

APROXIMACIÓN AL ANÁLISIS DEL SISTEMA DIÉDRICO ESPAÑOL COMO LENGUAJE

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Mientras la gramática del sistema diédrico español recurre a la formulación del modelo proyectivo para estructurar el pensamiento espacial del estudiante, el *direct method* anglosajón se apoya en la reconstrucción de la imagen mental de la configuración geométrica. La superación del marco epistemológico que da origen a la clásica geometría descriptiva conduce a un progresivo abandono de la especulación intelectual y su reorientación hacia el diseño aplicado. El retraimiento cultural de la época en el contexto español trae como consecuencia, en este caso, que la institución educativa permanezca ajena al avance del conocimiento en la materia, lo que va a propiciar un cierto grado de academicismo que todavía va a permanecer durante la segunda mitad del siglo xx.

Introducción

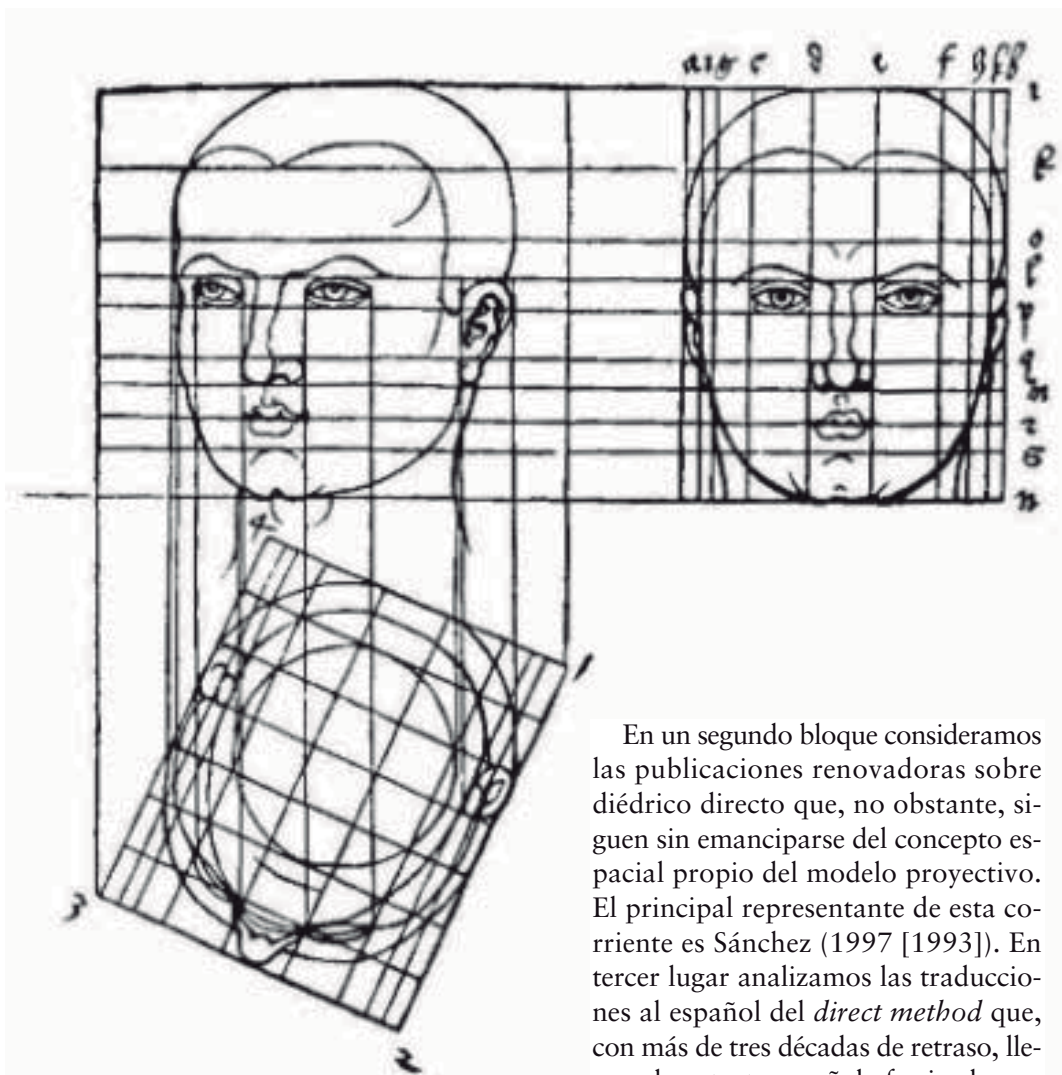
Frente a la pedagogía constructivista, el descrédito de la enseñanza conductista se refiere a obviar los procesos mentales del estudiante en la tarea de construir su aprendizaje. La mecánica de *restitución* espacial en el sistema diédrico considera la posibilidad de recuperar la estructura tridimensional de la configuración geométrica representada. Tal proceso se ha tratado de aplicar igualmente para justificar la obtención de la imagen mental correspondiente (Taibo 1966 [1944], 2). Esta investigación pretende poner de manifiesto que la gramática del sistema diédrico español, heredera de la clásica geometría descriptiva crea unas expectativas formativas de difícil fundamentación en torno al desarrollo y estructuración del pensamiento espacial del estudiante.

A lo largo de la historia la comunicación gráfica, ha desarrollado variantes e híbridos descriptivos en función de las necesidades prácticas de representación. Durante el Renacimiento las representaciones técnicas fueron utilizadas para describir objetivamente la forma tridimensional partiendo de la síntesis visual de su configuración geométrica (Fig. 1).

Concepto espacial

Teniendo en cuenta que la manifestación de la representación gráfico-geométrica no es sino expresión de la evolución de un concepto espacial específico asociado a un determinado contexto científico, el sustrato epistemológico sobre el que se erige la clásica disciplina académica permite caracterizar el orden sintáctico en que se apoya el modelo proyectivo como formulación orientada a estructurar el pensamiento espacial del estudiante (Fig. 2).

