenomena are, as it were, predigested.

6. Jean Baudrillard, *The Ecstasy of Communication*, translated by Bernard and Caroline Schutze (New York: Semiotext(e), Foreign Agents Series, 1987) 33. Baudrillard discusses contemporary attitudes of the gaze. In the case of fascination, he says it is the disembodied passion of a gaze without an object and without an image.

7. Irigaray, 255. Irigaray gives an appropriate relationship to the internal manifestation of the reflection in Plato's *Cave*, but this cave is already an inner space of reflection--opening, enlarging and contriving the scene of representation, the world as representation.

8. Tarnas, 434. Although the Cartesian, Kantian epistemological position has been the dominant paradigm of the modern mind, it has not been the only one. The radically different epistemology of the study of natural forms developed a perspective that the human mind of the world was ultimately not dualistic but participatory.

9. Tarnas, 434.

10. Riane Eisler, *The Chalice and the Blade* (San Francisco: Harper Collins, 1988) 191. Eisler discusses the issue of over-identification of one gender or another as a psychic distortion in both men and women. She writes that if women are over-identified with the notion of affiliation with others, whereas a man sees himself put through this into a position of danger, then the feminine, so far considered a weakness, should be regarded not only as a strength but as a new necessary psychic starting point that contains

the seed for the idea that individual development for both men and women only proceeds by means of affiliation.

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ANNEX 1

Explanation of figures in Illustration 1

Photographic reproduction of engravings of five different types of camera obscura from a nineteenth-century encyclopedia of science, London, England, 1817.

Figure 1 — A dark room with a small opening not containing a lens inverts the image of the head placed in front of the hole. The moveable screen finds an exact position in order to focus the image.

Figure 2

A) A mirror can act as a focussing device and can also reflect objects closer and farther away by tilting it upward or downward.

B) A lens, held by a plate, attached in front of the hole or opening lets light fall into the dark chamber (or camera obscura).

Figure 3 — A circular camera obscura observatory.

A/B) A rotating cupola on wheels which has a fixed mirror and lens system.

C) A rope moves the mirror upward or downward.

D) The image is projected onto a concave table to accommodate the simple convex lens. This table winds upward or downward on a screw system, giving variable focussing positions.

Figure 4 — A camera obscura installed in a fixed roof.

A) Light shaft extends focal length.

B) Protective casing for mirror and lens.

Figure 5 — An eighteenth-century book-form camera obscura. This particular model was designed by George Adams, mathematical instrument-maker in London, England.

A) A collapsable housing withh oepning for viewing projection.

C, D) Book edge with a hole.

E) Hollow book base.

F) Mirror and lens housing.

G) Cog and wheel for lifting or lowering to give variable focus.

H) A cloth and sleeve to insert the hand for the purpose of tracing the projected image.

Figure 6 Bottom of lens of mirror and lens unit.

Figure 7 Small portable camera obscura.

A) Lens.

a-b) Forty-five degree slanted inside mirror.

C) Viewing surface of projection.

E, F) Retractable non-flexible bellow.

ANNEX 2

Dimensions of Joseph Légaré's works

Légaré's camera obscura:

Maximum diameter of the round image:	19cm
Size of rectangle produced inside circle:	12.5 x 16.5cm

Small Portraits:

Brother Louis, Recollet (c.1825) oil on cardboard	19.1 x 22.9 cm
Portrait of a Man (1837) graphite on paper	14.5 x 19.6cm
Portrait of a Man (1846) watercolour and pen on paper	17.4 x 21.7cm
Portrait of a Lady (c.1846) watercolour, pen and gouache	17.3 x 22.5cm

Small outdoor paintings:

Montmorency Falls (n.d.) oil on paper	15.9 x 21.cm
Wild Boar (n.d.)	12.3 x 14.7cm
Church of Notre Dame of Quebec City (c.1844) oil on paper	16.8 x 21.7cm
The Saint Ferréol Falls (c.1842)	12.1 x 16.5cm

(compare to larger oil sketch, 37.1cm x 54.6cm)

The Jeune Lorette Mills and Saint Charles River Falls (c.1842) (see larger version, 30.2cm x 49.5cm)	12.4 x 15.9cm
From Jacques Viger Letter (1839) 6 or 7 inches x 5 inches = 12cm x 19cm	12.7 x 16.5cm
Sault-à-la-Puce, 2 different views (n.d.)	12.7 x 16.5cm
Cape Torment from La Puce River (n.d.)	12.7 x 16.5cm
Falls, Saint-Anne du Mont River (n.d.)	12.7 x 16.5cm
Ship repair, Point-Lévis (n.d.)	12.7 x 16.5cm
Niagara Falls (n.d.)	12.7 x 16.5cm
Saint Ferréol Falls (n.d.)	12.7 x 16.5cm
Montmorency Falls in Winter (n.d.)	12.7 x 16.5cm
A view of Quebec from Point-Lévis (n.d.)	12.7 x 16.5cm

The larger oil sketches that fall within an enlargement of:
3 x (12.7 x 16. 5) = 38.1 x 49.5 cm

Quebec Viewed from Sainte-Petronille Point, Ile d'Orléans (n.d.) oil gouache on paper	30.5 x 49.5 cm
Bridge on Chaudière River (1831) graphite and oil on paper	37 x 52.7 cm
Country House of Phillippe Panet on the Little Sainte Charles River (c.1831) oil and gouache on paper	34.9 x 46.cm
Baie Saint Paul (n.d.) oil on paper	36.8 x 55.9cm

Quebec at Sunset (c.1835) oil on cardboard pasted on canvas	37.1 x 53.6cm
Chateau Haldimand and the Citadel (n.d.) oil on paper	36.2 x 54.cm
Hôpital-Général, Quebec City (n.d.) oil on paper	35.1 x 51.1cm
Old Water Mill of Hôpital-Général (n.d.) oil and graphite on paper	34.3 x 49.5 cm
Saint Anne River Falls (c.1839) oil on paper	38.4 x 53.3cm
Chaudière Falls (n.d) oil on paper	36.8 x 55.3cm
The Montmorency Falls (c.1839) gouche graphite and oil on paper (compare to photograph and oil painting)	31.9 x 54.cm
The Saint Ferréol Falls (n.d.) oil on paper pasted on cardboard (compare to small version) size 12.1 x 16.5	37.1 x 54.6cm
The Huron Village of Jeune Lorette (n.d.) oil and gouache on paper (squared off and mounted) (note, in this, the obvious frontal enlargement)	35.6 x 50.5cm
The Saint Charles River Falls, Jeune Lorette (n.d.) charcoal, gouache and oil on paper	38.4x 53.4cm
The Jeune Lorette Mills and the Saint Charles River Falls (n.d.) oil on paper (see small version of this, 12.4cm x 15.9cm)	30.2 x 49.5cm

Paintings that fall into the following category of enlargement:
12.7cm x 16.6cm x (5) x (6) x (7)

x 5 = 63 x 82cm:

The Saint Charles River Falls at Jeune Lorette (n.d.) — 57.2 x 83.7cm
oil on canvas

The Chaudière Falls (n.d.) — 54.9 x 85cm
oil on canvas

x 6 = 76.2 x 99.cm:

Niagara Falls (c.1838) — 73.6 x 99.1cm
oil on canvas

x 7 = 88.9 x 115.5cm:

The Jacques Cartier River Falls (n.d.) — 80.8 x 111.1cm
oil on canvas

The Etchemin River Basin at Saint-Anselme (before 1846) — 81.3 x 110.5cm
oil on canvas