diségno 17 / 2025

The Revealed Structure. Drawing between Construction and Form

Stefano Chiarenza, Marta Salvatore

Configuring and revealing: drawing and structural order

The coherence of built architecture often depends on a latent structural design whose essential role can govern architectural outcomes even when not overtly visible. Structural logic is either integrated into the building as a whole or concealed behind finished surfaces. However, this concealed structure often defines space and regulates formal relationships. Instead of viewing structure and form as opposites or as directly corresponding, it is more accurate to understand them as mutually influential, their relationship shaped by specific design choices. Every construction act creates an order, and every form manifests through its underlying structure, highlighting an ongoing interplay between these elements.

What Leon Battista Alberti defined as the "*armonia delle parti in relazione a un tutto al quale esse sono legate secondo un determinato numero, delimitazione e collocazione*" [Alberti 1966, p. 816] [1] in fact expresses a principle of ethical –or, if one prefers, tectonic– and aesthetic coherence at once. This principle has long constituted the foundation of architecture. It refers to a fundamental system of relationships that also permeates other fields of knowledge, from structural mechanics to evolutionary biology and even the theory of complex systems.

Structural order, whether perceptually implicit or explicit, does not preclude aesthetic experience. One might instead argue that it determines it. When Ludwig Mies van der Rohe stated that function is an art [Mies van

This article was written upon invitation to frame the topic, not submitted to anonymous review, published under the editorial director's responsibility.

https://doi.org/10.26375/disegno.17.2025.2

diségno ISSN 2533-2899

der Rohe 1953, p. 276], he understood the essence of architectural beauty as the perfect harmony between structural order and form: a form that is recognizable and meaningful, determined by the structure that enhances its expressive value. As Curt Siegel observes, "the prominent vault ribs of the great Gothic cathedrals are not merely decorative trimming. They are themselves part of the structure and splendid examples of structural form" [Siegel 1962, p. 10] (fig. 1).

Aesthetic experience is not foundational, yet it cannot be separated from the relationships that enable it. "Such is the case with the most perfect and appealing creations of Nature […] whose outer beauty is deeply influenced by the perfection of the skeleton, which itself is unattractive but does enhance the poetry of the whole by its own indirect means of expressiveness" [Torroja 1967, p. 268] (fig. 2).

In architecture and structural engineering, order therefore assumes the character of an organizational principle internal to construction; structure constitutes the relational law governing the elements, which can be formalized through geometric rules [Strappa 1995]. Form thus does not appear as an arbitrary outcome, but as the legible configuration of this system of relationships. In certain cases, it coincides with what is referred to as structural form, which nonetheless retains intrinsic autonomy and can guide particularly effective design choices. This autonomy emerges when form renders recognizable the order that generates it, revealing structure as an active principle rather than merely a technical solution (fig. 3).

A similar principle can be observed in natural morphogenetic processes, in which biological form arises from the interaction of geometric constraints, growth dynamics, and environmental conditions. Even in the absence of a dynamic formalization, Thompson had already recognized physical and geometric factors as the principal generators of form [Thompson 1969] (fig. 4).

Today, advanced dynamic theories of morphogenesis – from the reaction–diffusion models developed by Alan Turing [Turing 1952] to fractal growth models– reveal

Fig. 1. Guillermo Sagrera, Castel Nuovo, Sala dei Baroni, Naples. Ribbed vault, fifteenth century (photograph by Miguel Hermoso Cuesta; source: <https://upload.wikimedia.org/wikipedia/commons/3/39/Castel_Nuovo_Sala_dei_Baroni_07.JPG>).

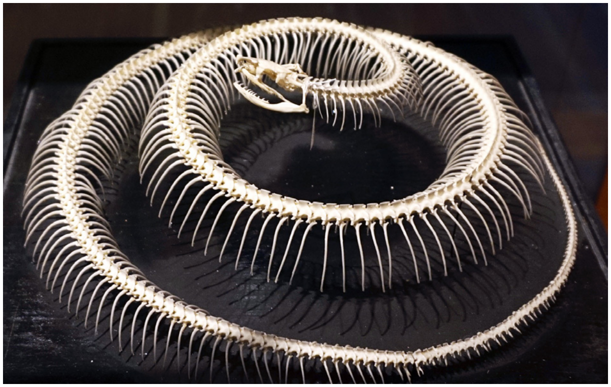


Fig. 2. Snake skeleton (photograph by Tiia Monto; source: <https://commons.wikimedia.org/wiki/File:Snake_skeleton_3.jpg>).

how complex natural forms, from the venation patterns of leaves to the logarithmic spirals of shells and the convoluted cortical structure of the brain, can be generated and understood through rigorous mathematical models. These models formalize non-linear dynamics in which regimes of stability, instability, and complex attractors emerge spontaneously from the elementary interactions of morphogenetic fields [Petitot 2009]. Establishing a parallel between natural and artificial processes in architecture is therefore not merely coherent but essential, insofar as both classes of phenomena obey shared emergent logics. Form thus emerges as the result of systemic interactions between energy, information, and matter, governed by universal topological and relational principles [De Paolis 2020].

Computational architecture and generative design develop these ideas in concrete and innovative ways, effectively transforming the design process itself. According to this approach, architectural form should be understood as the inevitable outcome of processes – such as parametric modeling, topological optimization, and structural simulations– that rigorously integrate construction constraints, material properties, and loading conditions into defined and verifiable algorithmic rules. It emerges as the visible and performative configuration of a complex web of relationships, fully analogous to the natural growth phenomena previously outlined [Menges 2011], in which an underlying order generates emergent complexity. The synergy between advanced digital design, smart materials, and computational morphogenetic logics demonstrates in exemplary and empirically validated ways how form derives from a deep order that inseparably binds space, structure, and matter within a coherent and functional system [Ramirez-Figueroa, Dade-Robertson, Hernán 2013] (fig. 5).

From a theoretical and philosophical perspective as well, the question of an order that precedes and guides

Fig. 3. Santiago Calatrava, OAKA Olympic Stadium, Athens, 2004 (photograph by Georgios Liakopoulos; source: <https://commons.wikimedia.org/wiki/File:Calatrava_Agora_Athens_Olympic_Sports_Complex_%28250427331%29.jpeg>).

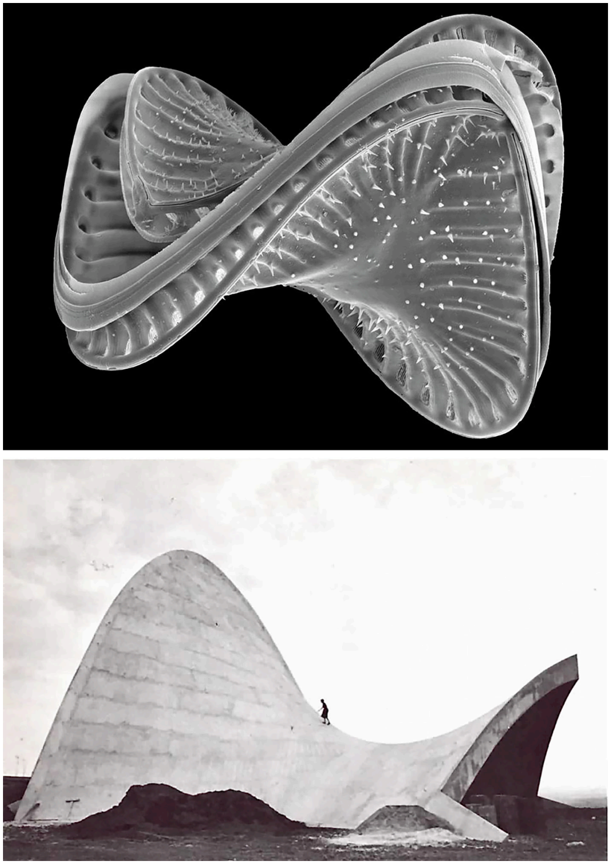


Fig. 4. Top: Campylodiscus clypeus (source: <https://www.sciencephoto.com/media/891862/view>); bottom: Félix Candela, Chapel of Lomas, Cuernavaca, 1958–1960 (source: <https://www.flickr.com/photos/147316538@N02/36084417680>).

form finds solid grounding, as demonstrated by theories of adaptive morphogenesis and data-driven generative processes [Nebuloni, Buratti 2023]. If form can be conceived as the inevitable product of an underlying structural stability –a deep relational order that generates its essence– and if beauty manifests itself as the harmonious expression of such order, then the question inevitably arises of how this invisible dimension may be rendered legible within built matter. Here, drawing assumes a fundamental and irreplaceable role in the processes through which form is both structured and revealed.

