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Seventeenth-century controversies about the representation of the sun's shadow. The manuscript "Artes Exçelençias de la Perspectiba" in context

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Abstract

Some of the 'geometric contradictions' in certain works, especially manuscripts about perspective, can be used to understand which paradigms in the history of representation clash with each other. The manuscript *Artes Exçelençias de la Perspectiba* introduces us to this important chapter in the history of perspective, not only in Spain, but throughout the seventeenth century in Europe. During this period solutions were found, tested and formulated regarding the delicate problem of the graphic control of shadows produced by sunlight – or "striking" – within the perspective method.

Keywords: perspective, theory of shadows, historical treatises, descriptive geometry, architectural representation.

The anonymous but extremely interesting treatise *Artes Exçelençias de la Perspectiba*, dated 1688 and dedicated to "maestro P. Gomez de Alcuña", focuses on perspective in the seventeenth century in Spain and Europe.[1] The four-book document contains ninety-six sheets. The first two books are dedicated to the geometric fundamentals of perspective and its use in architectural representation.[2] The fourth book, inserted in the binding after the second, focuses on regular and star polyhedra.[3] The incomplete third book, in which some texts are missing, is dedicated to the study of the projections of shadows and perspectives on walls and ceilings. Since the treatise remained a manuscript, it never circulated in contemporary artistic and scientific milieus.[4] The manuscript is an excursus on the most popular Italian treatises on perspective in seventeenth-century Spain, for example the ones by Vignola-Danti (Le due regole della prospettiva pratica, 1583), Daniele Barbaro (*La pratica della perspettiva*, 1568) and Lorenzo Sirigatti (*La pratica di prospettiva*, 1596).

It summarises the most common procedures used to create perspective in Spain: the procedure based on the direct intersection of the visual pyramid, and the one based on the use of distance points, with interesting variations made by seventeenth-century

[1] The anonymous manuscript *Artes Exçelençias de la Perspectiba a maestro P. Gómez de Alcuña, 1688*, is currently housed in the archive of the Fundación Casa de Medina Sidonia, Sanlúcar de Barrameda, Cadiz. Ms. 3130. For an initial approach to the study of the manuscript, see Gentil, Martín-Pastor 2006. A complete study is reported in the Doctorate Dissertation by Martín-Pastor 2009. For a facsimile edition of the manuscript with studies and transcriptions, see Martín-Pastor, Beltrán Corbalán, Marsilla de Pascual 2010.
[2] See Martín-Pastor, Granado-Castro 2015.
[3] See Gentil, Martín-Pastor 2015.
[4] Regarding the fate of the manuscript, see Gentil 2012.

authors.[5] In addition, the manuscript reveals French and north-European influences that were completely novel for Spain, i.e., references, amongst others, to Samuel Marolois (1633), Jean Dubreuil (1642), Jean-François Nicéron (1646), and Girard Desargues cited by Abraham Bosse (1648) and Henry Hondius (1625) who influenced both the iconographic repertoire and the geometric system. The topic discussed in this article is one of the most controversial aspects of the representation of shadows produced by sunlight; it is presented in the third book of the treatise and contextualised at European level. What emerges is that the anonymous author of the manuscript commits the same 'mistakes' made by Dubreuil, mistakes for which the latter was harshly criticised by Desargues during the heated debate that raged in Paris in the seventeenth century.

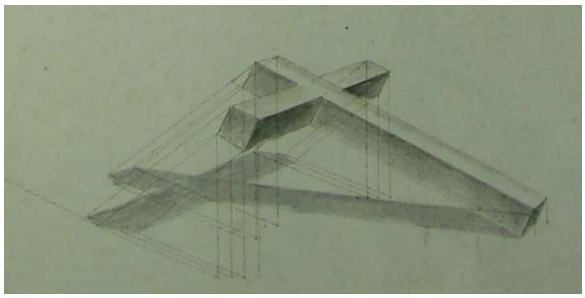

Fig. 1. Anonymous, *Artes Exçelençias de la Perspectiba*, 1688, Fol. 94. Note that in the perspective image the sun's rays are parallel straight lines.

Using several examples, we will see that the Spanish author thought he could represent the shadow of sunlit objects by drawing radii that remain parallel even in the perspective image (figs. 1, 2). We will try to identify the geometric construction behind the procedure we believe to be clearly incorrect since the perspective image of any bundle of straight lines that are parallel to each other in space, but are not parallel to the picture plane will, in the image, necessarily become a bundle of straight lines converging in a vanishing point.

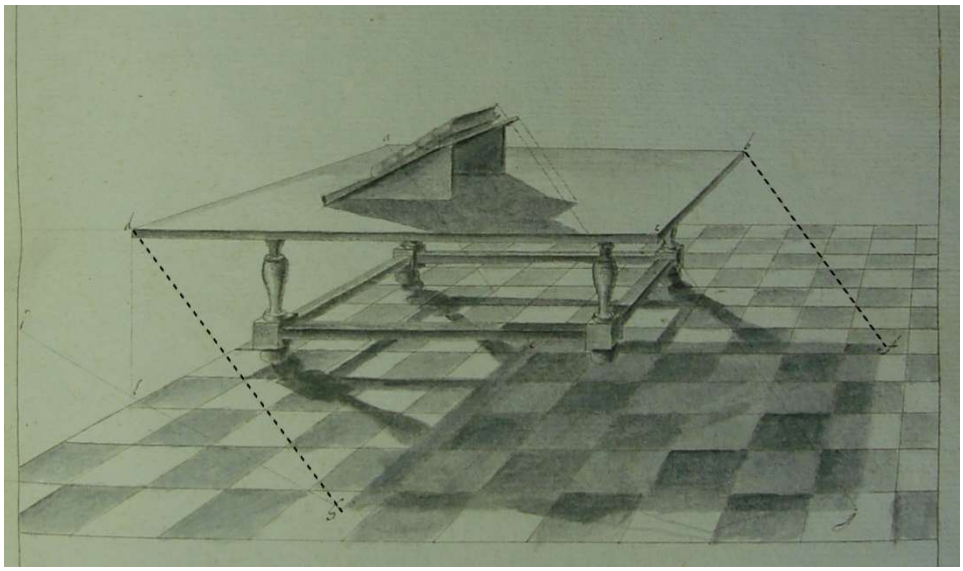

Fig.2. Anonymous, *Artes Exçelençias de la Perspectiba, 1688*, Fol. 94. The projection of a shadow is created by drawings parallel lines also in the image. This way the sun's rays assume an apparent, incorrect parallelism.

