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ITALIAN AND DUTCH DEVELOPMENTS OF SCIENCE

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KEY WORDS

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ABSTRACT

This article illustrates how during early modernity Italian and Dutch cultures and particularly artistic traditions contributed differently to both the theoretical and practical developments of science. To achieve this goal, it will firstly compare the two forms of detextualization of space operated by Italian artists and by Dutch artists. Finally, it will indicate how each detextualization allowed for the development within the science of the mathematical tradition by the Italian Culture and the experimental tradition by the Dutch culture.

1. Introduction

The scientific revolution is strictly related to events occurring in Europe during the early modern period (second half of the 15th century- 1815 approximately). Despite its shared general characteristics, this epochal epistemological transformation was traversed by different tendencies, conceptions, and methods, strictly related to divergent geocultural conditions within the 'Old Continent'. In this regard, the strongest cultural dichotomy to take shape during this age and contribute to the emergence of the new scientific mentality referred to Catholic Southern and Protestant Northern Europe. For instance, the Italian Renaissance in the south and Dutch Golden Age in the north were the most relevant, influential and diversified expressions of the two areas.

This paper specifically illustrates how during early modernity Italian and Dutch cultures and particularly artistic traditions contributed differently to both the theoretical and practical developments of science.

From a wider perspective, it demonstrates through a specific case study how science does not abruptly distance humanity from cultural contexts but it is historically and geographically influenced and even internally differentiated by them.

Firstly, the dissertation will compare the two forms of detextualization of space operated by Italian artists and specifically by Albertian perspectival theory, and by the Dutch *Old Masters*.

Secondly, the dissertation will address the two models of vision developed by Alberti and Kepler and how these were respectively followed by the Italian and Dutch traditions.

Finally, the dissertation will explore the Italian and Dutch contributions to science.

2. Detextualization of Space and Scientific Revolution

The artistic achievements of both the Italian Renaissance and the Dutch Golden Age contributed to the development and advancement of the Scientific Revolution. They allowed for the creation of a context which made the birth of science possible, along with other events occurring in early Modern Europe (e.g. Reformation and Counter-Reformation, and the discovery, exploration, and colonization of the Americas). The most relevant contribution given by both artistic traditions to the growth of the new scientific mentality was the *detextualization of space*, corresponding to the constant disentanglement of the figural (or visual) from it textual (or narrative) objective, which otherwise characterised the Medieval worldview and its pictorial art. This process was an 'important element in the larger shift from reading the world as an intelligible text (the 'book of Nature') to looking at it as an observable but meaningless object' (Jay, 1993, 51), allowing for the mechanization of the world so pivotal to the development of modern science and technology and contributing to secularization: 'Secular autonomization of the visual as a realm unto itself' (Ibid., 44).

Moreover, major attention is given to visuality, its emancipation from narrative, symbolism and generally textuality, allowed for the emancipation of space from time so pivotal for the development of the scientific project.

This section analyses the modern process of *detextualization of space* (and the figural):

- Firstly, by outlining the target of this process, corresponding to the medieval notion of space as it was conveyed through the visual culture of that historical period.
- Secondly, by outlining the distinctive characteristics of the detextualization which stemmed from the Italian visual tradition flourished during the Renaissance.
- Finally, by outlining the distinctive characteristics of the detextualization which stemmed from the Dutch visual tradition flourished during the seventeenth century.

2.1. Medieval Narrative Art

The balance between figurality and textuality is a common trait of medieval pictorial art: 'In the medieval tradition the story was often illustrated, the scene following scene, as in a strip cartoon'. (Berger, 1972, 48) (fig.1). The great stained-glass windows of Canterbury Cathedral well exemplify how this sequential character of the medieval art was submitted to the religious message (the Word) and it's delivery to the unlettered people. The images have the educational function of rigorously training the common people into following the instructions of the sole orthodox interpretation of the Bible (Bryson, 1981, 1).

Mappae Mundi also exemplifies the juxtaposition of figural and textual occurring in the medieval visual tradition. They often present rich explanatory texts below the images that inhabit them, along with the depictions of events relevant to Christianity and Western civilization. However, their peculiarity is to apply such conflation of visual and narrative to space. These world maps are, in fact, devoid of any accurate informative geographic function and they are otherwise meant to create an affective, community-based relationship with a specific lived space. There is not yet an objective reticular space so that there are not yet objective coordinates meant to direct the observer. A *Mappa Mundi* is a symbolic representation of the Earth from the perspective of a specific community rather than its accurate universal and objective representation.

A first material divergence with modern cartography is the disposition of the four cardinal points, which does not follow a functional, practical logic but rather the conveyance of symbolic values rooted in Christianity. In fact, the East always appears at the top of the map instead of the North, because of the reference to the rising Sun as a metaphor for the rise of the divine light. The constant presence of a drawing of Jesus Christ resurrected above this fundamental coordinate confirms both its symbolic meaning and priority.

As a second divergence from the realism of modern maps, and yet another acknowledgment of their symbolic value, Jerusalem occupies the centre of all the recovered medieval maps as the centre of the Christian world through the Crusade.

The *Hereford Mappae Mundi* (ca. 1290 A.D.) (Fig. 2) is the largest medieval world map preserved intact and in excellent condition. It was originally exposed to the believers on a corridor wall inside Hereford Cathedral (England) where it would remain for approximately seven hundred years until the Interregnum. Its public availability, imbued with sacral significance as any other *mappae mundi*, served not only those didactic and devotional instructions the viewers already received from the abundant iconography, triptychs and glass stained windows of both Romanic and gothic churches. It also provided them with a sense of place, charged with history and meaning, and conveying a common identity (Christian in this specific case) through a set of visual devices.