On the one hand, it functions as an instrument of primary configuration. Through drawing, it becomes possible to regulate space, define the genesis of surfaces through geometric operations, and manage the generative processes that determine the geometric and material articulation of the project. In this context, drawing represents the locus in which formal decisions acquire concrete expression, guiding the project from its earliest conceptual stages in accordance with the structural order being articulated.

On the other hand, drawing acts as a revealing instrument. It does not constitute a direct transcription of structure but rather an operation of abstraction and selection that establishes a distance between representation and building (fig. 6). What in construction is embedded in matter –static relationships, geometric hierarchies, and the distribution of stresses– is, in drawing, isolated and reorganized according to its own order [Pérez-Gómez 1982]. Within this interval, structure becomes intelligible, assuming a form that corresponds neither to the initial idea nor to the built work. As Robin Evans outlined, the passage from drawing to building always entails a transformation, in which something is lost, and something is reorganized, thereby generating a system of relations endowed with its own coherence [Evans 1997]. Within this redefinition, geometry

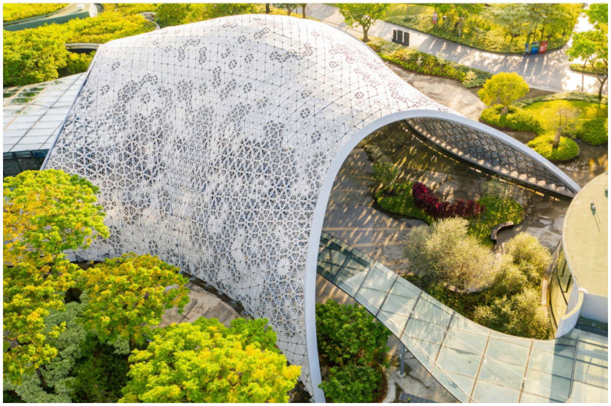


Fig. 5. SUTD Advanced Architecture Laboratory, The Future of Us Pavilion, Singapore (source: <https://loopdesignawards.com/project/the-future-of-us-pavilion/>).

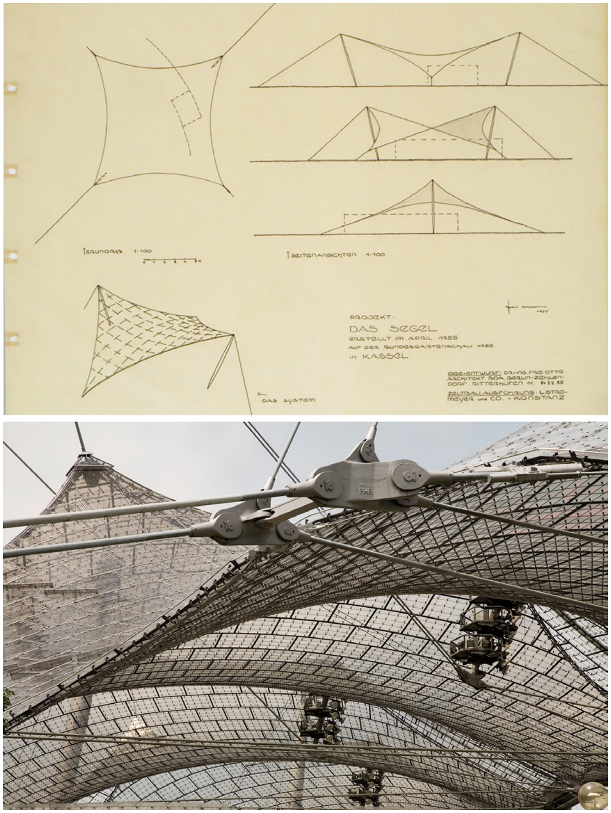


Fig. 6. Frei Otto, examples of tensile structures. Top: graphic diagrams of the Musikpavillon, Kassel (<http://www.freiottofilm.com>); bottom: detail of structural elements of the roof of the Olympic Stadium, Munich (bottom) (source: <https://upload.wikimedia.org/wikipedia/commons/0/06/Munich_-_Frei_Otto_Tensed_structures_-_5244.jpg>).

operates as a configurational instrument, making explicit the relationships that compose form.

Drawing thus emerges as the essential locus in which the structural order of form becomes legible through rigorous geometric operations that isolate and abstract the relationships between the graphic model and the built space [Rykwert 1998]. Relationships of curvature, alignments, and conditions of planarity or developability –embedded in the surface continuity of construction– are made explicit as verifiable relations.

Representation thereby assumes a specific epistemic value: it renders measurable and comparable the conditions that determine the construction of form, which may be interpreted as a system of correlated elements and constraints. Structure appears as a network of geometric and static relationships in which formal continuity results from a balance between discretization, approximation, and constructive coherence (fig. 7).

This legibility of structural order, emerging in drawing as a verifiable and autonomous geometric configuration, not only clarifies the potential for realization of form but also raises crucial questions concerning the cognitive and operational value of representation itself, paving the way for an analysis of its mediating role in the genesis of architecture.

Within this framework, drawing is not merely a means of translation between idea and construction, but the instrument through which the relationship between structural order and form is realized. This function is neither a recent acquisition nor one exclusively tied to contemporary computational practices; rather, it is rooted in a well-defined theoretical and practical tradition in which geometry historically constituted the language through which form was constructed and validated. It is within this tradition that drawing assumes a central role in knowledge and design processes, starting a reflection on the contribution of synthetic geometry to the construction of architectural form.

Visible form of design thought

Drawing, a universal language for communicating space through visual descriptions, reveals its heuristic value in the relationship between construction and form, expressing its constructive dimension through the research and control of the geometric properties of figures.

The cognitive potential of drawing finds its theoretical foundation in synthetic geometry. Geometry serves to translate the morphological properties of figures into conceptual and operational tools for design, and has been employed for this purpose since ancient times. The properties of certain classes of surfaces encouraged their use in construction, first in an intuitive manner and later with conscious and controlled application. History records a vast repertoire of works whose formal structure is based on geometry, enabling the identification of specific fields of application of this science in design, which contributed to the development of Descriptive Geometry, anticipating some of its principles. Among these, the art of stone cutting is exemplary, as it represents a synthesis of morphological control, rigorous representation, and constructive awareness (fig. 8).

Synthetic geometry, rooted in antiquity, acquired a modern form between the late eighteenth and early nineteenth centuries. At the time when Gaspard Monge wrote his *Leçons* in Descriptive Geometry, there was a need to establish a method for studying geometry that could stand alongside mathematical methods, founded on logical reasoning and supported by the science of projections [2]. Monge's Descriptive Geometry recognized drawing as the tool through which the synthetic method could measure itself against contemporary rigorous analytical descriptions, distinguishing itself by the clarity of its reasoning, the simplicity of its demonstrations, and the effective application of theorems; his scientific output clearly exemplifies this approach [3]. In his *Cours de Géométrie descriptive*, Théodore Olivier recounts how Monge attempted to demonstrate the contents of his *Analyse appliquée à la géométrie* using the methods of Descriptive Geometry, citing one of his own significant reflections: "*Si je refaisais mon ouvrage qui a pour titre* de l'analyse appliquée à la géométrie […] *je l'écrirais en deux colonnes: dans la première, je donnerais les démonstrations par l'*analyse*; dans la seconde je donnerais les démonstrations par la* géométrie descriptive*, en d'autre termes, par la méthode des projections; et l'on serait peut-être, ajoutait-il, bien étonné, en lisant cette ouvrage, de voir que l'avantage serait presque toujours du côté de la seconde colonne, pour la clarté du raisonnement, la simplicité de la démonstration, et la facilité de l'application des* théorèmes *trouvés aux diverses* travaux *des* ingénieurs" [Olivier 1843, p. VI] [4].