[5] For more information about the different procedures used to construct perspective in Spain in the seventeenth century vis-à-vis the manuscript, see Martín-Pastor 2014.

All this brings us back to an important moment in the history of the classification of perspective considered as a representation method, an issue that undoubtedly requires further in-depth study. We are referring to the control of parallelism between straight lines in perspective; instead, as concerns the representation of the shadow produced by sunlight, this problem was tackled, verified and solved during the seventeenth century.

The European codification of the projection of the shadow created by sunlight

We will now briefly cite several key works focusing on the classification of the construction of the shadow produced by sunlight in perspective and draw attention to some of the issues dealt with by Kaufmann (1975) and other scholars. The first person to scientifically tackle the problem was Leonardo da Vinci, but it was not until Albrecht Dürer published his *Underweysung der Messung* in 1525 that the problem of sunlight was studied comprehensively. In the four etchings presented by Dürer in his book (fig. 3), and in the copies later made by Barbaro (1569), the sun is not at an infinite distance, but in a specific point in space.[6] Certain 'paradigms' had to be removed before it was possible to envisage a graphic model with an illumination using parallel rays coming from a source – the sun – placed at an infinite point.[7] This is why most seventeenthcentury treatises on perspective propose objects lit by a punctiform luminous source such as a torch or candle; but either they neglect the problem of solar illumination or they tackle the issue marginally or even incorrectly. We will concentrate on these aspects.

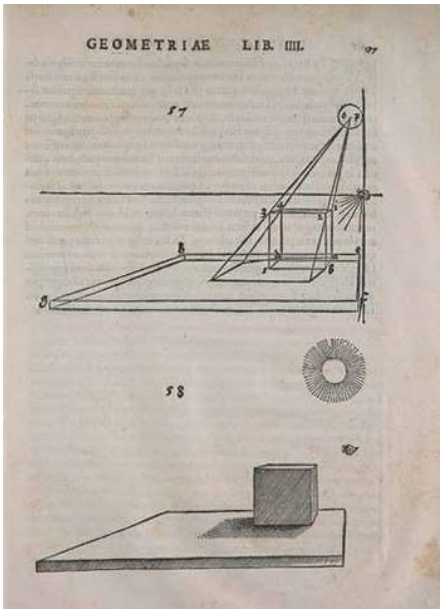

Fig.3. Albrecht Dürer, *Underweysung der Messung*, Nuremberg 1525, Fol 87r. In this etching, like other etchings related to the study of shadows, note that the icon representing the sun is not above the horizon.

[6] Kaufmann 1975, p. 275; De Rosa 1997, pp. 60, 61; Sgrosso 2001, p. 291; Camerota 2004, p. 194; Andersen 2007, p. 195; Càndito 2010, p. 157.

[7] "Changes in paradigms usually produce important changes in the criteria determining the legitimacy of both the problems and the proposed solutions": cfr. Thomas Kuhn. *La estructura de las revoluciones científicas*. Translation by Agustín Contin of *The structure of scientific revolutions*. Chicago: Chicago Press, 1962, p. 174.

In his early seventeenth-century manuscript *Perspectivae Libri Sex* (1600) Guidobaldo del Monte makes considerable headway in the geometrisation of problems associated with perspective.[8] His key input into the problem we are dealing with here is a definition of the "punctum concursus" as a generalisation of the point where parallel straight lines directed into space nevertheless converge, a point that does not coincide with the main point or distance point. This discovery was the core idea on which he based all his work; its specific application is represented in the sixth of the twenty-three methods presented.[9] Most people agree that his procedure – modestly presented in a graphically unclear treatise – was never popular with later treatise writers, even if two important theorists, Simon Stevin (1605) and François d'Aguilon (1612), helped to disseminate it in The Netherlands,[10] while in Florence people began to speculate about its use in the construction of shadows. In his manuscript-treatise *Prospettiva Pratica* (c. 1613) the painter Ludovico Cardi, known as 'il Cigoli', graphically portrayed this geometric problem applied to the illumination produced by the rays of the sun.[11] The procedure used by Cardi appears to follow Guidobaldo del Monte's method, especially in the use of the aforementioned "punctum concursus" (fig. 4).[12]

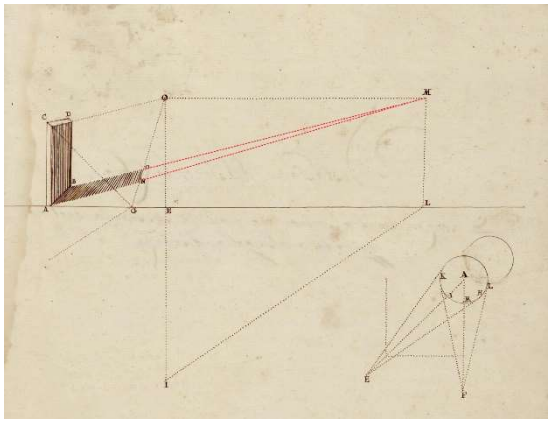

Fig.4. Ludovido Cardi, *Prospettiva pratica*, c. 1613. "Et venendo all'operazione per descrivere lo sbattimento tirisi .G. al punto retto, e si seghi con / .AM. in N. et con .BM. la GO. In .O. et chiuso infra .ANOB. haremo il contenuto dello sba-/ttimento del sole, il quale per le ragioni dette di sopra si debe dipingere crudo, e terminato./" Cardi, c. 1613, "Libro Secondo. Quinta Parte/ Terza Regola/ Degli sbattimenti del sole", fol. 81v, fol. 82r.