Proponemos dos hipótesis de partida con un claro componente dialéctico en su enunciación. En primer lugar se considera que el marco epistemológico que sustenta la gramática del sistema diédrico español prioriza la representación proposicional sobre la analógica (Ballesteros Jiménez, 1993) y, en consecuencia, establece determinadas mecánicas deductivas a partir de las variables lógicas de la operatividad proyectiva. Dicha doctrina es, en principio, ajena al proceso psicológico de formación de conceptos espaciales a través de la construcción de imágenes mentales. En segundo lugar se considera que el *direct method* anglosajón supera los problemas del modelo pro-



1. Estudio de una cabeza mediante varias vistas asociadas. Albrecht Dürer.

yectivo al plantear, desde el inicio, la asimilación del concepto espacial favoreciendo la construcción de una imagen mental nítida del diseño tridimensional. En tal sentido el *direct method* se ocupa de potenciar la orientación espacial del estudiante mediante la obtención de vistas ortográficas de síntesis perspectiva para apoyar la cognición de las relaciones espaciales (Fig. 3).

Para validar tales hipótesis indagamos en la metodología operativa de la representación gráfico-geométrica valorando cuatro bloques bibliográficos en los que hemos clasificado el material existente. El primero de ellos identifica las publicaciones afines a la disciplina académica en el contexto español: Taibo (1966 [1944]), Izquierdo (1956) y Rodríguez de Abajo (1958) entre las de mayor difusión (Fig. 4).

En un segundo bloque consideramos las publicaciones renovadoras sobre diédrico directo que, no obstante, siguen sin emanciparse del concepto espacial propio del modelo proyectivo. El principal representante de esta corriente es Sánchez (1997 [1993]). En tercer lugar analizamos las traducciones al español del *direct method* que, con más de tres décadas de retraso, llegan al contexto español ofreciendo una versión descontextualizada respecto a sus fundamentos originales: Warner and Mcneary (1964 [1934]), Rowe and Mcfarland (1967 [1939]) y Wellman (1964 [1948]) entre los autores más relevantes. Finalmente se contemplan las publicaciones originales del *direct method*, prácticamente sin presencia en las bibliotecas españolas: Millar (1922 [1913]), Hood (1926), Warner and Mcneary (1934), Rowe and Mcfarland (1946 [1939]) y Wellman (1948), como autores fundadores de esta corriente alternativa (Fig. 5).

El análisis bibliográfico de los bloques reseñados se refiere, de manera particular, a la secuencia de contenidos y el equilibrio teórico-práctico, sin obviar el interés que tienen las construcciones geométricas como expresión de un concepto espacial aplicado. La adopción del idioma original en algunos conceptos y citas, responde a la intención de mantener la identidad tex-

tual del contenido y evitar la distorsión que la traducción pudiera añadir. La versión completa del estudio forma parte de la tesis doctoral de Grassa-Miranda (2008).

Análisis vs síntesis

El filósofo y matemático René Descartes (1596-1650), impulsor de la geometría analítica, ya había considerado la posibilidad de reconstruir la realidad deductivamente a expensas de la experiencia. Su concepción racionalista del mundo, tuvo una profunda influencia en el continente europeo con su epicentro en Francia. En consistencia con el razonamiento proposicional, el creador de la geometría descriptiva Gaspard Monge (1746-1818) se propone interpretar las relaciones espaciales en base a determinadas variables lógicas que surgen de la operatividad proyectiva (Boker, 2001 [1963], 25). La motivación por extender la legitimidad de las operaciones de análisis al terreno de la representación gráfica va a ser uno de los principios embrionarios de esta formulación (Sakarovitch, 1998, 261) (Monge, 1996 [1803], 90) (Fig. 6).

Como fundador de la École Polytechnique, la posición institucional y política de Monge justifica, en buena medida, el papel privilegiado de la geometría descriptiva para constituirse

2. Alfabeto del plano (Gutiérrez Vázquez; Izquierdo Asensi; Navarro de Zuñillaga; Placencia Valero; 1984, p. 121).

3. Proceso de visualización/representación de objetos tridimensionales (Bertoline, 1997, 241).

4. Lámina 2 de la *géométrie descriptive* (Monge, 1996 [1803]).

en una de las disciplinas académicas del modelo napoleónico de formación politécnica y su posterior difusión (Boyer, 1982 [1968], 598), contando además con la enorme influencia que Francia ejercía en gran parte del continente europeo. La normativización que promueve el modelo proyectivo da lugar, durante la primera mitad del siglo XIX, a un proceso de reinterpretación de técnicas que determinará la codificación de los sistemas de representación:

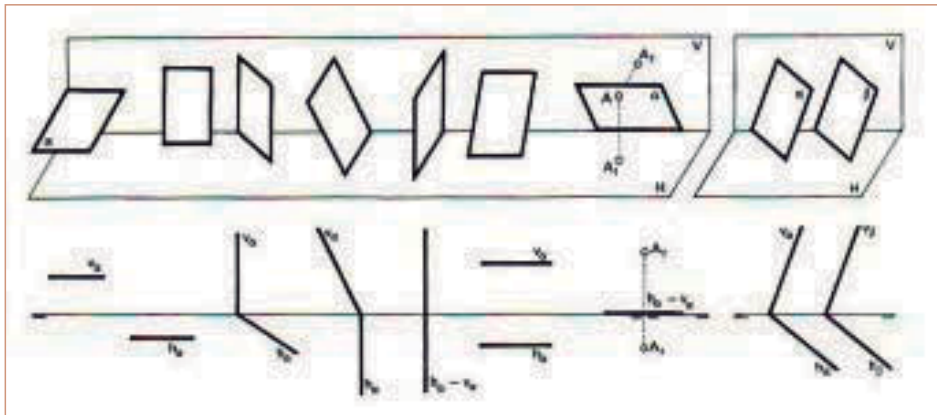
Ya hemos mencionado la supresión en la École Polytechnique de las perspectivas caballerías de las láminas de De la Rue. A pesar de que este sistema de representación era genuinamente francés, no se le prestó atención en Francia hasta los escritos de Theodore Olivier. Aún menos habrían de estudiar los primeros discípulos de Mon-

ge la axonometría ortogonal (...). Por otra parte la perspectiva cónica era en la escuela de Monge mera aplicación de la geometría descriptiva, más para demostrar la capacidad operativa del método de Monge que como reproducción del viejo procedimiento de Alberti. De la Gourniere siente nostalgia de la riqueza de procedimientos gráficos de los gremios y la variedad y matices en los modos de representar, cortada por la imposición de una lengua normalizada. Su crítica se completa con la reivindicación de un terreno propio para la perspectiva cónica y la caballera. (Monge, 1996 [1803], 91).