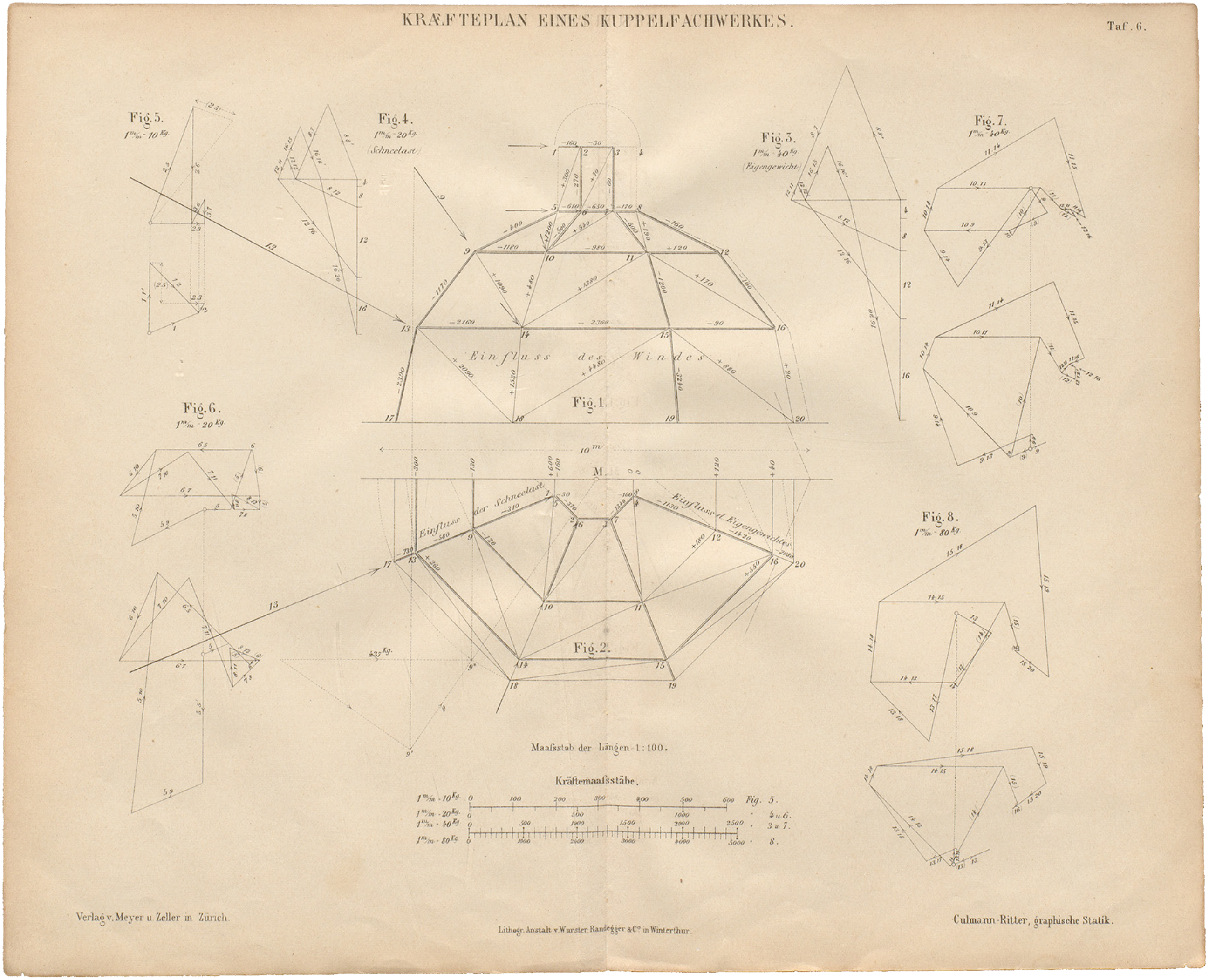


Fig. 7. Study in graphic statics of a dome structure [Ritter 1890, pl. 6, pp. 242, 243].

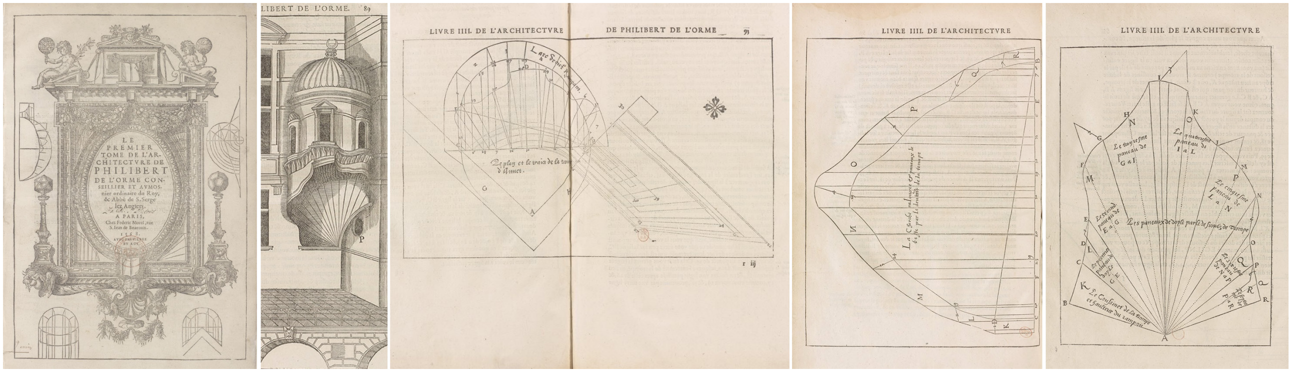


Fig. 8. Philibert Delorme, frontispiece of Le premier tome de l'architecture and traits géométriques of the trompe of the Château d'Anet (Delorme 1568, Frontispiece and ff. 89r, 92v, 93r, 94v, 95v).

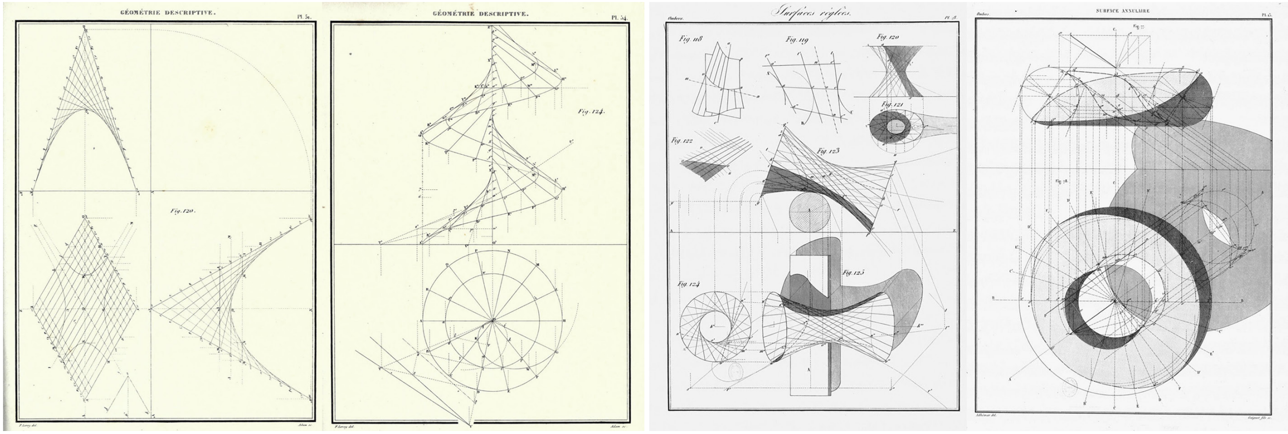


Fig. 9. From left to right: Charles François Antoine Leroy, construction of a hyperbolic paraboloid and an oblique ruled helicoid (Leroy 1842, planches 51 and 54); Joseph Alphonse Adhémar, construction of shadows of notable surfaces (Adhémar 1866, planches 28 and 13).