In the last pages of his treatise Lo inganno de gl'occhi (1625), Pietro Accolti, also active in Florence, provides a theoretical approach to the problem of sunlight (fig. 5).[13] He establishes a unique correspondence between the projection of the sun's shadow and the 'vision of the sun', a perspective in which the straight lines do not converge. Using this method the Florentine author arrives at an oblique axonometric projection, as a

[8] The importance of Guidubaldo's work is universally acknowledged: Poudra 1864, Sinisgalli 1984, Kemp 1990, p. 102.
[9] This aspect is remarked upon by Andersen 2007, p. 254.
[10] See Sinisgalli 1978; Andersen 2007, p. 265.
[11] "Libro Secondo. Quinta Parte/ Terza Regola/ Degli sbattimenti del sole"; Cardi c. 1613, Fol. 81v, Fol. 82r. See Camerota 2010.
[12] Camerota 2010, pp. 283, 284, theorises that both the AN segment and the BO segment have to vanish in point M, that is a point of 'collusion' found a priori according to Guidobaldo del Monte's theory. This is presented also in Camerota 2004, p. 195.
[13] Accolti's illustrations on this issue are extensively commented by De Rosa 1997, p. 87; Camerota 2005, p. 85 and Parenti 2010.

special case of perspective when the centre of projection is shifted to infinity.[14] This initial conceptual and procedural development of the problem of parallelism vis-à-vis the shadow projected by sunlight followed the approach established by the two Florentines, Cardi and Accolti, at the beginning of the seventeenth century; a few years later, it continued as a topic in the debate in Paris, as we will see further on.[15]

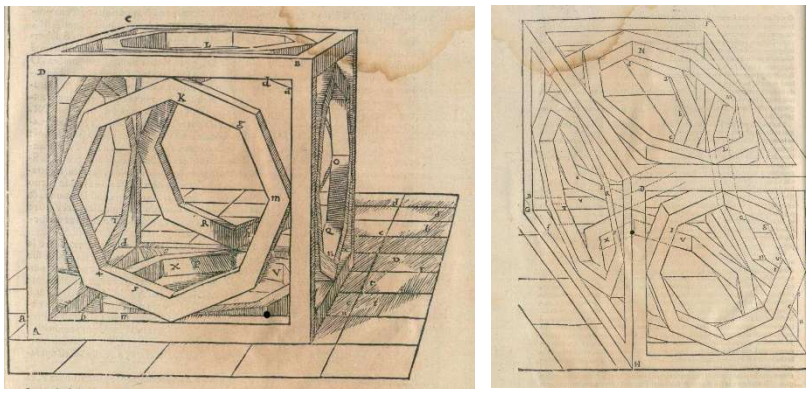

Fig.5. Pietro Accolti, *Lo inganno de gl'occhi: prospettiua pratica di Pietro Accolti...,* Florence 1625, pp. 140, 141.

Mistakes and syntheses. Criticism by Dubreuil and Desargues

The treatise written by the Jesuit Jean Dubreuil (*La perspective practique*, 1642) is a compilation of everything to do with perspective. It includes the complete treatise of shadows, produced either by a punctiform light or by sunlight. In some of his illustrations the 'Jesuit of Paris' undoubtedly put together a significant ensemble of skilful interpretations and mistakes in the construction of shadows produced by the sun (fig. 6). The examples show that it is the same 'mistake' made by the anonymous author of the manuscript *Artes Exçelençias de la Perspectiba* (1688) which we will analyse later.

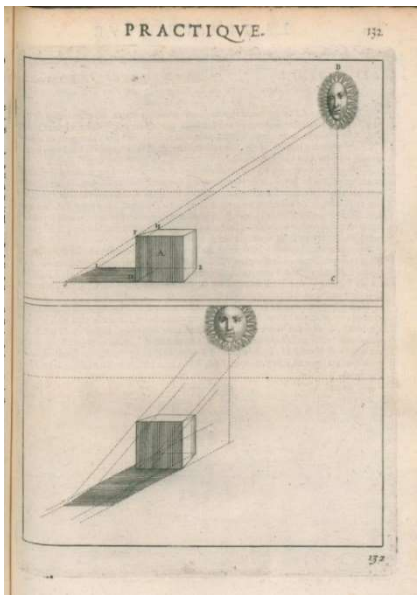

Fig.6. Jean Dubreuil, *La perspective practique*, Paris 1642, p. 132. In the figure note Dubreuil's 'error', i.e., the fact the sun's rays are represented as parallel straight lines in perspective.

[14] The concept of infinity is evident: "With the infinite distance of the light from shadows, from whence they derive, we are able to see it with our own eyes"; Accolti 1625, p. 139.
[15] Idea proposed in Camerota 2010, "Cigoli's contribution to the codifying of renaissance perspective", pp. 49-89.

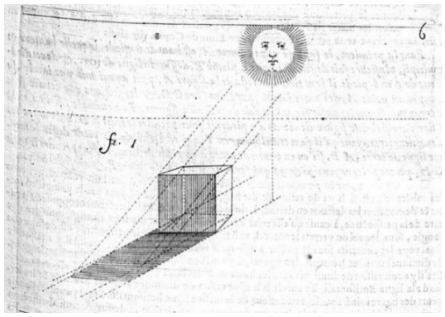

Fig.7. Girard Desargues, Six erreurs des pages 87. 118. 124. 128. 132. et 134. du livre intitulé La Perspective practique ..., Paris: Melchior Tavernier, 1642, p. 6v. In the figure Jean Dubreuil's error is copied and criticised.