An effective visual strategy recurring in every medieval world map was the figurative construction of boundaries, distinctions between the inside and the outside, qualitatively differentiated representations of themselves and the others. On the one hand, the *Hereford Mappa Mundi* portrays foreign populations living at the border of the world as wild, uncivilized, abnormal and represent them through drawing of gigantic, monstrous of fantastic humanoid creatures often hybridised with animals, as such as the Cynophales, men with dog heads living in Norway (northern extremity), or the Centaurs in Egypt. A similar exoticist approach affects the depiction of animals inhabiting outside the western Christian world. Camels, placed in the Asian continent and toward the south-East border of the known world, are said to be living for a hundred year. Lynxes are dislocated in Asia Minor, described textually as able to see through walls and their head is visually drawn with the features of a gargoyle head. On the other hand, all Christianity inhabits the central area of the map, with Jerusalem which typically features at the exact centre just below a crucifixion scene. All this section of obviously includes stylized icons of the most important cities of the Christian world, as such as Rome and Paris.

Another identarian device is constituted by the presence of elements belonging to the Western and Christian tradition, such as mythical and biblical locations (e.g. the labyrinth of the minotaur and the tower of Babel) and events (e.g. the siege of Troy and the Exodus).

The identitarian characterization of space conveyed by *Hereford* and any other *Mappa Mundi* is what Marc Augé has defined as ‘place in the established and symbolized sense, anthropological place’ (Augé, 1995, 81). Each church, city and even continent is characterized through shared values, it narrates a story which has a resonance with the viewers. Each place is a place of 'identity, of relations and of history' (Ibid., 52), whereby identity requires a repeated, almost ritual definition and redefinition of borders, the distinction between an inside and outside, sameness and otherness, as exemplified by the *Hereford Mappa Mundi*. The kind of identity developed is inevitably communitarian and absolutely not merely individual, insofar as each individual strictly depends on the common shared identity of the specific belonging group. In order words, individual identities could not be developed in the absence of such a comprehensive but specific social identity.

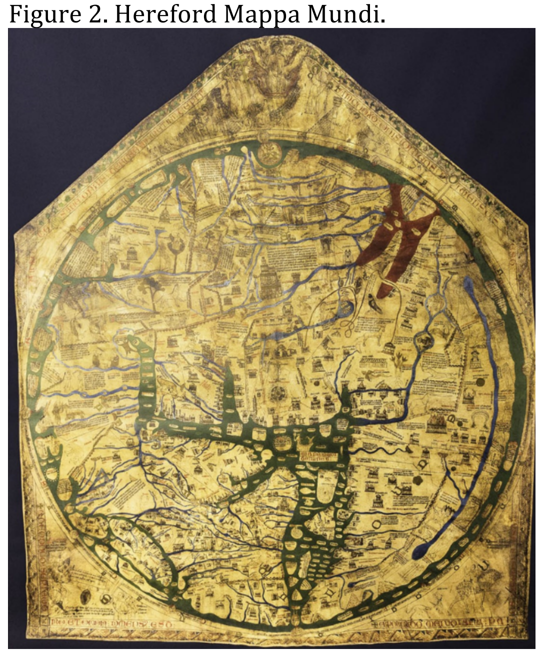
Such lived and communitarian way of experiencing space (i.e. anthropological place) was not limited to the Middle ages. On the contrary, it characterized the entire premodern mentality. To it the world appeared as a Cosmos, an unchangeable, 'hierarchically-ordered finite world-structure, […] a qualitatively and ontologically differentiated world […] with its distinction and opposition of the two worlds of Heaven and of Earth' (Koyré, 1943, 404).

Mappae Mundi are small scale representation of the Cosmos (for instance the Christian cosmos). They are not only geographical and cartographical instruments, but visual encyclopaedia encasing the entire world. Through both textual explanations and figural depictions, medieval world maps contain historical, anthropological, ethnographical, biblical, classical and theological information which submit space to history and thus time. The elements within the world (e.g. legendary beasts, cities, imaginary populations, myths) are showcased as more relevant than the accuracy of its omni-comprehensive representation. They define the space they inhabit, not vice versa.

Figure 1. Saint Francis Altarpiece.

Fuente: Bonaventura Berlinghieri, ca. 1260-1272.

Figure 2. Hereford Mappa Mundi.



Fuente: ca. 13th Century.

2.2. The Detextualiazation of Renaissance's Perspective

'During the Renaissance the narrative sequence disappeared' (Berger, 1972, 49) in favour of single moments in mythology and religious stories (the Albertian *istoria*). Therefore, the construction of meaning stops being the main reason behind painting and becomes mainly its pretext. As noticed by Wendy Steiner, '[Alberti] uses the term *istoria* in spatial rather than temporal sense, as a whole uniting and organizing the elements within it' (Steiner, 1988, 23), as prove by the following definition by Alberti:

> I say composition is that rule in painting by which the parts fit together [...] in the painted work. The greatest work of the painter is the istoria. Bodies are part of the istoria, members are parts of the bodies, planes are parts of the members. (Alberti, 2004, 22)

The specificity of Italian contribution to detextualization and subsequently to the scientific revolution stems from the discovery, or rediscovery of *perspective* (from the Latin word perspicere, meaning 'to see through'), which had been codified by Leon Battista Alberti in his *On Painting*, and its consequent application in painting. Perspective worked similarly for both the new artistic order and the new scientific order. In fact, it would definitively become the representative optical effect of a naturalized visual culture after the separation of aesthetic and religion operated by the Reformation. Perspective would also contribute to the eradication of narrative from the scientific cognitive method, which produces eternal truth regarding an objective and mechanical external reality.

The detextualization of space developed by Italian Renaissance through perspective had abstraction, idealization and geometrization as its specific features. Not by chance, Alberti built his aesthetic theory on the window metaphor:

> First of all, on the surface on which I am going to paint, I draw a rectangle of whatever size I want, which I regard as an open window through which the subject to be painted is seen. (Ibid. 66-67).