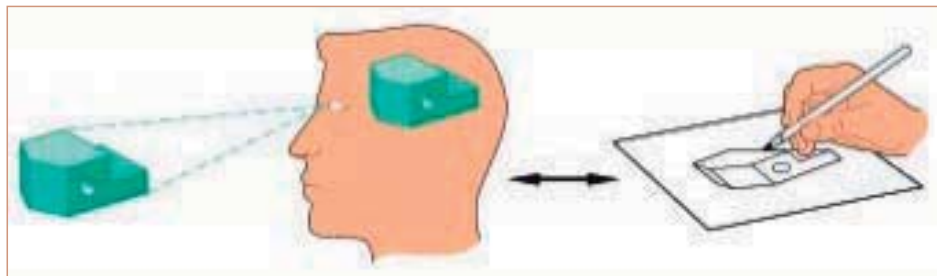
El estatus de “sistema” otorgado a los procedimientos perspectivos, tendrá la contrapartida de someter la cognición espacial a las variables lógicas de la operatividad proyectiva. En tal sentido, se trata de interpretar la es-

5. *Direct method*. Vistas auxiliares. Giesecke (1979, 278).

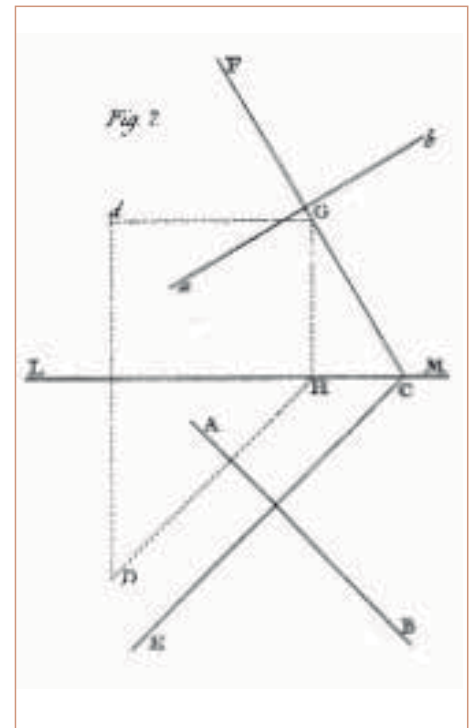
tructura del diseño tridimensional en base a las mecánicas deductivas de una organización racional independiente de la experiencia (Grassa-Miranda, 2009). Si el significado de la realidad se establece a expensas de las percepciones del sujeto, no se hace necesario verificar los conceptos mediante observación empírica y, por tanto las imágenes mentales resultan inútiles para asimilar las relaciones proyectivas. Esta situación introduce, asimismo, una discontinuidad respecto al carácter analógico que había acompañado a la representación de formas desde el Renacimiento, y el espíritu de observación de la naturaleza yacente que había dado preponderancia a la imagen visual (Fig. 7).



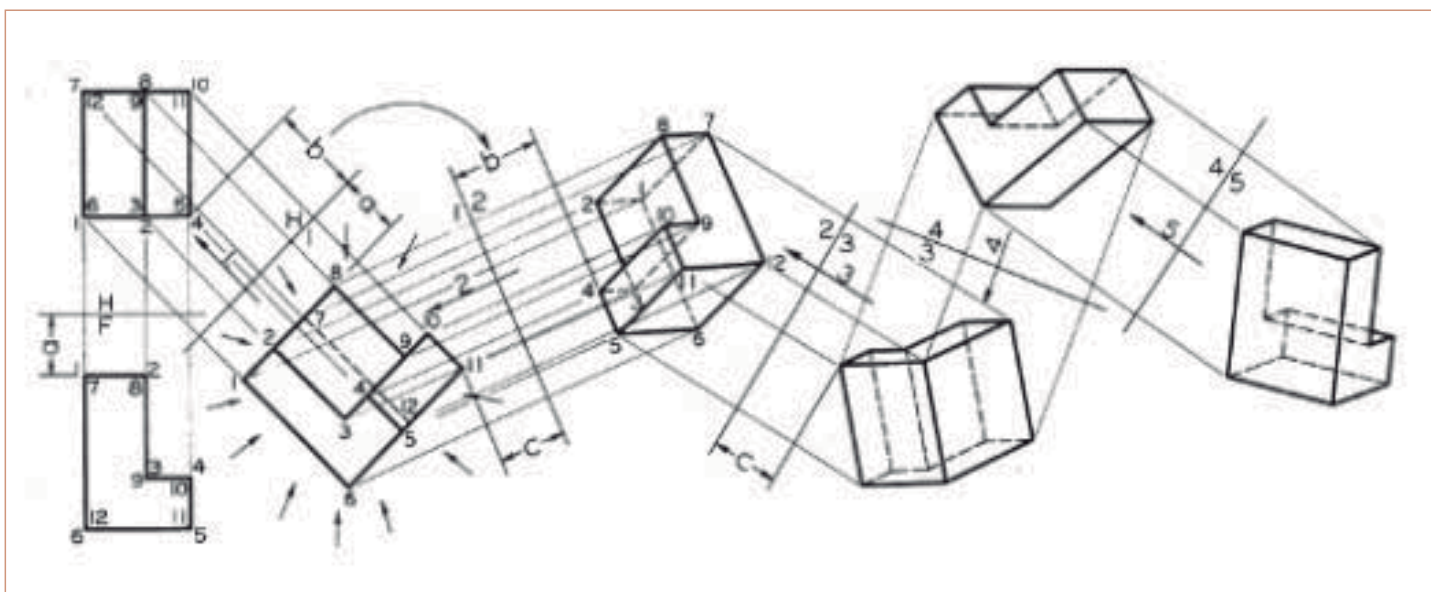
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El origen del direct method

¿Qué posibilidades existen para fundamentar la capacidad de estructurar el pensamiento espacial a través del sistema diédrico español? Hace aproximadamente un siglo, en la *Annual Conference of the Society for the Promotion of Engineering Education*, el profesor French (1976, [1913], 22) exponía las diferencias entre dos posibles modalidades de representación gráfico-geométrica:

The methods now in use, with all their variations, may be divided into two general classes:

1. Those which begin with the theory of the point, line and plane, and progress to the solid.
2. Those which begin with the solid, and afterwards take up the analysis of lines and surfaces.(...)