Monge therefore recognized the cognitive capacity of the method of projections, and consequently of drawing, establishing it as the privileged tool of Descriptive Geometry. Unlike ancient geometry, which had supported constructive processes in various ways within specific areas of application, the emerging Descriptive Geometry, by the late eighteenth century, was taking shape in a novel and abstract form (fig. 9). In the introduction to his *Traité de géométrie descriptive* (1822), referring to the Leçons delivered by Monge at the École Normale in Paris in 1795, Jean-Nicolas-Pierre Hachette notes: "*Le recueil de ces leçons est le premier traité de géométrie descriptive dans lequel on a considéré cette science d'une manière abstraite, et indépendamment de ses applications.* […] *On y reconnaît cette faculté d'imagination qui lui faisait découvrir les propriétés de l'étendue figurée*" [Hachette 1822, p. X] [5]. The idea of a speculative science was fostered by Jean-Victor Poncelet in his *Traité des propriétés projectives* *des figures* (1822), to whom, according to Gino Loria, the revival of pure geometry is owed [Loria 1896, p. 24]. Whereas Monge's geometry sought the rigor and abstraction of an exact science devoted to the study of the geometric properties of lines and surfaces, with Poncelet's Projective Geometry, synthetic geometry emancipated itself from dependence on specific configurations, enhancing its capability for generalization through the exploration of the projective transformations of figures [Poncelet 1865, IX-XXXII].

Although theoretical abstraction had conferred scientific dignity on Descriptive Geometry, it remained strongly linked to its applications. The theoretical principles discussed had direct repercussions in architectural and engineering works, finding expression in Descriptive Geometry manuals in dedicated experimental chapters. Both a means of testing and validating speculative formulations and an autonomous corpus of Descriptive Geometry, these applications, in those years, acted as a driving force behind the development of innovative theories. The education offered at the École Polytechnique, and later at the polytechnic schools that followed, addressed the demands of a society marked by profound social and productive change, calling for theoretical abstraction to assume concrete form in the service of design across diverse fields of the arts and applied sciences [6] (figs. 10, 11). Within this context belong the contributions of students of Monge's school – among them Jean-Nicolas-Pierre Hachette and Charles Dupin– authors of authoritative treatises on theoretical Descriptive Geometry, as well as works devoted to geometry applied to engineering and the fine arts, such as the *Traité élémentaire des machines* [Hachette 1811] and the *Géométrie et méchanique des arts et métiers et des beaux-arts* [Dupin 1825] [7].

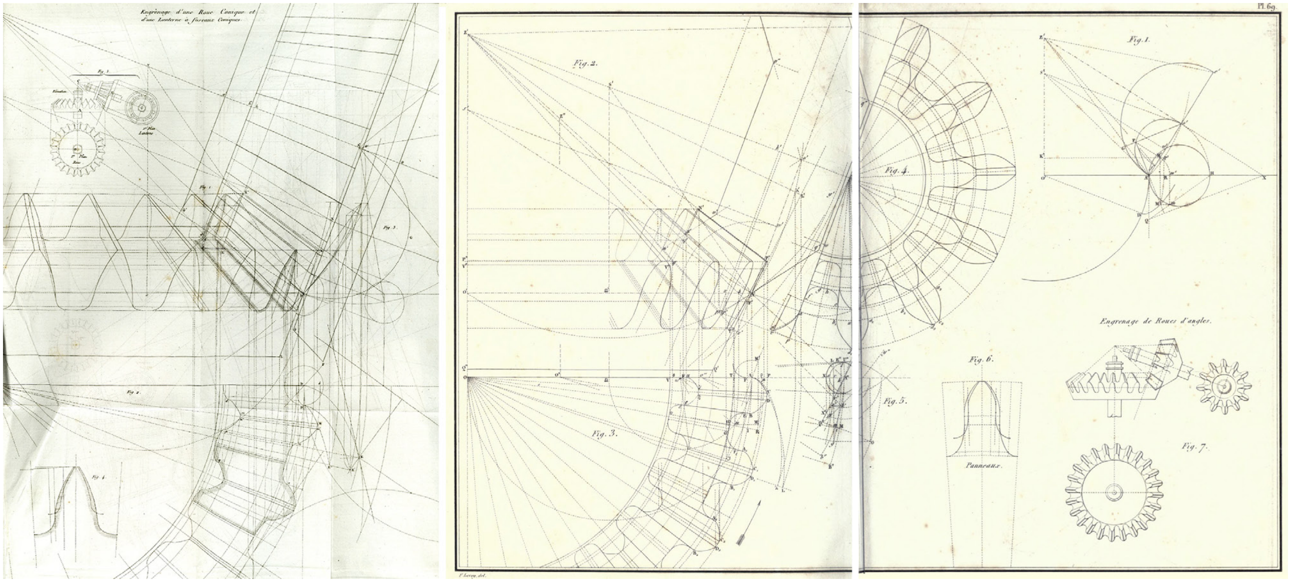
The synthetic method is therefore the tool through which Monge's school of Descriptive Geometry engages with figured space. Its scientific foundation is found in the second objective of this science, stated by Monge in the introductory program of his *Leçons*, which refers to a passage "from the known to the unknown", encapsulating and revealing the very essence of the heuristic value of drawing. This passage alludes to a process of knowledge in which drawing does not merely describe form, but becomes a tool for exploration and discovery, allowing the derivation of new properties of figures [Monge 1798, p. 2].

The cognitive dimension of drawing stems from the effectiveness of 'construction'. In his *Metodi matematici* published in 1935, Loria describes construction as a method of existence proof for figures: "*è noto che Euclide nei suoi Elementi non ragiona mai su una figura di cui non abbia prima insegnata la costruzione; questa funge, quindi, come dimostrazione dell'esistenza delle figure di cui erasi prima data la definizione*" [Loria 1935, p. 77] [8].

Whether mental or graphic, construction demonstrates the very existence of form, transforming drawing into a geometric, logical, and generative act. It is precisely the generative processes inherent in the act of constructing, and enacted through drawing, that enable the rigorous manipulation of form in space through visual languages, thereby granting Descriptive Geometry a central role in the morphogenetic control of design. If construction is the expression of a mental process that guides geometric operations in space, it simultaneously expresses a physical process leading to the material realization of form; in this sense, it acts as a bridge between idea, design, and built reality [Migliari 2012].

The idea of geometry as a generator of form, which had fueled nineteenth-century research in the domain of Descriptive Geometry, gradually drifted away from the generative processes of design over the course of the twentieth century, evolving into a didactic discipline that supports its graphic representation. Despite the innovative contributions made in the early decades of the century by mathematicians such as Otto Wilhelm Fiedler and Edmond Brhunes [Migliari 2009], to name but a few, the cognitive value of drawing was destined to be overshadowed by a predominantly abstract approach, marking the beginning of a gradual decline of Descriptive Geometry as a bridge between idea and material construction [9].