When the scholar of geometry from Lyon, Girard Desargues, noted the mistake and other inaccuracies (fig. 7) he quickly wrote an essay entitled *Six erreurs du livre intitulé La Perspective pratique…* which he published the same year as Dubreuil's text (1642). Some of these 'mistakes' were actually incorrect interpretations, if not plagiarism of his essay dated 1636 *Exemple de l'une des manières universelles du S.G.D.L. touchant la pratique de la perspective*.[16] This is a key element in the debate we are having here and was critically and eloquently commented by Desargues: "this rule is false; because in both cases when the shadows are projected their perspective images are not straight lines parallel to each other on the picture plane".[17]

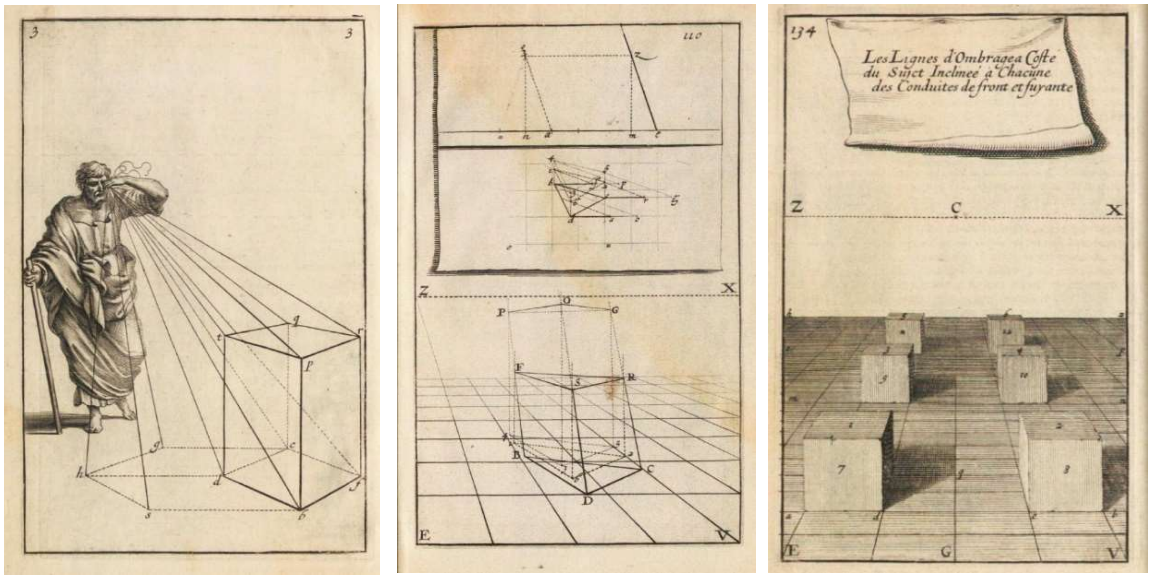

Fig.8. Abraham Bosse, 1648 (1st ed. 1643). Left: tab. 3, p. 61; a synthesis of the method that requires finding the projection of the shadow on the construction plane. Centre: tab. 110, p. 168; the position of the sun is not considered a problem a priori. Right: tab. 134, p. 303. The graphic examples show the parallels to converge in a very distant point in the image.

Six years after this incident Abraham Bosse published *La Manière Universelles de M. Desargues* (1648). The text includes an image of shadows projected by several objects illuminated by sunlight. It's interesting to note that, without exception, the graphic

[16] Poudra 1864, p. 497; Taton 1951, pp. 51, 55.
[17] "or cette regle est faulse; car quand les ombres se jetten ainsi en avant d'une ou d'autre sorte, leurs perspectives ne sont pas des lignes paralelles entre elles dans le tableau"; Desargues 1642, p. 6r.

procedure used by Bosse-Desargues in his long text creates shadows using projections on a 'point by point' grid (fig. 8); this is why the sun is not represented in any of the illustrations.[18] According to other scholars, Desargues' essay is not the first to adopt the concept of infinity, nor the first to graphically express the convergence of parallel lines.[19]

We believe that the most important graphic image appeared two years earlier in Jean-François Nicéron's *Thaumaturgus Opticus* (1646), published the year Nicéron died prematurely; in this case the treatise written in Latin includes new graphic examples in the graphic appendix of the text.[20] Moving on compared to what had been proposed by Cardi and Accolti, the text presents an infinite point in the sky, as the origin and terminal point of shadows. It provides a precise, strict method with which to represent the three possible cases of illumination: first, when the sun is in front of the onlooker, as a precise point in the sky (fig. 9 left); secondly, when the sun is behind the onlooker, as a vanishing point below the horizon (fig. 9 right), and thirdly when the rays are parallel to the picture plane.