In a subject which depends wholly on the clearness of perception, and whose value is entirely lost if the mental picture is confused, the possibility of this condition is most unfortunate.

Mientras la primera opción, heredada de la formulación proyectiva se ocupa de teorizar en torno a las abstracciones del punto, la recta y el plano, la segunda se inicia en la visualización del diseño tridimensional como

origen para interpretar su estructura geométrica. Esta propuesta considera el papel fundamental de la imagen mental en la cognición de las relaciones espaciales, aspecto que será determinante para la génesis posterior del *direct method* (Fig. 8).

Adam V. Millar (1873-1960) se considera el primer autor en realizar una propuesta alternativa a la formulación del modelo proyectivo (González et al. 1977, 3), pero es George Jüssen Hood (1877-1965) quien, pocos años después, realiza un amplio desarrollo de todas las consecuencias del *direct method*. Esta metodología favorece la interacción sujeto-objeto mediante la construcción de vistas ortográficas de síntesis perspectiva con el fin de estimular la orientación espacial del estudiante. Cada problema de diseño tridimensional dispone de un punto de vista estratégico desde el cual poder abordar su solución. Por tal motivo el *direct method* se ocupa, desde un principio, de ejercitar al estudiante en el modo de obtener vistas auxiliares y construir una imagen mental nítida del diseño tridimensional (Fig. 9).

En este sentido, los desarrollos del *direct method* mantienen un alto grado de identidad entre representación y visualización tal y como se había entendido en la tradición renacentista:

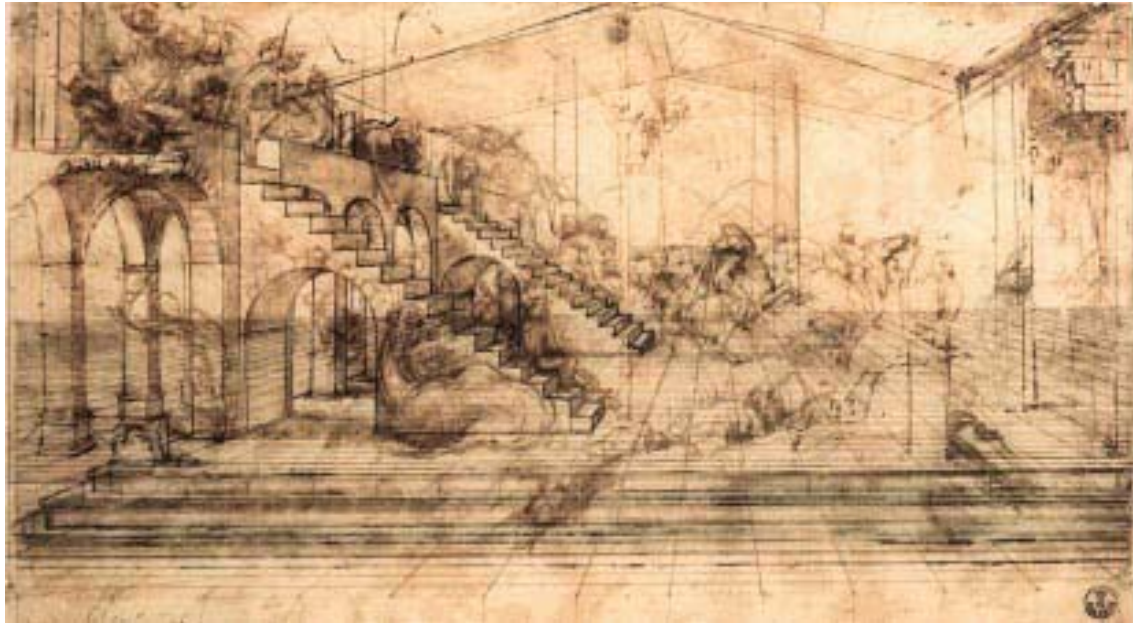
When the engineer draws or reads a view, he visualizes the views as representing the solid three dimensional object. It is a mistake to think that the object is projected on a plane, or regard the view as flat. (Hood 1946 [1926], 19)

El *direct method* propone tratar sin intermediarios con la configuración espacial, lo que significará derogar el aparato deductivo-cartesiano de la geometría descriptiva clásica. En palabras de Hood “*el direct method trata con el objeto mismo y requiere de una actitud mental diferente*” (Hood et al. 1979 [1969], 445).

Si la visualización perspectiva resulta un soporte cognitivo eficaz ¿por qué no integrarla dentro de la representación ortográfica? La combinación de diferentes vistas ortográficas en perspectiva del diseño tridimensional constituye una de las características más destacada del *direct method* cuyo fin específico es facilitar la comprensión y el análisis de la configuración geométrica (Fig. 10).