It is difficult to determine the reasons for this transformation, which was likely the combined effect of technological, cultural, and disciplinary changes that distanced design from the geometric processes of construction. At the end of the 1990s, in the conclusions of his *Épures d'architecture*, Joël Sakarovitch cites in this regard the words of Carlo Bourlet, the last holder of the chair of Descriptive Geometry at the Conservatoire national des arts et métiers in Paris, in 1907: "[*La géométrie descriptive*] *passa ainsi des mains des praticiens dans celles des théoriciens. Bientôt ceux-ci oubliant sa raison d'être, lui donnèrent une tournure de plus en plus dogmatique* […] *Les théoriciens nous défendent de lire dans l'éspace* […] *et,*



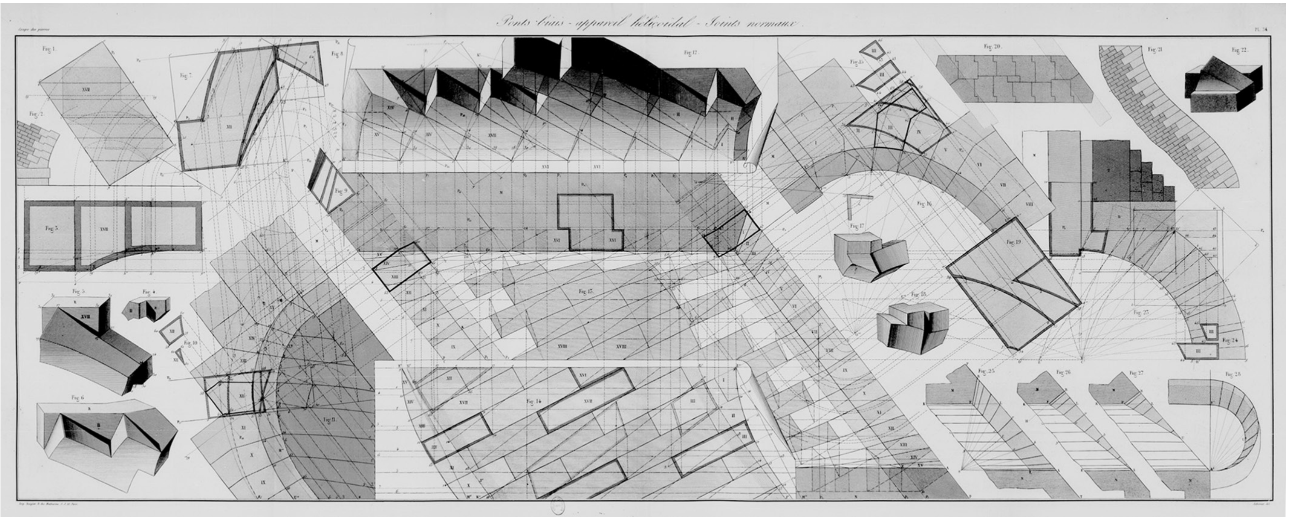
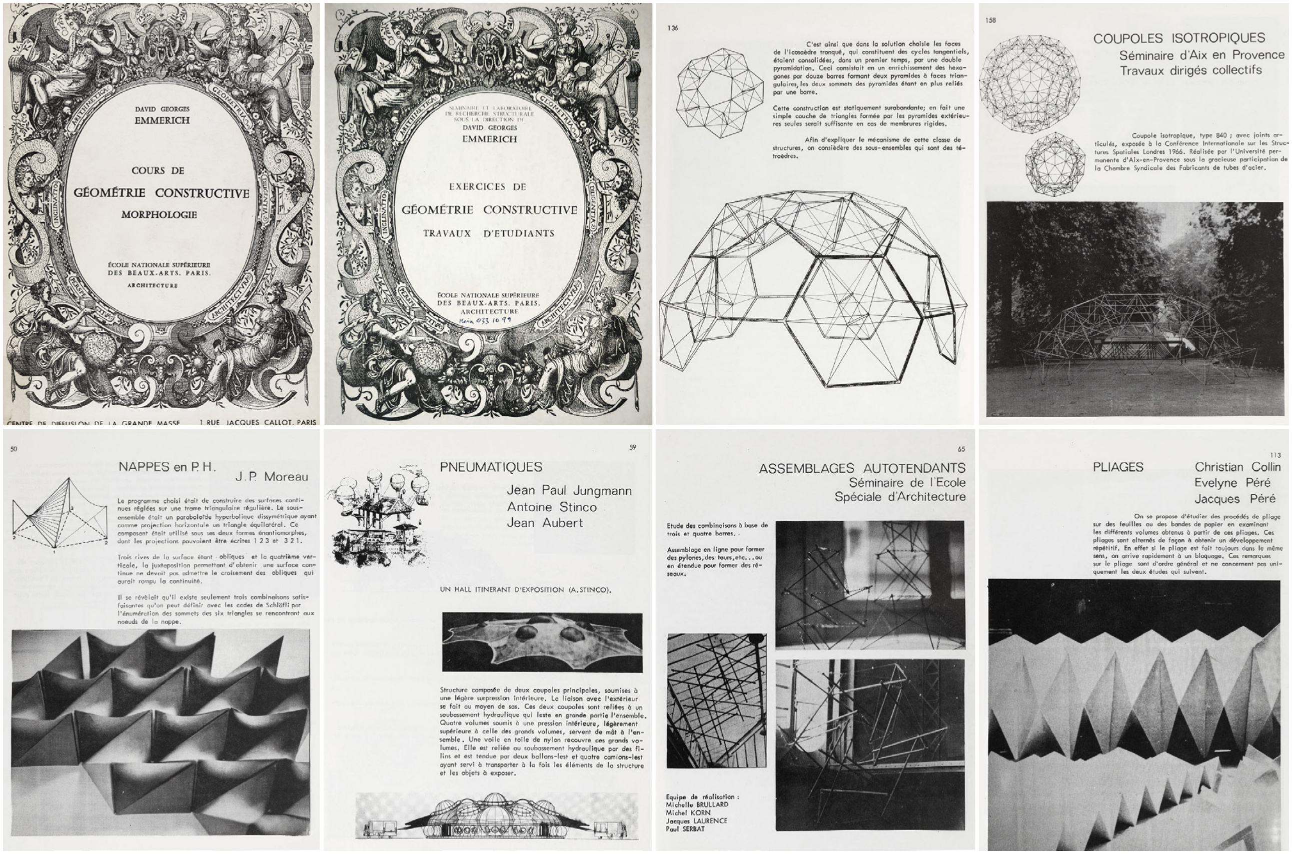


Fig. 10. Construction of bevel gears. Left: Hachette 1811, planche V 2^me chap.; right: Leroy 1842, planche 69.

Fig. 11. Joseph-Alphonse Adhémar, stereotomic apparatus for the construction of skew bridges (Adhémar 1856, planches 74 and 80).



DAVID GEORGES
EMMERICH

COURS DE
GÉOMÉTRIE CONSTRUCTIVE
MORPHOLOGIE

ÉCOLE NATIONALE SUPÉRIEURE
DES BEAUX-ARTS. PARIS.
ARCHITECTURE

CENTRE DE DIFFUSION DE LA GRANDE MASSE 1 RUE JACQUES CALLOT. PARIS

SEMINAIRE ET LABORATOIRE
DE RECHERCHE STRUCTURALE
SOUS LA DIRECTION DE
DAVID GEORGES
EMMERICH

EXERCICES DE
GÉOMÉTRIE CONSTRUCTIVE
TRAVAUX D'ETUDIANTS

ÉCOLE NATIONALE SUPÉRIEURE
DES BEAUX-ARTS. PARIS.
ARCHITECTURE
Maia 033 10 99

136

C'est ainsi que dans la solution choisie les faces de l'icosaèdre tronqué, qui constituent des cycles tangentiels, étaient consolidées, dans un premier temps, par une double pyramidation. Ceci consistait en un enrichissement des hexagones par douze barres formant deux pyramides à faces triangulaires, les deux sommets des pyramides étant en plus reliés par une barre.

Cette construction est statiquement surabondante; en fait une simple couche de triangles formée par les pyramides extérieures seules serait suffisante en cas de membrures rigides.