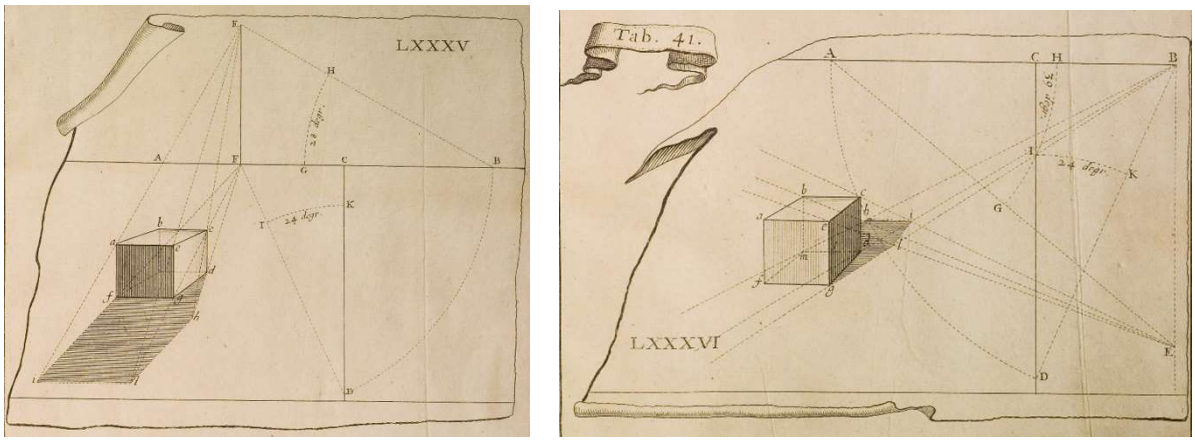

Fig.9. Jean-François Nicéron, Thaumaturgus Opticus, Paris 1646, fig. 85 & 86. In these etchings the projection of the sun's position on the horizontal plane ends on the horizon and, therefore, on infinity.

The direction of the sun is established using two angular measurements: the angle it creates with the north, or azimuth, and the vertical angle representing the height of the light source compared to the horizon, thus pushing Guidobaldo del Monte's schema of the "punctum concursus" to the limit.[21]

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[18] This absence of a vanishing point is not accidental and is in keeping with the title of the book "la práctica de la perspectiva sin usar ningún tercer punto, ni de distancia ni de ningún otro tipo". According to Field 1987, p. 27, the advantage of the method presented by Desargues in 1636 was that it did not need to use any point on the picture plane apart from the main point.

[19] Critics agree that it was Desargues who provided a complete solution to the problem of infinity and how it relates to the sun's shadow (Kaufmann 1975, p. 283). Field 1987, pp. 28, 29 and Andersen 2007, p. 434 note that undoubtedly the conceptual inspiration behind Desargues' work is written in mathematical terms and that there is no graphic evidence of it in his book Exemple de l'une des manieres universelles du S.G.D.L. del 1636. We believe that these problems will be solved graphically by following the indications provided by Cardi, Accolti and Nicéron, on the basis of Guidobaldo del Monte's hypotheses.

[20] A recent study about Nicéron is published in De Rosa 2013.

[21] Kaufmann 1975, p. 284 found the complete solution to the problem of the sun's shadow in Taylor (1715) and Kirby (1734), forgetting the input by Nicéron. Andersen 2007, pp. 244, 357,

Clarifications about perspective in Spain. Controversies

In the seventeenth century the debate on perspective was still raging in Florence and Paris, but since peninsular Spain was completely unaware of these discussions perspective evolved in a very different direction. For most of the century quite a few different and complex issues succeeded in preventing a scientific debate on perspective. Even after several Academies and the scientific movement known as 'los novadores' were founded in the late sixteenth century, the Colegio Imperial of the Jesuits in Madrid was the only place where individuals interested in perspective gathered to debate and confer.[22] The sixteenth-century cultural and scientific milieu was undoubtedly very different, influenced as it was by the Castilian translation of Greek perspective, cartography and nautical science following the discovery of the New World. Accordingly, the advent of 'Italian' perspective with its innovative graphic methods sparked a conflict between angular and linear paradigms; this partially explains why perspective was rejected by certain scientific circles in Spain. In fact, this state of affairs was clearly described in the treatise of angular perspective by the Renaissance architect Hernán Ruiz II - further proof that the angular paradigm had become popular in certain milieus.[23] Contrary to what happened in the previous century, in the seventeenth century the Italian procedures used to construct a perspective were now accepted and consolidated in Spanish cultural and artistic milieus, especially in the fields of painting, architecture and building. In fact, throughout the century the most commonly used graphic schema were the two most popular in Italy: the one based on direct intersection of the visual pyramid with the picture plane, and the one based on distance points. These two procedures are reported in the texts about perspective as applied to architecture and building: these treatises include the ones written by Torreblanca (1616-1619), Salvador Muñoz, (1642), Lázaro de Goiti (1643) and Luis Carduchi (c. 1650). They have survived as manuscripts and, in most cases, are either translations or compilations of works by authors active in the previous century such as Serlio, Vignola Danti, Barbaro and Sirigatti.[24] This was the situation when the third book of shadows of the *Artes Exçelençias de la Perspectiba* was published; the third book is an extremely important milestone we can exploit to understand how widespread these arguments were in Hispanic territories in the second half of the seventeenth century. It is the first Spanish treatise to include French and Dutch graphic procedures, very different to the traditional ones used in Italy. These new procedures were tackled to study the construction of shadows, as illustrated in the first treatise that focused on this problem in the long history of Spanish treatises.

The shadow of a candle and the shadow of the sun

The first part of the third book – unfinished and with pages missing – focuses on the study of shadows produced by a punctiform luminous source.[25] An obvious reference is present in an essay by Samuel Marolois; he uses a very clear, accurate graphic language

524, also omits to mention Nicéron when he tackles the evolution of the sun's shadow in treatises on perspective, from Guidobaldo del Monte's theoretical concept (1600) to the proposals by Ditton (1711), s'Gravesande (1711) and Taylor (1715).

[22] See Leoncio López-Ocón Cabrera. Breve historia de la ciencia en España. Madrid: Alianza, 2003.

[23] Cabezas-Gelabert 2013; Gentil, Martín-Pastor 2016.

[24] Ver Burucúa 1989-1991; Cabezas-Gelabert, 1984.