Once again, in Italian culture, a metaphor with a concrete referent is soon overtaken by a mathematical instance: perspective is indeed a mathematical representation of reality, based on a geometrical structuration of subjective perception. On this basis, Alberti formulated the method of one-point linear perspective, which marks a turning point in the development of naturalistic representation.

Italian Renaissance also anticipated the general tendency of Early Modern Age (specifically 17th century Dutch art) in its typical rigid proximity between art and technique of Italian Renaissance. Its art was developed in artisans' workshops known as corporations. These corporations were mostly workplaces where the words "artist" and "artisan" referred to the same person and where the romantic concept of self-expression had not yet been developed. Moreover, each workshop had a different specialization, with an inner differentiation between masters and pupils, one who was already acquainted with his job and the other who was only at the beginning of his experience as artisan/artist. Finally, these corporations were always in need of customers and patrons to finance their activities. It is in this specific work environment that the Albertian perspectival theory was practically developed.

The Italian invention and application of perspective also affected the relationship between the subject and object. This technique sharply distinguishes between the point of origin and the scene, which make up the two sides of the pyramid, at the basis of Albertian linear perspective theory. The pyramid itself is a structure of geometrical and thus mathematical nature.

> Now the participatory moment [...] was lost as the spectator withdrew entirely from the seen (the scene), separated from it by Alberti's shatterproof window. No longer did the painter seem as emotionally involved with the space he depicted; no longer was the beholder absorbed in the canvas. (Jay, 1994, 55-56)

The abstract detextualization operated by the Italian Perspective contributed to replace the medieval anthropological places (see above) with the non-symbolised geometric space of modernity (Augé, 1995, 80), an abstract geometric space as regularly ordered and homogenously inserted within an objective, uniform and purely extensive grid. In fact, ordinates and axis crossed each other indefinitely in Alberti's 'velo': 'a veil loosely woven of fine thread, [...] divided up by thicker threads into [...] many parallel square sections [...], and stretched on a frame. I set this up between the eye and the object to be represented' (Alberti, 2004, 65).

This reduction of space to objective plans and coordinates, and the prioritization of space over the objects in it, turns the world into a purely visual field, as overseen from a very high spot, and flattened to be well managed. Moreover, the abstract positions outlined by the Albertian grid replaced the substantive and varying meaningfulness of places, typical of the tribe, the polis and, most important, the medieval community. As a result, space overshadows the objects in it.

Several canvases exhibit a sharp separation between the foreground and the background, which impedes any form of interaction (fig. 3). This visual strategy was probably meant to reinforce that illusionary sense of depth already conveyed on the two-dimensional surface of the frame by the perspectival pyramid. It also divided characters from landscapes, humanity from nature.

Despite its geometrical and theoretical impulse, Renaissance did not reject realism. On the contrary, its abstractness was the foundation of a formal kind of realism, based then on strict norms (i.e. Alberti's theory). The representation of reality is possible only by adhering to specific rules which has often as result a paradoxically idealistic approach to reality, as exemplified by the unnatural colours of the horses in *La Battaglia di San Romano* (Fig. 4), which is also a great example of very precise application of the perspectival grid.

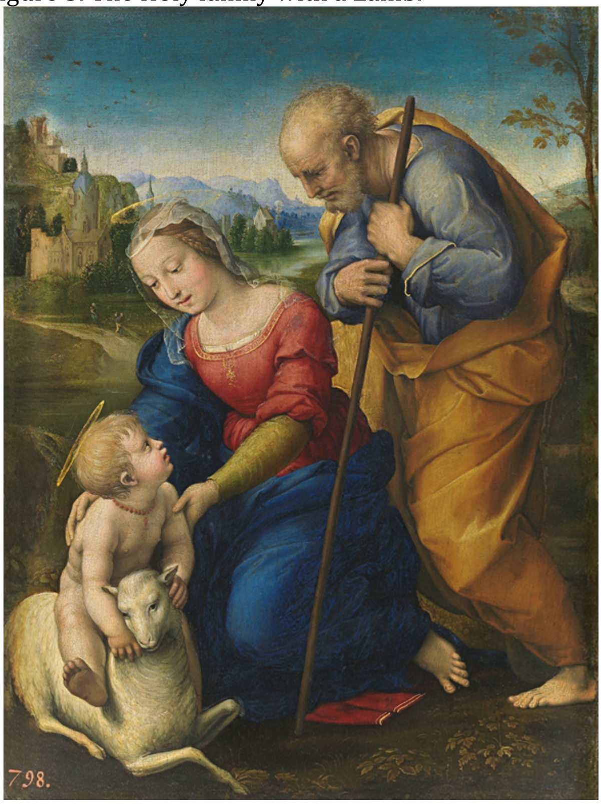
> The institutionalization of pictorial realism in the Renaissance made pictorial narrative [...] an impossibility. In a painting with vanishing-point perspective and chiaroscuro, the assumption is that we are observing a scene through a frame from a fixed vantage point at one moment in time. Nothing could be more foreign to Renaissance realism than the juxtaposing of temporally distinct events within a single visual field, as is commonly found in ancient and medieval art. Thus, [...] the strict adherence to the norms of Renaissance realism precluded narrativity from the visual arts. (Steiner, 1988, 23)

Karsten Harries argues that the speculations on perspective (by Alberti, Brunelleschi and later Cusano for instance) were the actual origin of the overthrowal of the 'hierarchical and limited medieval cosmos' (Harries, 1973, 31) instead of the Galileo, Kepler and Copernicus's science.

Once perspective is recognized, which means it is recognized that view of things depends on our position and distance toward a specific object, it is possible then to assume as many perspectives as possible. The world become an open indefinite field without any limitation. Therefore, this recognition of a multiplicity of positions that can be assumed only by following precise abstract rules is the second contribution of perspective – the first being the grid (alberti's *Velo*) - to the advent of an objective notion of space, and also of an infinite universe so indispensable for the new science and discoveries of the sixteenth century.