Afin d'expliquer le mécanisme de cette classe de structures, on consièdère des sous-ensembles qui sont des tétraèdres.

158

COUPOLES ISOTROPIQUES
Séminaire d'Aix en Provence
Travaux dirigés collectifs

Coupole isotropique, type 840 ; avec joints articulés, exposée à la Conférence Internationale sur les Structures Spatiales Londres 1966. Réalisée par l'Université permanente d'Aix-en-Provence sous la gracieuse participation de la Chambre Syndicale des Fabricants de tubes d'acier.

50

NAPPES en P. H.
J. P. Moreau

Le programme choisi était de construire des surfaces continues réglées sur une trame triangulaire régulière. Le sous-ensemble était un paraboloïde hyperbolique dissymétrique ayant comme projection horizontale un triangle équilatéral. Ce composant était utilisé sous ses deux formes énantiomorphes, dont les projections pouvaient être écrites 1 2 3 et 3 2 1.

Trois rives de la surface étant obliques et la quatrième verticale, la juxtaposition permettant d'obtenir une surface continue ne devait pas admettre le croisement des obliques qui aurait rompu la continuité.

Il se révèlait qu'il existe seulement trois combinaisons satisfaisantes qu'on peut définir avec les codes de Schläfli par l'énumération des sommets des six triangles se rencontrant aux noeuds de la nappe.

59

PNEUMATIQUES
Jean Paul Jungmann
Antoine Stinco
Jean Aubert

UN HALL ITINERANT D'EXPOSITION (A. STINCO).

Structure composée de deux coupoles principales, soumises à une légère surpression intérieure. La liaison avec l'extérieur se fait au moyen de sas. Ces deux coupoles sont reliées à un soubassement hydraulique qui leste en grande partie l'ensemble. Quatre volumes soumis à une pression intérieure, légèrement supérieure à celle des grands volumes, servent de mât à l'ensemble. Une voile en toile de nylon recouvre ces grands volumes. Elle est reliée au soubassement hydraulique par des filins et est tendue par deux ballons-lest et quatre camions-lest ayant servi à transporter à la fois les éléments de la structure et les objets à exposer.

65

ASSEMBLAGES AUTOTENDANTS
Séminaire de l'Ecole
Spéciale d'Architecture

Etude des combinaisons à base de trois et quatre barres. .

Assemblage en ligne pour former des pylones, des tours, etc. . . ou en étendue pour former des réseaux.

Equipe de réalisation :
Michelle BRULLARD
Michel KORN
Jacques LAURENCE
Paul SERBAT

113

PLIAGES
Christian Collin
Evelyne Péré
Jacques Péré

On se propose d'étudier des procédés de pliage sur des feuilles ou des bandes de papier en examinant les différents volumes obtenus à partir de ces pliages. Ces pliages sont alternés de façon à obtenir un développement répétitif. En effet si le pliage est fait toujours dans le même sens, on arrive rapidement à un bloquage. Ces remarques sur le pliage sont d'ordre général et ne concernent pas uniquement les deux études qui suivent.

Fig. 12. David Georges Emmerich, cover of Cours de géométrie constructive, Morphologie (Emmerich 1969); cover of Exercices de géométrie constructive, Travaux d'étudiants, results of courses held at the École Nationale Supérieure des Beaux-Arts in Paris and a seminar conducted at the Université Permanente d'Aix-en-Provence (Emmerich 1970, pp. 50, 59, 65, 113, 136, 158).

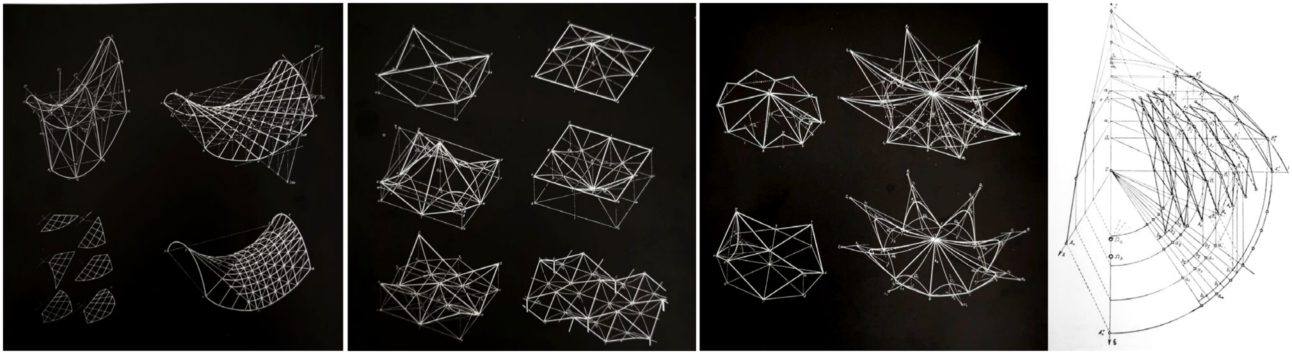


Fig. 13. Adrian Gheorghiu e Virgil Dragomir, representations of spatial structures, hyperbolic paraboloid, its aggregations and folded surfaces (Gheorghiu, Dragomir, 1971, pp. 42, 52, 55, 108).

pour justifier leurs prétensions, font exécuter, parfois à leurs élèves, des épures bizarres dont les données sont choisies à dessein de façon à rendre la vision impossible" [Sakarovitch 1998, p. 344] [10].

According to Bourlet, Descriptive Geometry should have been understood once again as the body of drawing applications aimed at solving execution problems in industry or providing accurate representations in the arts [Sakarovitch 1998, pp. 345, 346].

In the years following the First and especially the Second World War, the demands of reconstruction and the increased use of new building materials fostered significant advances in the application of geometry to design. Engineers such as Pier Luigi Nervi Eduardo Torroja, and Félix Candela used geometry as a tool for expressing architectural form, integrating structural calculation, geometry, and construction.

Starting from the mid-1950s, David Georges Emmerich, an architect, engineer, and professor of 'morphology' at the École des Beaux-Arts in Paris, promoted in France the idea of a *géométrie constructive*. Emmerich perceived a clear separation between architecture and geometric knowledge. He argued that "*L'architecture se mettait ainsi en dehors d'elle-même, en dehors de sa propre science*" [Emmerich 1969, p. 6] [11] and, in contrast, proposed the teaching of a 'science of forms' aimed at imagination, dimensioning, and the configuration of spatial structures, capable of classifying geometry, structures, and processes through the construction of physical models [Chassagnoux 2006] (fig. 12). In line with Emmerich's vision, but with a strong focus on the role of drawing in the generative processes of form, are the studies of a Romanian engineer and a Romanian architect, Virgil Dragomir and Adrian Gheorghiu, who, during the same period, focused on the study of structural geometries and their graphic representation, convinced that the genesis of spatial structures results from the synergistic action of architects and engineers, for whom geometry is the meeting point [12] [Gheorghiu, Dragomir 1978, p. 5] (fig. 13). These seemingly minor studies on structural morphology stand in continuity with the geometric experimentalism that, a few years earlier, had characterized the visionary works of Richard Buckminster Fuller, and appear in line with the pioneering form-finding experiments carried out in the same years by engineers such as Heinz Isler, Frei Otto, and Sergio Musmeci.

Generative physical models and graphic representations thus contributed to interdisciplinary research on architectural form, the former serving as tools for morphological experimentation and the latter as a means of visually representing the geometric properties of spatial structures.