[25] *Artes Exçelençias de la Perspectiba*, Fol. 86, 91, 92, 93.

to explain several procedures illustrated by Guidobaldo del Monte and Stevin. This new approach was later used as a model by the Parisians Nicéron and Dubreuil who presented a joint iconographic repertoire containing the same illustrations found in *Artes Exçelençias de la Perspectiba* (fig. 10).[26]

As in European treatises the third book focuses first on illumination produced by a punctiform luminous source and only afterwards superficially concentrates on the study of shadows produced by sunlight.[27] Figure 11 illustrates the construction of a shadow created by directions parallel to the picture plane: parallelism between the rays of light is also maintained in the perspective image. It is a very important illustration showing sunlight penetrating inside a house through skylights, doors and windows; the problem is tackled using the same procedure adopted in a similar example by Dubreuil and accurately executed based on geometric principles. Since there are no explanatory notes in this part of the manuscript, we have to be somewhat cautious, but everything seems to suggest that the next illustrations (Fol. 94) tackle the study of the remaining two types of solar illumination (figs. 1, 2) with the contradictions already highlighted. We noted that the author wanted to illustrate two kinds of solar illumination by representing the parallel luminous rays directly on the perspective plane. Since this is the most controversial part of the treatise it deserves an in-depth geometric review.

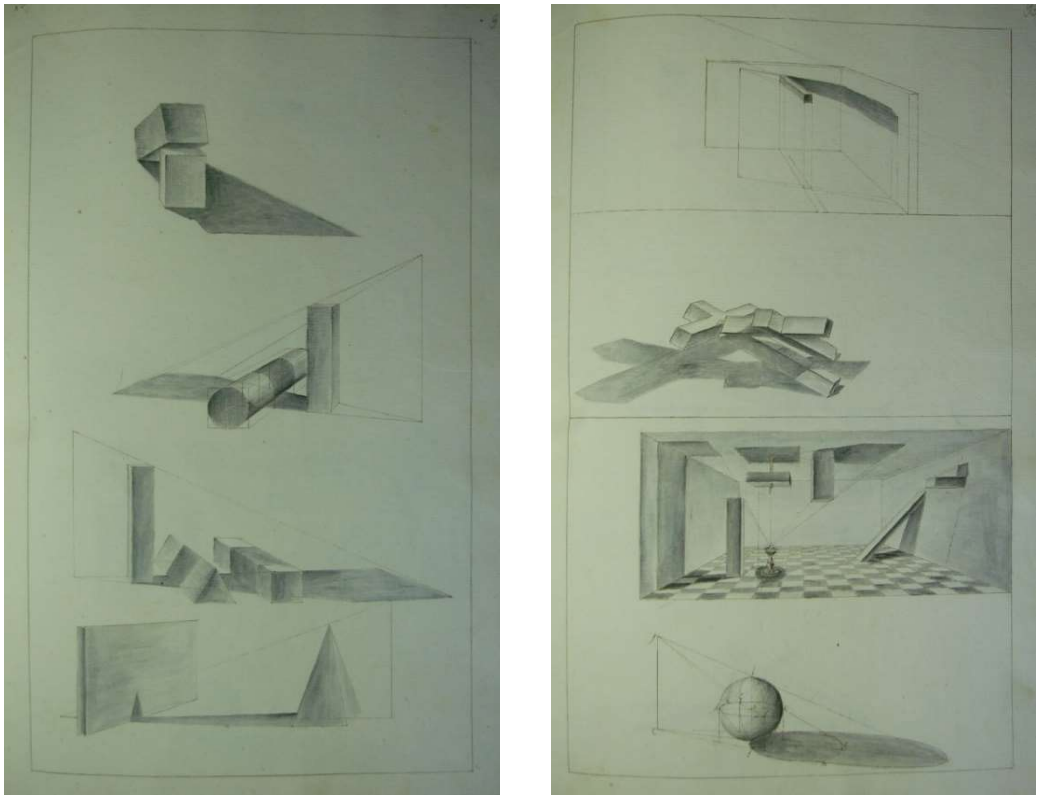

Fig.10. Anonymous, *Artes Exçelençias de la Perspectiba, 1688*. Right: Fol. 92. Left: Fol. 93.

Fig. 11. Anonymous, *Artes Exçelençias de la Perspectiba, 1688*, Fol. 94. The shadows projected by the sun are in a parallel position compared to the picture plane where the sun's rays are parallel.

[26] Marolois 1633, Lam. 69; Nicéron 1646, Lam. 39, 40; Dubreuil 1642, p. 144.
[27] *Artes Exçelençias de la Perspectiba*, Fol. 94.

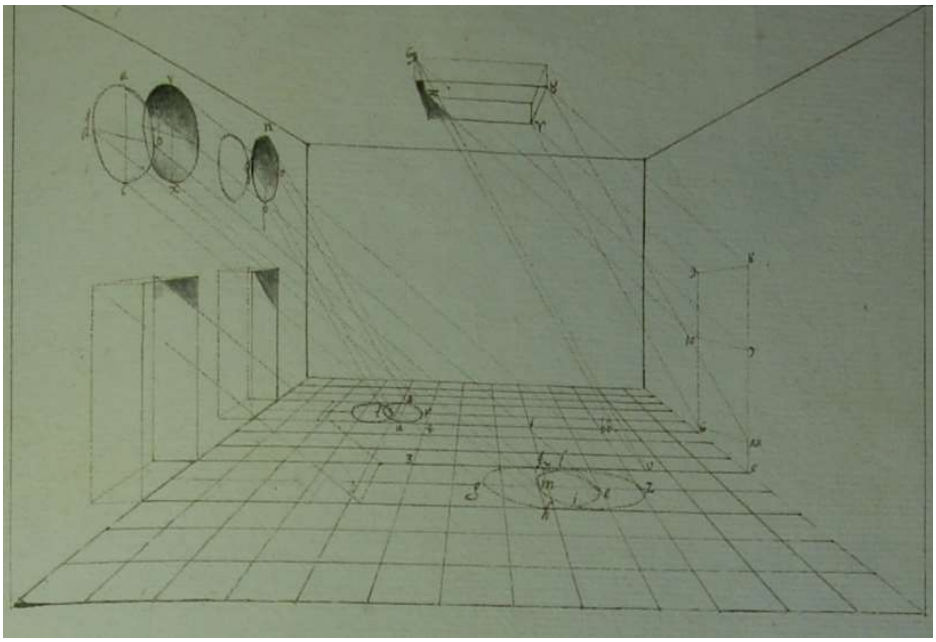

Fig. 12. A graphic construction of the shadow of a cross produced by sunlight and obtained using pseudo-parallel rays, and comparison with the shadow projected by a candle (images by the Author).