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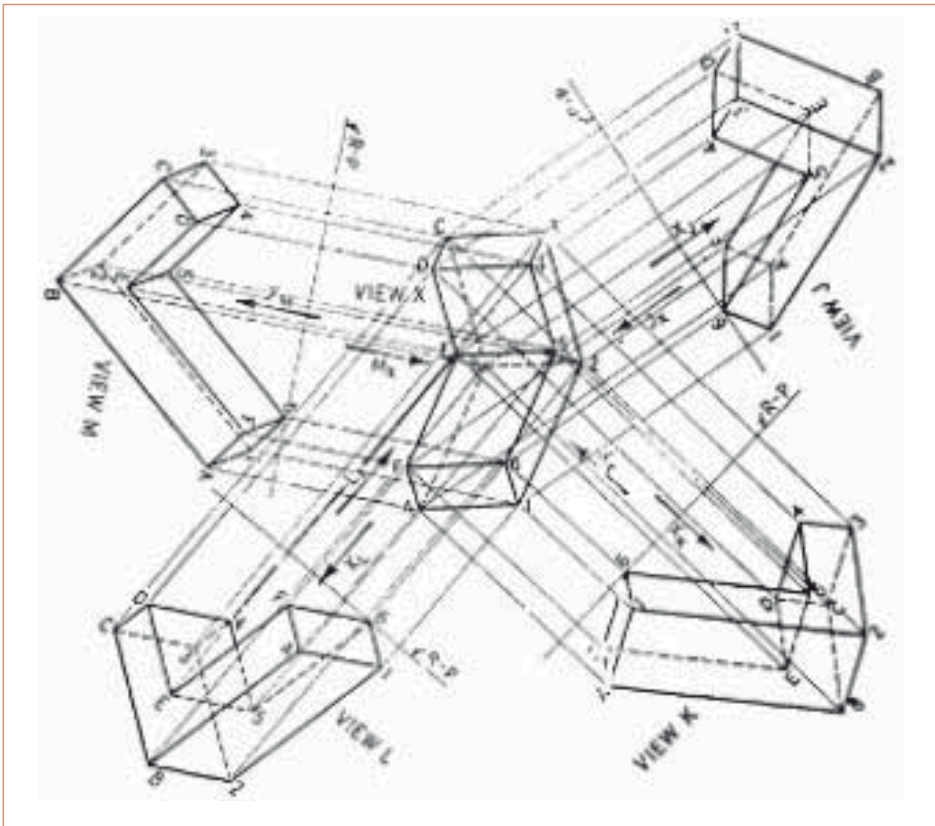


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Conclusión

El estatus de lenguaje que ostenta la gramática del sistema diédrico español como organización racional orientada a estructurar el pensamiento espacial del estudiante podría ser

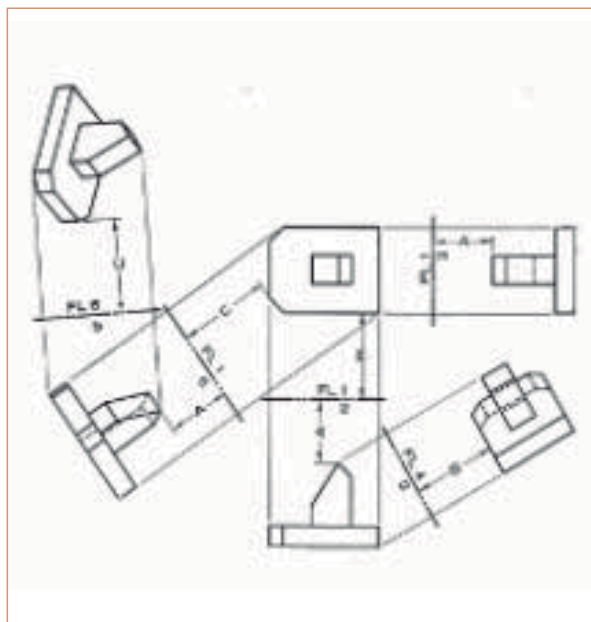
cuestionado en base a una insuficiente fundamentación del proceso constructivo de la imagen mental de la configuración geométrica que propicia el desarrollo de una secuencia metodológica alejada de la praxis. La corriente anglosajona del *direct method* soluciona este problema al plantear, desde el inicio de su secuencia didáctica la asimilación del concepto espacial favoreciendo la construcción de una imagen mental nítida del diseño tridimensional. La superación del marco epistemológico que da origen a la clásica geometría descriptiva conduce a un progresivo abandono de la especulación intelectual, y su reorientación hacia el diseño aplicado. Tal renovación se desarrolla en base a una metodología alternativa, consistente en obtener vistas ortográficas de síntesis perspectiva como modo de potenciar la interacción sujeto-objeto. Ajena al avance del conocimiento, en este caso, el retraimiento cultural de la institución educativa española de la época, va a propiciar el academicismo en una disciplina que, fiel a los preceptos de la tradición clásica, todavía se prolongará durante la segunda mitad del siglo XX.



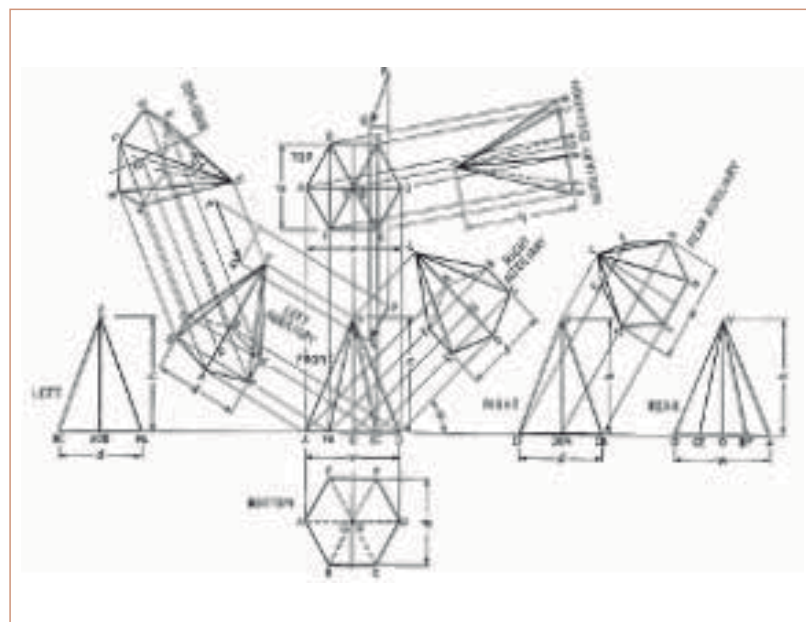
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- 6. Caricatura de Monge por uno de sus alumnos hacia 1802 (Sakarovitch, 1998, 246).
- 7. Estudio arquitectónico para *La Adoración de los Reyes Magos*, Leonardo da Vinci.
- 8. *Direct method*. Dinámica para representar/visualizar (Hood 1946, 22).



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- 9. *Direct method*. Representación de un elemento a través de diversas vistas auxiliares (Warner, 1934, p. 14).
- 10. *Direct method*. Vistas auxiliares diversas de una pirámide (Hood, 1946, 25).