The demonstrative capability of drawing, which had underpinned the scientific formulation of Descriptive Geometry and seems to have diminished in the following years, found new life in the early 2000s thanks to the spread of digital representation (fig. 14). Virtual exploration of three-dimensional space and the possibility of

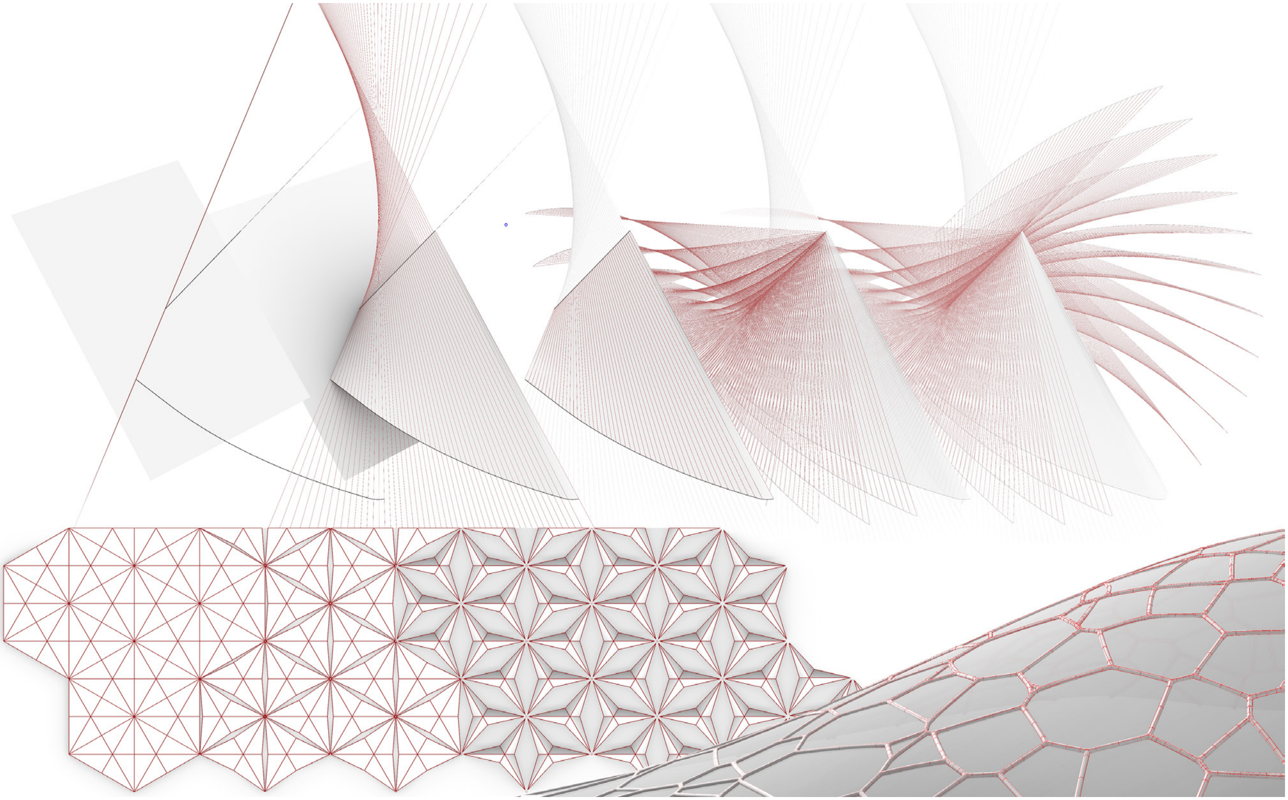


Fig. 14. Top: geometric genesis of a ruled surface with a director plane according to the Milwaukee Art Museum model by Santiago Calatrava, 2001; bottom: kinematically folded surfaces based on the Al Bahr Towers model in Abu Dhabi by Aedas, 2012; and tessellation of continuous surface using the Voronoi diagram (graphic elaboration by the authors).

using classes of skew curves and double curvature surfaces to derive the geometric properties of figures have restored renewed vigor to the construction and to the heuristic value of drawing, with significant repercussions in research and education [13].

During these same years, the development of digital representation tools and the possibility of working with an unprecedented and extensive repertoire of forms in architectural design fostered the development of Architectural Geometry, an experimental research field that places geometry at the center of the processes of generation and representation of form in architectural design [Pottman et al. 2007]. Through the tools of parametric design and computational modeling, Architectural Geometry explores freeform shapes, complex geometries, parametric structures, and problems of tessellation and discretization, integrating descriptive, differential, and computational geometric approaches.

Today, the languages of constructive geometry allow the aesthetics of design to emerge through the synergistic interaction of different disciplines, contributing to the creation of performance-efficient, constructively optimized, and morphologically innovative architectures. This virtuous synergy also involves Descriptive Geometry.

As a grammar of representation capable of translating space into models and as a science that studies the geometric properties of figures, Descriptive Geometry is, indeed, the only discipline that allows, both today and in the past, the dynamic and rigorous visual manipulation of form, enabling the exploration of design thought processes through the universal language of drawing.

Notes

[1] “Harmony of the parts in relation to a whole to which they are bound according to a precise number, delimitation and position” (translation by the authors).

[2] Pierre Boutroux, in *Les principes de l’analyse mathématique*, recounts the intent of certain geometers to elevate pure geometry to the level of the algebraic method by proposing a synthetic geometry capable of the same effectiveness and generality [Boutroux 1919, pp. 109-116].

[3] The origin of the name *géométrie descriptive* is discussed by Théodore Olivier in the introduction to the second edition of his *Cours de géométrie descriptive*, where he explains how Descriptive Geometry serves to depict what the mind sees and what it has seen, thereby revealing what is imagined as what is known [Olivier 1843, p. VIII]. As Gino Loria observes, Monge attributed a theoretical value to Descriptive Geometry arising from the way this science facilitated the conception and study of geometric figures, comparing its procedures to those of analysis and demonstrating their essential identity [Loria 1896, pp. 22, 23].

[4] “If I were to rewrite my work entitled *de l’analyse appliquée à la géométrie* […] I would write it in two columns: in the first, I would present the demonstrations through analysis; in the second, I would present the demonstrations through Descriptive Geometry, in other words, using the method of projections; and perhaps one would be surprised –he added– to see upon reading this work that the advantage would almost always lie with the second column, for the clarity of reasoning, the simplicity of the demonstrations, and the ease of applying the theorems obtained to the various works of engineers” (translation by the authors).

[5] “The collection of these lessons is the first treatise on Descriptive Geometry in which this science was considered in an abstract manner, independently of its applications. […] One can recognize therein that faculty of imagination which allowed it to discover the properties of figured space” (translation by the authors).

[6] For further information on the École Polytechnique see Cardone 1996.

[7] The influence of Descriptive Geometry on early 19th-century applications was mainly felt in gear theory, which responded to the needs of an emerging industrialization, and in stone stereotomy, which maintained continuity with a centuries-old tradition; for further details, see [Sakarovitch 1998, pp. 299-319].

[8] “It is well known that Euclid, in his *Elements*, never reasons about a figure without first having taught its construction; this, therefore, serves as a proof of the existence of the figures for which a definition had previously been given” (translation by the authors).

[9] In those years, Descriptive Geometry, consolidated and apparently complete, was still taught in the faculties of Mathematics, Architecture, and Engineering by mathematicians such as Gino Fano, Francesco Severi, Enrico Bompiani, and Luigi Campedelli, and, in the second half of the twentieth century, by Orseolo Fasolo and Ugo Saccardi, who carried the responsibility of keeping alive a centuries-old science that seemed exhausted [Migliari 2009, p. 19].

[10] “[Descriptive geometry] thus passes from the hands of practitioners into those of theorists. Soon, the latter, forgetting its very purpose, gave it an increasingly dogmatic character […] The theorists forbid us to read in space […] and, to justify their claims, sometimes have their students produce bizarre drawings whose data are deliberately chosen so as to make the visualization impossible” (translation by the authors). In his commentary on the quotation, Sakarovitch highlights how the abolition of the chair of Descriptive Geometry at the Conservatoire national des arts et métiers roughly coincided with the end

of the teaching of Descriptive Geometry at the École Polytechnique, and with the conclusion of the 'golden age' of this discipline in France: Sakarovitch 1998, p. 346.