Playing with candles and black holes

A geometric analysis of the graphic construction used in figure 1 shows that this kind of shadow does not correspond to the one produced by the sun, instead it reproduces a shadow generated by a punctiform light source strategically placed on a projecting plane parallel to the picture plane (fig. 12). Even if this approach is very different to the one ostensibly imagined by the author, we believe that the same conditions in this example can be reproduced by simply using one candle, i.e., a perfectly natural kind of illumination in certain conditions. Undoubtedly in the second case, in which the shadow of a table projected by a light source coincides with the centre of projection, the ensuing illumination does not correspond to any natural phenomenon. So these are the same conditions illustrated by Dubreuil and criticised by Desargues (figs. 6, 7). Despite the fact that the anonymous author wanted to represent a third variant of sunlight, in strictly geometric terms he actually described something completely different. The graphic image shows that the projection of this kind of shadow follows an inverse path compared to the path of light. In fact the light seems to come from all points in space and veers towards the point where it ends, i.e., on the picture plane (fig. 13). There is one curious note. We have observed that the thing that exists in nature and is closest to this light absorption phenomenon is something that theoretical physicists mathematically deduced a few decades ago but was only proven very recently: the ‘black hole’. Ever since the eighteenth century several authors, such as Tomas Vicente Tosca (1705), used the solution for sunlight (fig. 14) proposed by both Dubreuil and the anonymous author of the manuscript.

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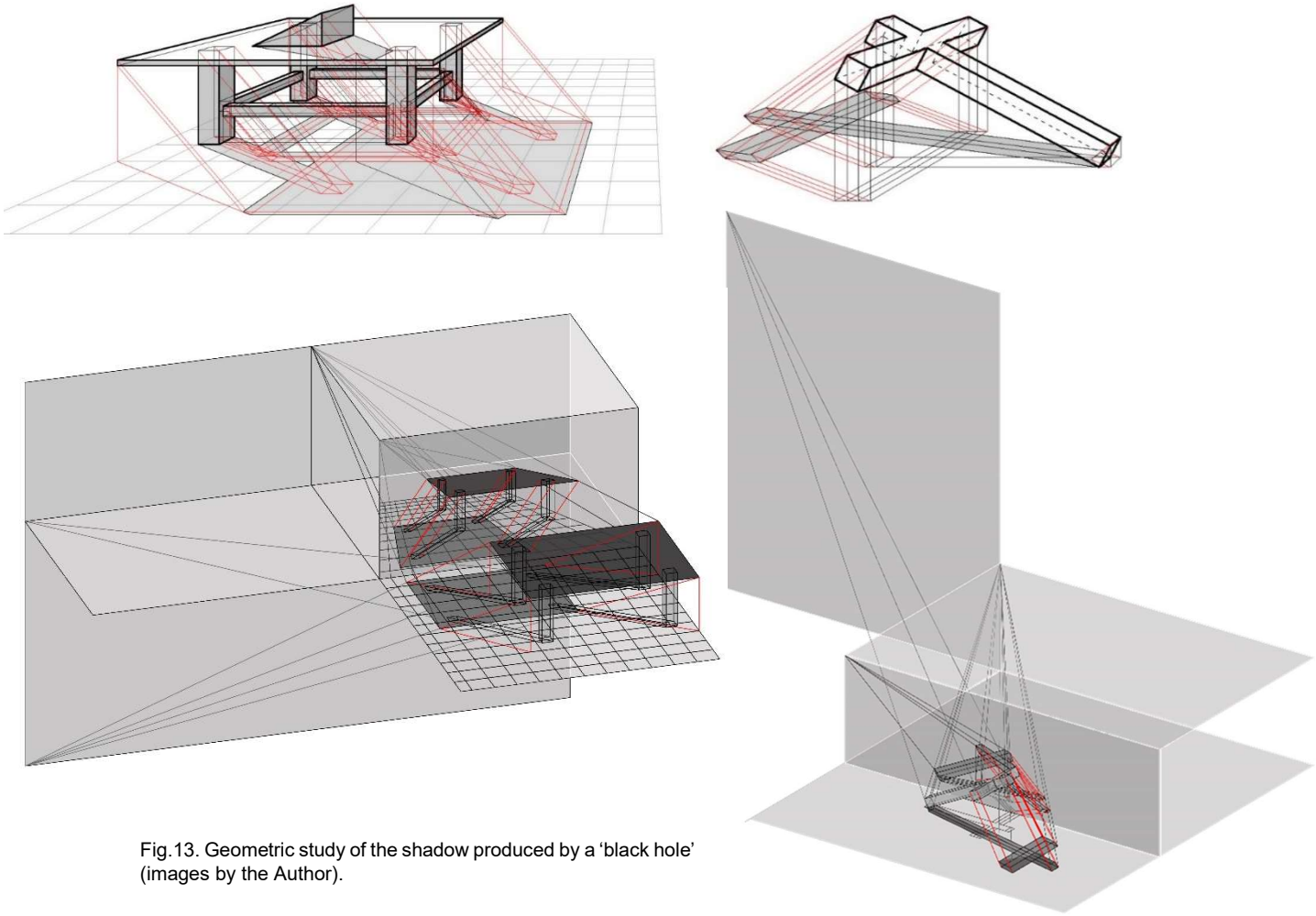

Fig.13. Geometric study of the shadow produced by a ‘black hole’ (images by the Author).