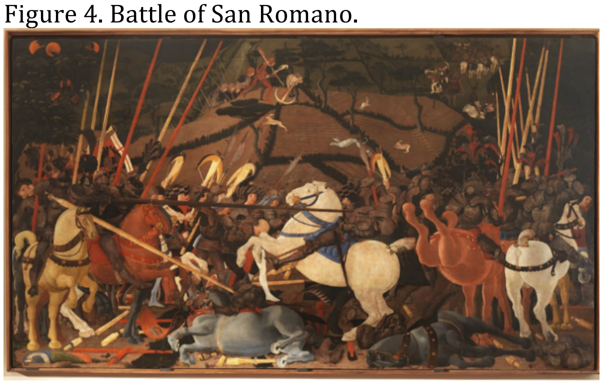
So, the geometrical and ideal representation of space of ideal cities and allegorical landscapes also overshadows the cosmos of the medieval *Mappae Mundi*. The perfect symmetry these pictorial subjects were usually featuring, the architectural perfection of buildings shaped after regular geometrical figure and the usual absence of people in these utopian citadels (fig. 5) contrast with the great unordered variety of disproportionate grotesque creatures and human figures, and the symbolic but yet concrete depictions featuring on medieval world maps.

Figure 3. The Holy family with a Lamb.



Source: Paolo Uccello, ca. 1435-1440.

Figure 4. Battle of San Romano.



2.3. The Detextualiazation of Dutch Golden Age's Mapping

During the 17th century, Dutch artists introduced *mapping*, a new form of objectification of space alongside the already established perspective and its renewed Cartesian version. This new scopic regime, like the older perspective was the result of the intertwinement of craft, art and natural knowledge, with a special regard to the new optical instruments. In fact, the Dutchmen were renowned for their proficiency with lenses and mechanical aids to vision. For instance, the philosopher Spinoza ground lenses; Huygens (a major figure of the scientific revolution) built a refractor telescope; the spectacle-makers Hans and Zacharia Jansen invented the microscope.

However, the guilds of the Dutch Golden Age did not mathematize optics as the corporations of the Italian Renaissance did. On the contrary, they had a more pragmatic approach toward the use and craft of lenses, privileging measuring and experimentation over geometry. Such skills explain their exceptional talent as cartographers and merchants, which was proved by the rise in the 17th century of Dutch maritime supremacy and decline of Spanish and Portuguese armadas, and by the subsequent transformation of colonization into a means for trade (as proved by the United East India Company) instead of exploitation and political power.

Continuing a process started by the Renaissance (when painting was an instrument of both knowledge and possession), 'the Dutch mixture of trade with art' (Alpers, 1983, 100) definitively made objects into mere properties and exchangeable goods. Increasingly after the 17th century, paintings also became commodities, defining the social status of their client. In fact, Dutch painters soon became 'the purveyors of luxury goods to the rich' (Ibid., 115).

Oil painting, available in Northern Europe since the fifteenth century, supported this proto-capitalist mentality along with Dutch descriptive attitude.

Firstly, 'the period of the oil painting corresponds with the rise of the open art market' (Berger, 1972, 88).

Secondly, 'Due to its ability to reduce 'everything to the equality of objects' (Ibid., 87), with its impact on colors and textures, an opaqueness and solidity spread on the canvas, this specific technique came to define what we still mean by pictorial likeness.

Consequently, the Dutch art was descriptive instead of prescriptive. It was more concerned with still life, landscapes, and domestic scenes than the idealizing religious and mythological themes of the Italian Renaissance. 'The Dutch art [...] [added] actual viewing experience to the artificial perspective system of the Italians' (Alpers, 1983, 27).

'Northern artists characteristically sought to represent by transforming the extent of vision onto their small, flat working surface' (Ibid. 51), avoiding the direct relationship with an external viewer created by the fictional third dimension of perspective. As a result, the canvas surface contained a self-sufficient complete semblance of the world, democratically including different coexisting views without any hierarchical deep focus. In contrast with Italian painting, the patterns are usually asymmetrical, there is no prior frame and the viewer is positioned within and not outside the representation. In fact, the mapping and concretely descriptive technique characterizing Dutch art, tendentially decentralized pictures.

Such democratic way of seeing was also the result of the peculiar historical situation of 17th century Holland. The bloodshed of the Reformation had not stained the Netherlands, explaining its incomparable religious tolerance, along with the Spanish-Dutch Peace Treaty of Westphalia signed in 1648. Moreover, Holland was the commercial center of Europe, characterized by a sizeable urban middle class, and gathering merchants from every part of the continent.

Dutch descriptive attitude of mapping, oil painting and ability with cartography increased the detextualization and objectification of space started by the Italian perspective. In fact, mapping extended the commodification of reality and thus that search for possession already inaugurated by the Albertian imposition of an abstract and geometrical grid on space.

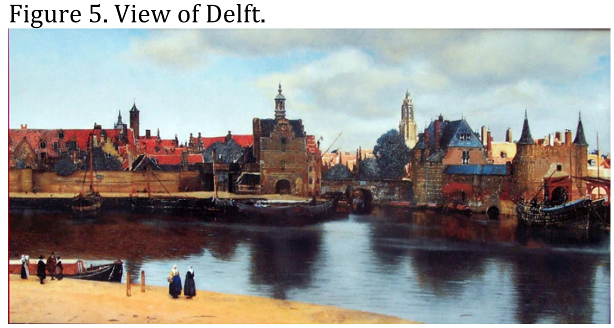
The Dutch based their relationship with the world by conceiving the frame after the map and not the window, as the Italians did. Like maps, their paintings, especially landscapes (i.e. Vermeer's *View of Delft*) are flat surfaces, devoid of any center (fig. 5). The Northern tradition do not recur, in fact, to any theory to achieve an illusionary rendering of the third dimension. It rather retains the concrete flatness of the canvas, favoring panoramic over perspectival view: 'In the entire [Dutch] tradition of panoramic landscapes [...] surface and extent are emphasized at the expense of volume and solidity' (Alpers, 1983, 139). The result is a dense plane where the viewer is not located, the texture of the world is more relevant than the positioning of its objects.