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drawings of the National Library with those preserved at the Palace.

6 / Antonio PONZ, *Viage de España*, VI tome, third edition, Viuda de Ibarra (facsimile edition, Madrid, 1972), pp. 89 to 91; to accommodate the scale model a box was fitted on the wall of the War Museum, which overlooks the Palace although it was later moved to the workshop under the arch, which communicates with the Garden of the Royal Pharmacy. Gaspar M. de JOVELLANOS also mentioned this scale model in his *Elogio a Ventura Rodríguez leído en la real Sociedad Económica de Madrid*, Viuda de Ibarra, Madrid, 1790. Both Pascual MADDOZ, *Madrid...*, 1848, pp. 248 and 333, and Ángel FERNÁNDEZ DE LOS RÍOS, *Guía de Madrid...*,

ity and the municipal authorities, both in their daily activities as administrators and representatives of power and in public festivities and ceremonies. Nor were the surrounding establishments, the Tapestry Manufacture and the Snow Pits, suitable neighbours for a royal residence. In the second half of the eighteenth century, Antonio Carlos of Bourbon projected for these lands royal stables which did not come to be built. At the end of that century a Bleach Filtrations Factory was established there. This was also a royal manufacture, as much as the tapestry one.

The two supposed locations, at both sides of San Bernardino's road, besides their good communication with the Royal Residences, would have maintained a prominent position over the Manzanares river and would have enjoyed the same panoramic views onto the Casa de Campo as they had enjoyed from the Alcázar. Because of their being in raised grounds, they would have had also better views onto the town and to the north they would have enjoyed ample views onto the Sierra de Guadarrama. Even though, it seems more practical to have located the palace to the west of the promenade, between the road and the river where the advantages above mentioned are stressed. There, the smoother relief is to be found at the eastern margin of the promenade, in front of the Seminary of Noblemen and near the Bodyguards barracks.

Any one of the places considered could have housed the new palace, but the two latter are the most likely according to the textual description: a place *situated in San Bernardino Heights*. Finally, we can situate Juvarrá's palace in a last place which also observes this requisite: in the axis of San Bernardino's road and a little further away from the enclosing wall, in the lands which formed the large estate of La Florida. This situation seems the most convenient because it joins together the advantages of the previous ones and gives room to the spreading out of the gardens looking onto the north and east proposed by Juvarrá in his first outlines, as much as to the laying out of the square before the main façade. The axial composition of this square, the palace and the gardens would be strengthened by San Bernardino's promenade, thus avoiding the ambiguity of the accesses typical of the situation tangential to the road. The Palace would be the crowning element of one of the main streets in the city.

All the sitings we have considered for the building would have changed the shape of Madrid and influenced its growth. In the nineteenth century, the urban grid jumped over the enclosing wall. The first centre of population to be settled in the outskirts of the city was the suburb of Chamberí, a humble quarter situated to the north of the city between the gates of Fuencarral and Recoletos where Carlos María de Castro situated the working quarter in order to pre-

1876, p. 230, 484 and 485, recorded the same dimensions registered by Ponz, but Madoz says that the model was kept in the Topographical Cabinet located at the Buen Retiro and Fernández de los Ríos informs us of its removal to the Museum of Engineers. The new scale model was made for the exhibition about Philip V before mentioned.

7 / The comparative study of the different projects made for the new Royal Palace forms part of the graphic documentation gathered by Javier Ortega Vidal, Aitor Goitia Cruz, Ángel Martínez Díaz and María José Muñoz de Pablo for the above mentioned exhibition *El arte en la Corte de Felipe V*.
8 / Gianfranco GRITELLA, *Juvarra. L'Architettura*, Modena, 1992, t. II, p. 439.

serve the existing houses and small factories when he drafted the Preliminary Plan for the Enlargement of Madrid in 1860.

If Juvarrá's Palace had been built in any of the mentioned places, the growth of Madrid would have had other features. The nobility with their palaces and gardens and the institutional and administrative buildings would have occupied this area instead of the dunghills, shanty towns, cemeteries and humble dwellings which formed the suburb originally. The building up of the Palace would have altered the spatial distribution of the social classes and the location of institutions and services in the city. The urban grid and the typology of the buildings would also have been affected.

12. A hypothesis about the location of the Royal Palace designed by Juvarrá for the town of Madrid about 1740, superimposed over the present urban grid, by M. J. Muñoz de Pablo, 2008.

When we superimpose the projected Palace and the town existent in the second third of the eighteenth century over the present urban grid, we can see how some of the roads which were later transformed into promenades and later on into the streets which structure the city, would have been erased by the palace complex. This also enables us to imagine a different city, where the structure of the streets would be subject to the laws imposed by the Palace, and the dimensions of the blocks and plots would be greater than the existing ones, a town designed to accommodate the representative buildings and the sumptuous houses of the aristocracy instead of the constructed town, destined to house the working quarters. San Bernardino's asylum, situated where is nowadays the rectory of the Complutense University, would not have been installed in the ancient convent of the same name, because it would have been razed to the ground by the works of the Palace. The Ciudad Universitaria would have had to find another place to be settled, because it would have been occupied by the gardens of the Palace. The present square of Moncloa and the way out of Madrid through La Coruña road would have had a completely different shape... However, the building of Juvarrá's Royal Palace in the Heights of San Bernardino, although possible, is only a dream; the actual development of the events followed another course which led to the present city.

Nevertheless, the drawing up of different plans has helped us to learn about forgotten ideas from the past and to speculate about a different present, providing new images to the rich collection we already have about that slipped opportunity. These drawings show the most forgotten aspect of this subject: the plot of the Palace and its relationship with the city. Maybe the knowledge of the past facts and their would-be consequences will allow us to foresee more clearly a future which is always to come.

APPROACH TO THE ANALYSIS OF THE SPANISH 'SISTEMA DIÉDRICO' AS A LANGUAGE

by Víctor Grassa-Miranda
Roberto-Vicente Giménez Morell

The perception of shape is the beginning of conceptualisation.