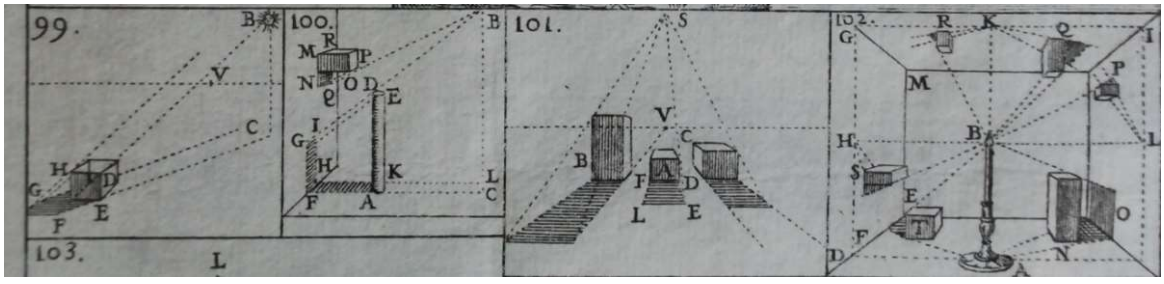

Fig.14. Thomas Vicente Tosca, Compendio Mathematico, Valencia,1705-1715. Figure n. 99. Tosca makes the same mistake as Dubreuil when he represents the parallel rays of sunlight, even if the latter are not parallel to the picture plane.

As a sort of conclusion

The discussion that arose around the representation of a shadow projected by sunlight should not be interpreted as the outcome of a mistake or lack of control, but instead stems from the difficult process of invalidating schema which, at a certain point in time, were no longer considered valid, and the fact that people had to accept the widespread dissemination of new systems. This explains how people, who at that particular moment were considered to be representation specialists, were in fact unable to grasp the contradictions which we can now see so clearly. We also discovered that in the impassioned Parisian panorama of the early seventeenth century the question of solar illumination remained unsolved. The multiple approaches to the problem, including the one adopted by Dubreuil and the anonymous Spanish author, should be considered as valid ways with which it can be tackled. Careful consideration of what has been presented here proves how difficult it was to accept Guidobaldo del Monte's method, graphically summarised in the second treatise written by Nicéron who re-elaborated Cardi's text. Nevertheless, a broader review of the issue shows how problematic it was to control and define the concept of 'infinity'; throughout the seventeenth century this absolutely revolutionary challenge for mathematical science developed in parallel with its graphic effects. This was possible thanks to the characteristics of perspective considered as a representation method. What we have discussed here demonstrates that more time and effort was needed to codify the sun's shadow compared to the shadow produced by candlelight. We could say that the codification and management of conic -or angular- projection has always preceded cylindrical projection, maybe because the latter requires a more in-depth assimilation of the concept of infinity.

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Figures

1. Anonymous, *Artes Exçelençias de la Perspectiba, 1688*, Fol. 94. Note that in the perspective image the sun's rays are parallel straight lines.

2. Anonymous, *Artes Exçelençias de la Perspectiba*, 1688, Fol. 94. The projection of a shadow is created by drawings parallel lines also in the image. This way the sun's rays assume an apparent, incorrect parallelism.

3. Albrecht Dürer, *Underweysung der Messung*, Nuremberg 1525, Fol 87r. In this etching, like other etchings related to the study of shadows, note that the icon representing the sun is not above the horizon.

4. Ludovido Cardi, *Prospettiva pratica*, c. 1613. "Et venendo all'operazione per descrivere lo sbattimento tirisi .G. al punto retto, e si seghi con / .AM. in N. et con .BM. la GO. In .O. et chiuso infra .ANOB. haremo il contenuto dello sba-/ttimento del sole, il quale per le ragioni dette di sopra si debe dipingere crudo, e terminato./" Cardi, c. 1613, "Libro Secondo. Quinta Parte/ Terza Regola/ Degli sbattimenti del sole", fol. 81v, fol. 82r.

5. Pietro Accolti, *Lo inganno de gl'occhi: prospettiua pratica di Pietro Accolti...,* Florence 1625, pp. 140, 141.

6. Jean Dubreuil, *La perspective practique*, Paris 1642, p. 132. In the figure note Dubreuil's 'error', i.e., the fact the sun's rays are represented as parallel straight lines in perspective.

7. Girard Desargues, *Six erreurs des pages 87. 118. 124. 128. 132. et 134. du livre intitulé La Perspective practique ...,* Paris: Melchior Tavernier, 1642, p. 6v. In the figure Jean Dubreuil's error is copied and criticised.

8. Abraham Bosse, 1648 (1st ed. 1643). Left: tab. 3, p. 61; a synthesis of the method that requires finding the projection of the shadow on the construction plane. Centre: tab. 110, p. 168; the position of the sun is not considered a problem a priori. Right: tab. 134, p. 303. The graphic examples show the parallels to converge in a very distant point in the image.

9. Jean-François Nicéron, *Thaumaturgus Opticus*, Paris 1646, fig. 85 & 86. In these etchings the projection of the sun's position on the horizontal plane ends on the horizon and, therefore, on infinity.

10. Anonymous, *Artes Exçelençias de la Perspectiba, 1688*. Right: Fol. 92. Left: Fol. 93.

11. Anonymous, *Artes Exçelençias de la Perspectiba, 1688,* Fol. 94. The shadows projected by the sun are in a parallel position compared to the picture plane where the sun's rays are parallel.

12. An incorrect graphic construction of the shadow of a cross produced by sunlight and obtained using pseudo-parallel rays, and comparison with the shadow projected by a candle (images by the Author).

13. Geometric study of the shadow produced by a 'black hole' (images by the Author).

14. Thomas Vicente Tosca, Compendio Mathematico, Valencia,1705-1715. Figure n. 99. Tosca makes the same mistake as Dubreuil when he represents the parallel rays of sunlight, even if the latter are not parallel to the picture plane.