[11] "Architecture thus placed itself outside of itself, outside its own science" (translation by the authors).

[12] In 1968, Adrian Gheorghiu and Virgil Dragomir published the volume entitled *La représentation des structures constructives*, a work that describes structural geometries through drawing. A review of the volume by Federico Fallavollita can be found in the *Readings/Rereadings* rubric of this issue of the journal *diségno*.

[13] In 2008, professors of Descriptive Geometry from numerous Italian universities, coordinated by Riccardo Migliari, promoted a *Manifesto* for the renewal of Descriptive Geometry, grounded in the rediscovery of the cognitive value of drawing through digital representation methods [Migliari et al. 2008].

Authors

Stefano Chiarenza, Department for the Promotion of Human Sciences and Quality of Life, San Raffaele Roma Open University, stefano.chiarenza@uniroma5.it
Marta Salvatore, Department of History, Representation and Restoration of Architecture, Sapienza Università di Roma, marta.salvatore@uniroma1.it

Reference List

Adhémar, J. (1856). *Cours de mathématiques à l'usage de l'ingénieur civil, application de géométrie descriptive, coupe des pierres* (cinquième édition). Paris: Victor Dalmont, Mallet-Bachelier, Mathias, L. Hachette.

Adhémar, J. (1866). *Cours de mathématiques à l'usage de l'ingénieur civil, application de géométrie descriptive, ombres* (troisième édition). Paris: Eugène Lacroix, H. Asselin, L. Hachette et C^{e}.

Alberti, L.B. (1966). *L'architettura (De re aedificatoria)*, 2 Vols., a cura di P. Portoghesi. Milano: Il Polifilo [Manuscript, *De re aedificatoria*, 1452].

Boutroux, P. (1919). *Les principes de l'analyse mathématique. Exposé historique et critique* (tome second). Paris: Librairie scientifique A. Hermann & Fils.

Cardone, V. (1996). *Gaspard Monge scienziato della rivoluzione*. Napoli: Cuen.

Chassagnoux, A. (2006). David Georges Emmerich Professor of morphology. In *International Journal of Space Structures*, Vol. 21, No. 1, pp. 59-71. DOI: 10.1260/026635106777641144.

Delorme, P. (1568). *Le premier tome de l'architecture*. Paris: Chez Federic Morel.

De Paolis, R. (2020). *Fondamenti del progetto e processi di morfogenesi*. Milano: FrancoAngeli.

Dupin, C. (1825). *Géométrie et méchanique des arts et métiers et des beaux-arts*. Paris: Bachelier libraire.

Emmerich, D.G. (1969). *Cours de Géométrie Constructive. Morphologie*. Paris: École National Supérieure de Beaux-Arts.

Emmerich, D.G. (1970). *Exercices de Géométrie Constructive. Travaux d'étudiants*. Paris: École National Supérieure de Beaux-Arts.

Evans, R. (1997). *Architecture and Its Three Geometries*. Cambridge - London: The MIT Press.

Gheorghiu, A., Dragomir, V. (1971). Representation géométrique des structures spatiales. In *Cahiers du centre d'études architecturales*, no. 12-13.

Gheorghiu, A., Dragomir, V. (1978). *Geometry of structural forms*. London: Applied science publishers LTD.

Hachette, J.N.P. (1811). *Traité élémentaire des machines*. Paris: J. Klostermann.

Hachette, J.N.P. (1822). *Traité de géométrie descriptive: comprenant les applications de cette géométrie aux ombres, à la perspective et à la stéréotomie*. Paris: Corby.

Leroy, C.F.A. (1842). *Traité de géométrie descriptive*. Paris: Bachelier.

Loria, G. (1896). *Il passato e il presente delle principali teorie geometriche*. Torino: Carlo Clausen.

Loria, G. (1935). *Metodi matematici*. Milano: Ulrico Hoepli.

Menges, A. (2011). Simple Systems – Complex Capacities. Integrative Processes of Computational Morphogenesis in Architecture. In *TECHNE - Journal of Technology for Architecture and Environment*, 1(2), pp. 68-77. DOI: 10.13128/Techne-9928.

Mies van der Rohe, L. (1953). Anmerkungen zur Zeit. In *Baukunst und Werkform*, 6. Jg., Heft 6, pp. 275-277.

Migliari, R., De Carlo, L., Inzerillo, M., Corazzi, R. Cocchiarella, L. (2008). Un manifesto per il rinnovamento della geometria descrittiva. In B. Aterini, R. Corazzi (a cura di). *La geometria fra didattica e ricerca*, pp. 188-193. Firenze: Area.

Migliari, R. (2009). La geometria descrittiva nel quadro storico della sua evoluzione dalle origini alla rappresentazione digitale. In L. Carlevaris, L. De Carlo, R. Migliari (a cura di). *Attualità della geometria descrittiva*, pp. 15-42. Roma: Gangemi.

Migliari, R. (2012). Geometria-Costruzione-Architettura. In *DisegnareCon*, 5(9), pp. 1-4. <https://disegnarecon.unibo.it/issue/view/337> (accessed 30 December 2025).

Monge, G. (1798). *Géométrie descriptive*. Paris: Bauduoin.

Nebuloni, A., Buratti, G. (2023). Design by data. From interfaces to responsive architectures. In *TECHNE - Journal of Technology for Architecture and Environment*, No. 25, pp. 93-100. DOI: 10.36253/techne-13629.

Olivier, T. (1843). *Cours de géométrie descriptive*. Paris: Carilian-Goeury et Vor Dalmont.

Pérez-Gómez, A. (1982). Architecture as Drawing. In *Journal of Architectural Education*, vol. 36, no. 2, pp. 2-7.

Petitot, J. (2009). Modelli dinamici di morfogenesi e teorie della forma. In A. Cavazzini, A. Gualandi (a cura di). *Logiche del vivente. Evoluzione, sviluppo, cognizione nell'epistemologia francese contemporanea*, XIX, I, 2009, pp. 205-226. Macerata: Quodlibet.

Poncelet, G.V. (1865). *Traité des propriétés projectives des figures*. Paris: Gauthier-villars Imprimeur libraire (prima ed. Paris: Bachelier 1822).

Pottman, H., Asperl, A., Hofer, M., Kilian, A. (2007). *Architectural geometry.* Bentley: Bentley Institute Press.

Ramirez-Figueroa, C., Dade-Robertson, M., Hernán, L. (2013). Adaptive Morphologies: Toward a Morphogenesis of Material Construction. In P. Beesley, M. Stacey, O. Khan (Eds.). *ACADIA 2013: Adaptive Architecture*, pp. 51-60. Cambridge, Ontario: Riverside Architectural Press.

Ritter, W. (1890). *Anwendungen der Graphischen Statik*. Nach Professor Dr. C. Culmann. Zürich: Verlag Von Meter & Zeller.

Rykwert, J. (1998). Translation and/or representation. In *RES: Anthropology and Aesthetics*, vol. 34, pp. 64-70.

Sakarovitch, J. (1998). Épures d'architecture. De la coupe des pierres à la géométrie descriptive. Basel, Boston, Berlin: Birkhauser Verlag.

Siegel, C. (1962). *Structure and Form in Modern Architecture*. New York: Reinhold Publishing Corporation.

Strappa, G. (1995). *Unità dell'organismo architettonico: note sulla formazione e trasformazione dei caratteri degli edifici*. Bari: Edizioni Dedalo.

Torroja, E. (1967). *Philosophy of Structures*. English edition by J.J. Polivka and Milos Polivka. Berkeley and Los Angeles: University of California Press.

Thompson, D'Arcy W. (1969). *Crescita e forma. La geometria della natura*. Torino: Boringhieri (prima ed. *On Growth and Form*. Cambridge 1942).

Turing, A. M. (1952). The chemical basis of morphogenesis. In *Philosophical Transactions of the Royal Society of London Series B, Biological Sciences*, vol. 237, no. 641, pp. 37-72.