Moreover, during the modern age, maps and globes lost the symbolic, narrative and communitarian characteristics of the medieval *Mappae Mundi*. They were secularized by colonization, exploration and scientific revolution and transformed into informational and practical instruments. They were privatized (especially in the Netherlands), transformed as they were into objects of desire, private possessions and their possession sign of prestige.

Moreover, maps and globes did not focus anymore on actions and events, on the drama felt by the witnesses of history, but they focus primarily on places and thus on space rather than time. The Dutch are who mostly pressed on this cultural transformation.

Finally, in the Netherlands, Calvinist iconoclasm also emancipated the figural from the textual, but without the intolerant and extremist aversion against images displayed by the same confession in Scotland and England.

Figure 5. View of Delft.



Source: Vermeer, ca.1661-1664.

3. The Albertian and Keplerian Models of Vision

The differences between Italian and Dutch aesthetic traditions and their influence on the scientific revolution stem also from two diverse models of vision. Whereas the formers followed the conception of vision implied by Alberti perspectival theory, the latters took as referent Kepler's innovative analysis of the eye's mechanism.

Both Alberti and Kepler used the camera obscura to developed their models of visions. However, they differed on how they applied it to their models of vision. This section explores these two models, how they are differently based on the camera obscura and their influence on the two different traditions: the Italian for the Albertian model and the Dutch for the Keplerian model.

3.1. Alberti's Model

Alberti references to the camera obscura as a visual prototype insofar as it prevents the observer from seeing his or her position as part of the representation.

Leon Battista Alberti found in this device, the concrete model for his perspectival scopic regime: 'All beholders would see the same grid of orthogonal lines converging on the same vanishing point, if they gazed through, as it were, the same camera obscura' (Jay, 1994, 189).

The mechanism of surveillance, which had been developed during the entire arc of modernity had a certain resemblance to the mechanism of this instrument: 'The camp was to the rather shameful art of surveillance what the dark room was to the great science of optics' (Foucault, 1991, 172). Both the camp and the darkroom represent hierarchized, empty, flat and impersonal spaces build to be crossed passively by an absolute gaze. The subject-mind-soul embodies such gaze, where the eye ('I') works as a bridge between physical and immaterial. Spirituality itself assumed a new form, utterly different from the medieval one: it seeks a scientific, rational and sure foundation.

So spatial hierarchy did: with the Albertian model there is no more hierarchy within the external world, as it occurred with the medieval qualitative distinction between Earth and Heaven, God and its creation. All physical things are in fact reduced to the same level of Being. The Albertian system constructed a secularized version of spatial hierarchy between the human and the world, the immaterial internal space of the subject, with all its representation, and the physical realm, where the perspectival grid is projected.

Finally, following the Albertian view, camera obscura *a priori* prevents the observer from seeing his or her position as part of the representation, which means that the subject is incapable of self-representation as both subject and object. 'Thus, the spectator is a more free-floating inhabitant of the darkness, a marginal supplementary presence independent of the machinery of representation' (Crary, 1990, 41).

By following Alberti's model of vision, Italian artists have usually distinguished between seeing and representing, seeing with one's own natural eyes and the mental eye which reconstructs the actual vision in a more refined way. Such differentiation between representing and seeing, and thus ideal and real, echoes Michelangelo's distinction between 'design (*disegno*) as the basis for rendering things selected from nature with an eye to beauty and color (*colore*) as the interest in following nature exactly' (Alpers, 1983, 38). Therefore, drawing is viewed by the Italian tradition as the privileged basis for painting.

The inevitable consequence is an active notion of vision, as an objectifying operation achieved by an invisible, unrepresentable subject, whereby the camera obscura is used a metaphor of such process.

Consequently, the perspectival subject has a frozen gaze on the world. The Albertian painter perfectly embodies such a notion, as the model of artist it builds abstracts himself from his actual body positioned in the world. Here the world is out there, beyond the window that protects us from any direct influence. Therefore, such frozen gazes exclude any form of sincere desire, as opposed to a mobile glance:

> The convention of perspective [...] centers everything in the eye of the beholder [the subject]. It is like a beam from a lighthouse - only instead of light travelling out, appearances travel in. The conventions called those appearances reality. Perspective makes the single eye the centre of the visible world. Everything converges on the eye as to the vanishing point of infinity. The visible world is arranged for the spectator as the universe was once thought to be arranged for God. (Berger, 1972, 16)

A monocular unblinking fixed eye at the centre of a flat world and detached from it replaces the two stereoscopic embodied eyes immersed in a world full of actual depth. Behind perspective, there is a mathematical conception of reality, still embedded into a certain religious background, where God finds his embodiment in the subject.

Moreover, the presence of a prior viewer implied by Alberti's active notion of vision inevitably privileges man as the measure of all things. Such anthropomorphic conception, is shared rather generally by the all Italian tradition: 'So many aspects of Renaissance culture, its painting, its literature, its historiography are born of this perception of an active confidence in human powers' (Alpers, 1983, 43). This centrality of the human viewer is not only confirmed by the converging point of perspectival grid, but also by the Italian attention for the proportioned human body, to which also the scale, symmetry and holistic beauty of the Renaissance architecture was submitted. In other words, the individual view is always translated into a 'unified sense of the whole' (Ibid., 85).