Arnheim (1998 [1986] 40)

Abstract

The grammar or guiding principles of the Spanish *sistema diédrico* use the projective schema of a model to help structure a student's spatial thinking, while the Anglo-Saxon *direct method* relies on the reconstruction of a mental image of the geometric configuration. The epistemological framework that created classical descriptive geometry has been superseded and this has led to a progressive abandonment of intellectual speculation and a reorientation towards applied design. Spain's previous cultural isolation meant that educational institutions fell behind advances in the field of drawing and a degree of scholasticism took hold until the second half of the twentieth century.

Keywords: visualisation, three-dimensional design, mental image, geometric drawing.

Introduction

From the viewpoint of constructivist teaching theory, the discredited behaviourist approach ignores the mental processes of students as they learn. The mechanics of *restitution* in the Spanish *sistema diédrico* consider the possibility of recovering the three-dimensional structure of the geometry represented. Such a process has also been applied to justify obtaining the corresponding mental image (Taibo 1966 [1944] 2). This paper aims to show that the grammar or guiding principles of the *sistema diédrico*, inherited from classical descriptive geometry, create learning expectations that are difficult to anchor with respect to the development and structuring of a student's spatial thinking.

Throughout the history of graphic communication, various descriptive variations and hybrids have been developed according to practical drawing needs. During the Renaissance, drawing techniques were used to objectively describe three-dimensional shapes based on the visual synthesis of an object's geometry (Fig. 1).

Spatial concept

A graphic-geometric drawing is simply an expression of the evolution of a specific spatial concept associated with a given scientific context. The epistemological platform on which the classical academic dis-



cipline stands enables us to characterize the syntactic order supporting the projective model as a design-oriented schema that aims to structure the spatial thinking of students (Fig. 2).

We propose two hypotheses with a clear dialectical component. Firstly, it is considered that the epistemological framework that sustains the guiding principles of the Spanish *sistema diédrico* prioritizes propositional representation over the analogue (Ballesteros Jimenez, 1993); and so establishes certain deductive mechanisms from the logical variables arising from the projective operatinality. This doctrine lies outside the psychological process of forming spatial concepts through the construction of mental images. Secondly, it is considered that the Anglo-Saxon direct method solves the problems of the projective model by considering, from the beginning, the assimilation of spatial concepts – and so favouring the construction of a clear mental image of three-dimensional design. The direct method enhances the spatial orientation of the student by producing orthographic views with synthetic perspectives that facilitate an understanding of spatial relationships (Fig. 3). To validate these hypotheses we will explore the operational methodology of graphical-geometric drawing by dividing the existing bibliography into four sections.

The first section includes the publications that discuss the academic discipline in Spain: Taibo (1966 [1944]), Izquierdo (1956), and Rodríguez de Abajo (1958) being among the most widely distributed (Fig. 4).

In a second section, we consider publications about the *sistema diédrico* that offer a revisionist view, but still remain tied to the spatial concept of the projective model. The main representative of this trend is Sánchez (1997 [1993]). Thirdly, we analyze the Spanish translations of books about the direct method. These books were published in Spain after a delay of 30 years and offered a de-contextualised version of the original fundamental principles: Warner and McNeary (1964 [1934]), Rowe and McFarland (1967 [1939]) and Wellman (1964 [1948]) are among the most relevant authors. Finally, the original publications – practically inexistent in Spanish libraries – about the direct method are considered: Millar (1922 [1913]), Hood (1926), Warner and McNeary (1934), Rowe and McFarland (1946 [1939]) and Wellman (1948), were the founding authors of this alternative trend (Fig. 5). The literature review of these sections refers, in particular, to the content and the balance between theory and practice, without forgetting the perspective of geometric constructions as a manner of expressing applied spatial concepts. The full version is part of the doctoral thesis of Grass-Miranda (2008).

Analysis versus synthesis

The philosopher and mathematician René Descartes (1596-1650) pioneered analytical geometry and con-

sidered the possibility of reconstructing reality deductively from experience. His rationalist worldview had a profound influence on Europe and especially in France. Consistent with propositional reasoning, the founder of descriptive geometry, Gaspard Monge (1746-1818), sought to interpret spatial relationships based on certain logical variables arising from projective operatinality (Booker, 2001 [1963] 25). The motivation to extend the legitimacy of such an analysis to the field of graphic drawing was one of the early embryonic stages of this schema (Sakarovitch, 1998, 261) (Monge, 1996 [1803], 90) (Fig. 6).

Monge founded the École Polytechnique and his institutional and political position helped explain the privileged role given to descriptive geometry as one of the academic disciplines of the Napoleonic model of technical university education. The spread of his ideas was further helped by the enormous influence that France exercised over much of Europe (Boyer, 1982 [1968], 598). During the first half of the nineteenth century, the standardization resulting from the projective model caused a reinterpretation of techniques for the description of drawing systems:

We have already mentioned the removal from the École Polytechnique of the gentlemanly perspectives produced by De la Rue. Although this system of representation was genuinely French, it was ignored in France until Theodore Olivier drew attention to the system in his writings. Even fewer have studied the early disciples of the axonometric orthogonal Monge (...). Moreover, in the school of Monge, conical perspective was a mere application of descriptive geometry and was intended as a demonstration of the operational capability of Monge's method rather than as a reproduction of the old procedure of Alberti. De la Gourniere remarked on the imposition of a standardised graphic language and expressed nostalgia for the earlier wealth of graphical procedures produced by the guilds and the variety and nuances formerly found in graphic drawing. His critique includes a demand for a legitimate place for the conical and cavalier perspectives. (Monge, 1996 [1803], 91)

The status of 'system' given to perspective procedures meant submitting spatial cognition to the logical variables of projective operatinality. The aim was to interpret the three-dimensional design using deductive mechanics in a rational organization that was independent of experience (Grass-Miranda, 2009). If reality is established at the expense of subjective perceptions, it is not necessary to verify the concepts by empirical observation, and therefore mental images are useless for assimilating projective relations. This introduces a discontinuity with regard to the analogue character that has accompanied drawing since the Renaissance, and the spirit of the observation of nature that gave prominence to the visual image (Fig. 7).