3.2. Kepler's Model

Kepler's explicit reference to the dark room for the development of his model of vision tends to avoid the spiritual and hierarchical implication of Alberti's implicit reference to that same optical instrument. By turning his attention from the use of optical instruments in astronomy to the instrument of observation itself Kepler evaluated the camera obscura as a perfect replica of the biological functioning of the eye (Upside down retinal image), providing a mechanistic explanation of vision. He subsequently avoided any speculation concerning the perceptive processes, whether a soul was involved or just the human brain. By bracketing the observer and the perceptive processes, and by focusing only on the image impressed on the eye Kepler deanthropomorphizes vision. It is the world to picture itself through light and color on the eye (Alpers, 1983, 36). To Kepler, vision is only a purely passive mechanism and the eye an impersonal 'dead eye', or a dissecting mechanical eye which is altogether with the world it observes.

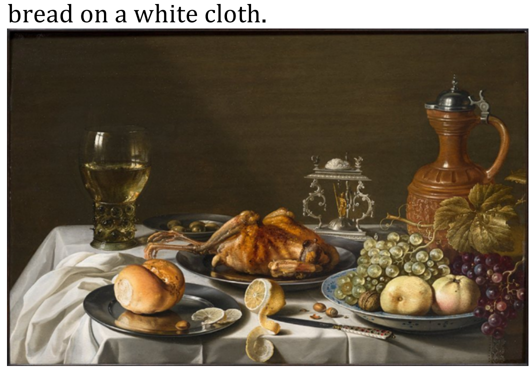
The Dutch tradition followed the Keplerian model by, firstly, replacing the southern measured distance of the viewer from the world with his insertion into the world. Moreover, it decentralized the frame, opting for the asymmetry of diagonal composition instead of the symmetry obtained through the strict application of linear perspective (fig. 6). These characteristics are well exemplified by the anamorphic paintings and the fragmented beauty typical of the *Old Masters*'s works. This fragmentary beauty replaces the Italian unifying and proportioned beauty by separating what is observed from the rest of the world and the viewers' eyes from the rest of the body. What the Dutch apply is a fly's eye instead of the monocular eye of an ideal human soul, a microscopic attention for details instead of an overall generalizing approach. De Gheyn is the Old Master who best delivered such a visual attention for multiplicity, while Vermeer's efficiency in achieving complete detachment and impersonal observation of tone best echoes the passivity of the Keplerian model.

Moreover, Kepler employed for the first time the term *picture* to define vision: 'Vision is brought about by a picture of the thing seen being formed on the concave surface of the retina' (Kepler, 1964, 150, cited in Alpers, 1983, 36).

> [It is] the first genuine instance in the history of visual theory of a real optical image within the eye – a picture, having an existence independent of the observer, formed by the focusing of all available rays on a surface. (Lindberg, 1976, 202)

The Keplerian expression 'Ut pictura, ita visio' (Kepler, 1964, 186, cited in Alpers, 1983, 36), or sight is like a picture, mirrored the Dutch equivalence between drawing and painting, between representation and observation. The absence of the formal distinction between *disegno* and *colore* was also fostered by the massive and privileged use of the watercolour in northern Europe. This technique allowed for immediate execution, as demonstrated by De Gheyn's drawing of animals and flowers.

Figure 6. A Still-Life with a Roemer, a Pheasant, a Silver Salt-Cellar with a Stoneware Jug, fruits and bread on a white cloth.



Source: Pieter Claesz, 1626 ca.

4. Two Developments of Science

By applying his archaeological method to the analysis of Velázquez' masterpiece *Las Meninas* (Foucault, 2002, 17), Foucault reveals the epistemological nature of images, how different eras develop different understanding of the world through specific way of representing it. For instance, the painting of Velasquez exposes seventeenth century form of knowledge and specifically how science influenced it.

Therefore, during modern age, art and science were strictly intertwined, insofar as painting, sculpture and architecture codified into images the new scientific mentality or the prelude to its rise.

Inspired to Foucault's notion of *episteme* and his analysis of *Las Meninas*, this section explores how variations of the new scientific approach stemmed from two different geo-cultural contexts and, especially, from their different visual cultures: Italian Renaissance and Dutch Golden Age.

The Dutch and Italian models generally refer to the two dominant strands which constituted and shaped the Scientific Revolution: 'the observational and experimental (in the original sense of experiential) practice promoted by Bacon [the former], and the new mathematics [the latter]' (Alpers, 1983, 10)

Kuhn similarly addresses the emergence within modern science of two juxtaposed traditions: the classical, or mathematical tradition and the Baconian, or experimental tradition. He underlines how these two approaches still determine the current development of science although a firm bridge has been established across this divide (Kuhn, 1976, 30).

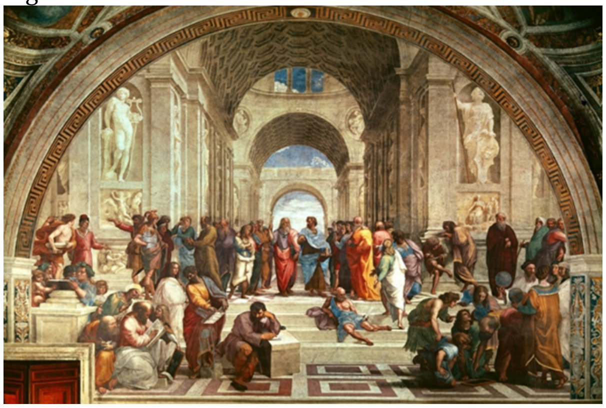
Moreover, while the Italian Renaissance fostered the mathematical strand of science which would have its centre especially France, the Dutch Golden Age fostered the experimental strand of Baconian sciences which would have as their centre Britain (Ibid., 25). What was found in the texts of Bacon and in the programs of the English Royal Society was painted by the Dutch.