The origin of the direct method

Is it possible to sustain the ability to structure spatial thinking using the Spanish *sistema diédrico*? Nearly a century ago, Professor French at the Annual Conference of the Society for the Promotion of Engineering Education (1976, [1913], 22) outlined the differences between two forms of graphic-geometric drawing:

The methods now in use, with all their variations, may be divided into two general classes:

1. *Those which begin with the theory of the point, line and plane, and progress to the solid.*
2. *Those which begin with the solid, and afterwards take up the analysis of lines and surfaces (...)*

In a subject which depends wholly on the clearness of perception, and whose value is entirely lost if the mental picture is confused, the possibility of this condition is most unfortunate.

The first option follows from the traditional projective schema and focuses on theorizing about the abstractions of point, line, and plane. The second option starts with the three-dimensional design visualization as a source for interpreting geometric structure. This proposal considers the fundamental role of mental imagery in the cognition of spatial relations, an aspect that was crucial in the subsequent development of the direct method (Fig. 8).

Adam V. Millar (1873-1960) is considered the first author to make an alternative proposal to the projective model schema (Gonzalez et al. 1977, 3). A few years later George Jüssen Hood (1877-1965) made a comprehensive presentation of the results of applying the direct method. This methodology favoured subject-object interaction through the construction of synthetic orthographic perspectives in order to stimulate the spatial orientation of students. Each three-dimensional design problem has a strategic standpoint from which to approach the solution. This is why the direct method trains the student from the outset in techniques for producing auxiliary views and constructing a clear mental image of a three-dimensional design (Fig. 9).

Developments of the direct method maintain closeness between drawing and visualization that was understood in the Renaissance tradition:

When the engineer draws or reads a view, he visualizes the views as representing the solid three-dimensional object. It is a mistake to think that the object is projected on a plane, or regard the view as flat. (Hood 1946 [1926], 19).

The direct method attempts to deal directly with the spatial configuration – and this means repudiating the deductive Cartesian apparatus of classical descriptive geometry. In the words of Hood 'the direct method deals with the object itself and requires a different mental attitude' (Hood et al. 1979 [1969], 445).

If the viewing perspective is an effective cognitive sup-



port then why not integrate the perspective with orthographic drawing? Combining different orthographic perspectives of three-dimensional design is one of the most prominent features of the direct method –the aim being to facilitate an understanding and analysis of geometrical configuration (Fig. 10).

Conclusion

The status of the grammar and language that expresses the guiding principles of the Spanish *sistema diédrico* as a rational organization aimed at structuring student spatial thinking can be challenged on the basis that it offers an insufficient foundation in the process of constructing a mental image of the geometrical configuration – and this prompts the development of a methodological approach that is distant from accepted practice. Secondly, it is considered that the Anglo-Saxon direct method supersedes the problems of the projective model by considering, from the beginning, the assimilation of spatial concepts – and so favours the construction of a clear mental image of three-dimensional design. Superseding the epistemological framework that created classic descriptive geometry leads to a progressive abandonment of intellectual speculation and a reorientation towards applied design. This renovation was based on an alternative methodology that sought synthetic orthographic perspectives as a manner of enhancing the interaction between subject and object. As Spain had culturally withdrawn from the modern world, the nation's educational establishment remained isolated from these advances in knowledge. This isolation led to a scholasticism that remained loyal to the classical tradition until the second half of the twentieth century.

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FIGURES

- Fig. 1. Study of a head using multiple views. Albrecht Dürer.
- Fig. 2. Plane alphabet (Gutierrez Vazquez; Izquierdo Asensi; Zuvillaga Navarro; Placencia Valero, 1984, p.121).
- Fig. 3. Visualization and drawing process of three-dimensional objects (Bertolino, 1997, 241).
- Plate 2 from the *Géométrie Descriptive* (Monge, 1996 [1803]).
- Fig. 5. Direct method. Auxiliary views by Giesecke (1979, 278).
- Fig. 6. Caricature of Monge drawn by one of his students in about 1802 (Sakarovitch, 1998, 246).
- Fig. 7. Architectural sketch for the *Adoration of the Magi* by Leonardo da Vinci.
- Fig. 8. Direct method. The dynamics of representation and visualisation (Hood 1946, 22).
- Fig. 9. Direct method. Drawing of an element using various auxiliary views (Warner, 1934, p. 14).
- Fig. 10. Direct method. Various auxiliary views of a pyramid (Hood, 1946, 25).

ANCIENT MAPS FOR THE STUDY OF THE LAND DEVELOPMENT: MAPS AND DRAWINGS FROM THE CIVIL DISPUTES IN SPAIN AND THE INDIES (II)

by Pilar Chías Navarro

Abstract

The usual sources of information at a local scale of the American territories conquered by the Spanish Crown during the 16th and 17th centuries are the *Relaciones Geográficas*, as well as the charts, the projects of fortifications or public works, and the maps drawn by the jesuites and the officials of the Crown. But there is another collection of maps that has a great importance because it provides essential data about the land properties or the land users' rights. These were maps drawn for civil disputes concerning the ownership or rights to particular pieces of land, which were judged at the Royal Audiences and Chancelleries. These institutions of justice had been created in Spain in the 14th century, with similar purposes to those already existing in England, France and the Low Countries. They were also soon exported to the Indies with their own singularities.

The article explores those singularities and their contributions to the history of the cartography and to the study of the evolution of the territorial frames, along four centuries. Such interesting cartographic materials still remain almost unknown. The collections are composed by more than a thousand manuscript maps from the 15th to the 19th century, which show the changing image of the Spanish and the Latinamerican territories.

Introduction

The searches that have focused on the Spanish territories at a local scale since the end of the 15th century, have used almost solely the usual sources of the *Relaciones Topográficas* (*Topographical Relations*) for the Iberian peninsula, and the *Relaciones Geográficas* (*Geographical Relations*) for the Indies.

Both *Relaciones* were more or less extended sets of questions derived from an institutional initiative, that took place mainly between 1530 and 1812 at the Indies, and between 1575 and 1578 at the Iberian peninsula. They were usually proposed by the Casa de Contratación in Seville, with the aim of gathering several information about the lands of the different provinces that then composed the vast Spanish Empire (Vilar 1970). But they also looked for reliable information in order to get the taxes.

The collectons of cadastral maps and of those drawn for civil disputes are also essential cartographic sources that are focused on describing the land ownership, the land uses and the duties related to the territories.