4.1. The Italian Art and Mathematical Science

Italian visual episteme prepared the ground for the mathematical and theoretical strand of science by:

- Distinguishing representation from observation.
- Privileging *a priori* over purely empirical approach the world. The Renaissance deemed theory (i.e Alberti's perspectival theory), the human viewer and the application of visual models (i.e. the window) as necessary prerequisites for observation and proper representation of reality theory, the human viewer, the perspectival theory, the reference to a theory defining the correct way of representing reality.
- Distinguishing between human inwardness and external reality. Such intimacy was figuratively achieved by the window-frame, which created a stiff separation between two unified realities, one outside and one inside. Such separation echoes the separation between man and a world at his disposal already occurring with Renaissance landscapes which presented a stiff separation between background and foreground.
- Opting for formal realism, obtained through the geometrization of reality (i.e. perspectival grid), a harmonic kind of beauty which unifies all objects painted, and focus on forms over texture.
- Prioritizing global view over details, unity over specificity, as testified by a symmetric and harmonic kind of beauty, the subsequent solidity of the compositions, unifying theory and elevated style, and a clearly framed image achieved by applying Albertian window model (fig. 7). Such model would become dominant during the modern age so to define even our way of seeing (Carbone, 2016, 92).
- Focusing on forms, objects and space rather than the textures of the world.
- Referring to the mathematical, geometrical and optic tradition of the classical antiquity. For instance, Alberti applied geometrical-optical principles from Euclide's Optics.

Figure 7. The School of Athens.



Source: Raffaello, 1509-1511.

4.2. Renaissance Influence on Galileo Galilei

Galilei is commonly portrayed as one of the founders of modern science and specifically of its new empirical approach. To support this representation of Galileo as empiricist it is usually recalled his deep involvement in the study of the Dutch applications of the lens, or how this interest brought him to perfect the telescope (essential for his later discoveries) or the refusal of his detractors to look through the telescope. However, the relationship between Galileo and empiricism is not that simple, straight and clear. As suggested by Koyré, experience and observation did not play a major role in Galileo's foundation of science and more generally in the first acts of the Scientific revolution (Koyré, 1943, 402).

On the contrary, Galileo remained firmly placed in the Italian tradition. The strong commitment of this tradition to mathematics and theory emerged with Alberti's conception of painting is in fact confirmed and furthered by Galileo's intertwined worldview and classical (as intended by Kuhn) orientation given to the new science.

Throughout his own works Galilei interpreted nature as a book written by God in:

> The language of mathematics. Its characters are triangles, circles and other geometric figures, without which it is impossible to humanly understand a word; without these, one is wandering in a dark labyrinth. (Galileo, 1957, 238)

This metaphysics of Neoplatonic inspiration constitutes only apparently a reduction of nature to a narration, a text to be codified, translated or at least read. On the contrary, it contributed to the modern process of detextualization. Along with the Reformation, Galilean physics reduces in fact the Bible to a solely religious text without any reference to how the world is. In other words, the Bible, with its narrative and historical structure, ceases being considered the book of Nature, as it was during the Middle Ages, replaced by Nature itself; a Nature constituted by eternal forms and thus without a history.

Galileo's metaphysics also displays the influence Neo-Platonism and thus Renaissance philosophy (Marsilio Ficino, Pico della Mirandola and Hermetism) had on him. As already accomplished by Alberti, Brunelleschi and Ficino, Galileo applies mathematics to nature, or it translate the physical world in mathematical terms, an impossible task for the old orthodox common-sense and Aristotelian physics.

Thomas Kuhn and Ernan McMullin have highlighted how Galileo was more dedicated to thought experiments (foundational practise of knowledge for all the Middle Ages), which he brought to their highest form, rather than physical experiment (Kuhn, 1976, 11). By applying a conceptual-historical approach, McMullin has specifically investigated the Galilean idealization of physics and thus of the new sciences, and its epistemological implication. He has reviewed several techniques used by Galileo and finally grouped them into the two main forms of idealization which have come to characterize the entire mathematical tradition of science, or, as he calls it, the Galilean tradition: *causal idealization* and *construct idealization*.

> In construct idealization, the models on which theoretical understanding is built are deliberately fashioned so as to leave aside part of the complexity of the concrete order. In causal idealization the physical world itself is consciously simplified; an artificial ('experimental') context is constructed within which questions about law-like correlations between physical variables can be unambiguously answered. [...] This kind of idealization was central to the new science of mechanics fashioned by Galileo. (McMullin, 1985, 273)

In several occasions, Galileo does not invoke any actual experiment, he does not give any detailed descriptions of concrete experimentation. In the second day of the *Dialogues Concerning Two New Science* (1638), wherein Salviati embodies Galileo's own position and Simplicio embodies the orthodox Aristotelian conception, the latter asks in regard to a specific experiment whether the former has carried out several texts to prove its reliability. Salviati (Galileo) answers:

> Without experiment, I am sure that the effect will happen as I tell you because it must happen that way. And I might add that you yourself already know that it cannot happen otherwise, no matter how you may pretend not to know it. (Galileo, 1906, 171, cited in McMullin, 1985, 269)

Another example is the following statement uttered by Salviati:

> Usual and necessary in those sciences which apply mathematical demonstrations to physical conclusions, as may be seen among astronomers, writers on optics, mechanics, music, and others who confirm their principles with sensory experiences that are the foundations of all the resulting structure. (Galileo, 1906, 212, cited in McMullin, 1985, 266)

As extensively outlined by Koyré, Galileo was a partisan of Platonism. His works do not only exhibit his explicit reference to Neoplatonism in stylistic terms in order to mock the Aristotelian orthodoxy of the Church, or to sympathise with the common reader or more generally to conform to the Renaissance use of rhetoric inspired to Platonic dialogues. To him the foundation of the new science is sincerely less grounded on experimentation, induction and observation than it rather is on mathematics and deduction. In accordance to Plato's epistemology, observation only functions as a reassurance of our a priori knowledge regarding the mathematical order of the universe. So, for Galileo observing the sky only confirms empirically geometrical and mathematical notions already inscribed in our mind. As a Platonist, he 'cannot be of a different opinion because for him to know is nothing else than to understand' (Koyré, 1943, 427). This adherence to Plato's doctrine of reminisce is attested once again by several parts of the *Dialogue*, especially by the following fictional conversation between Salviati-Galileo:

> SALVIATI: The solution of the question under discussion implies the knowledge of certain truths that are just as well known to you as to me. But, as you do not remember them, you do not see that solution. In this way, without teaching you, because you know them already, but only by recalling them to you, I shall make you solve the problem yourself.
>
> SIMPLICIO: Several times I have been struck by your manner of reasoning, which makes me think that you incline to the opinion of Plato that nostrum scire sit quoddam reminisci; pray, free me from this doubt and tell me your own view. (Galileo, 1906, 217, cited in Kuhn, 1976, 427).

The Methodology of Galileo is primarily hypothetical-deductive and only secondarily experimental and thus based on instruments as such as the telescope:

As Leonardo's career also indicates, instrumental and engineering concerns do not make a man an experimentalist, and Galileo's dominant attitude toward that aspect of science remained within the classical mode. (Kuhn, 1976, 17)

Following Renaissance theoretical and abstract model, the 'Galilean way in dynamics […] is to explain the real case by way of a theoretical one that can never be brought under observation, the concrete by the way of the abstract' (De Santillana, 1969, 51).

Finally, no less important, Galileo shared an excellency in rhetoric typical of the whole Italian tradition, rather than the descriptive rigour of a more empiricist approach to science and of the aseptic Dutch pictorial tradition of the Golden Age. Such rhetoric is a treat of both philosophy (especially Neo-Platonism) and art, painting and writing of the Italian Renaissance. It is closely related to the unrestrainable research of a unifying harmonic kind of beauty, constant allegorical allusions and a persistent but innovative reference to history, tradition and past, whether it be the reinvention of classical perspective, or the obsession for human body proportion inherited from the Ancients, or the inspiration from Greek philosophy or the application of Euclidean mathematics and optics to astronomy.

4.3. Dutch Art and Experimental Science

Dutch visual episteme prepared the ground for the upcoming diffusion and advancement of experimental (or Baconian) strand of science since:

- It did not refer specifically and obsequiously to a theory, but celebrated its absence. The Dutch lacked in fact of an ideal or elevated style which could orient their visual representation. The involuntary result was to echo in figural terms the empirical attitude of Francis Bacon, the relevance he gave to direct observation and his disregard for theory:

> It is better to dissect than abstract nature […]. It is best to consider matter, its conformation, and the changes of that conformation, its own action, and the law of this action or motion; for forms are a mere fiction of the human mind, unless you will call the laws of action by that name. (Bacon, 2012, 27)

- Dutch descriptive attitude implied a disinterest for any historical references. It neither belonged or craved to fit in any codified long-lasting tradition. Similarly, the observational, antitheoretical and nonmathematical Baconian foundation of science lacked of any ancient precedent, along with Bacon's own refusal of any reverence toward the past.
- Old Masters' richly detailed still lives devoid of any symbolic and allegorical meaning, exhibited an excellent classificatory attitude and reliance on empirical evidence. Such empirical approach of Dutch Golden Age is compensated by the figural approach of its scientists. Illustrations had, in fact, a pivotal role in the works of Dutch Naturalists like the microscopist Leeuwenhoek (1632-1723).
- 'The Dutch mixture of trade with art' (Alpers, 1983, 100) did not only impeded any real separation between art and craft. It also delineated a new practical attituded toward knowledge, whereby knowledge was not only contemplation of the natural order, but also a tool to achieve concrete trivial objectives.
- Dutch attentive eyes and the high status attributed to observation did not simply rest on direct confrontation with nature, but mostly on the application of new mechanical optical instruments (i.e. camera obscura and microscope).

Dutch art was not just concerned with mirroring nature, in contrast with the humanist attitude of Italian art. On the contrary, it was aware of the crafted, artificial nature of its works. It was aware of the necessity of manufacturing tools to achieve an attentive and scrupulous view of things. In order words, it followed the utilitarian attitude of Bacon, to whom nature needs to be forced to achieve knowledge: 'Seeing that the nature of things betrays itself more readily under the vexations of art than in its natural freedom' (Bacon, 2012, 21).

Such an empirical realism achieved through technical aid was the northern reply to Italian formal realism. It also echoed Baconian notion of the necessary link between technical ability and scientific (documentary) representation. As stated by Kuhn, Baconian sciences are instrumental as far as their instruments are not just a support (probably of educational kind) to confirm thought experiments and mathematical deductions occurred previously. Baconian sciences (as such as chemistry) necessitate tools and physical experiment in order to generate knowledge, or rather to grasp nature (Kuhn, 1976, 12).

As Bacon was not only interested in cataloguing natural living beings but also crafted objects, so Dutch artist 'established alliance […] with those craftsmen-goldsmiths, tapestry weavers, glassblowers, and geographers-whose products became the crafted objects in their representations' (Alpers, 1983, 103). In the seventeenth century Dutch painters were 'reproducing exactly, often with the help of the lens, the surface textures of cloth, mirrors, glasses, insects, fur, and feathers' (Wilson, 1988, 100). Similarly, the first microscopists were interested in studying and replicating the appearances of ordinary objects. This alliance is the consequence of the assumption that there is not real difference between discovering and making, between *natural* and *artificial entities*; a mentality very diffused in the seventeenth century, especially in Northern Europe.

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