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From Herbal to Grammar : Theorizing Ornament

Estelle Thibault

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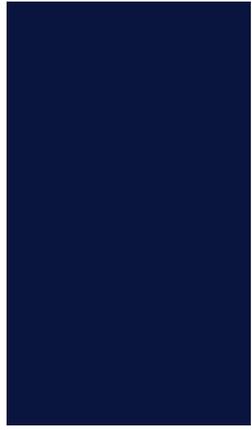
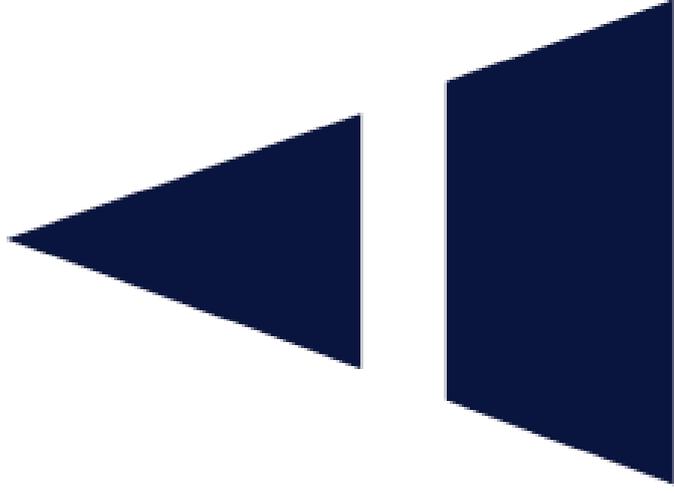
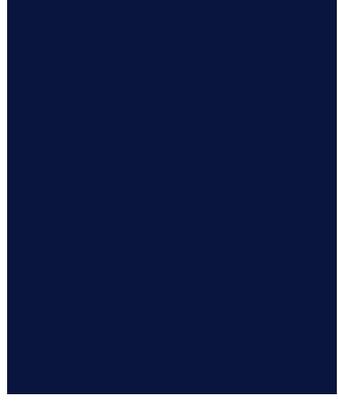
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EUROPEAN ARCHITECTURAL HISTORY NETWORK

DUBLIN 2016



EUROPEAN ARCHITECTURAL HISTORY NETWORK

DUBLIN 2016

PROCEEDINGS OF THE
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SESSION: Ornament and the Renewal of Architecture in the 19th century Ralph Ghoche, Columbia University; Martin Bressani, McGill University

During the 19th century, the call to renew the decorative surface of architecture was heard far and wide, and from voices in diverse artistic fields. French author and critic Théophile Gautier, for instance, published an impassioned plea in 1848 decrying “old and ancient emblems ... now empty of meaning” and calling for a “whole new, vast system of symbols” to be “invented to answer the new needs of our time.” Gautier appealed to artists and ornamentalists to collectively transform the “nudity of Parisian edifices” and “envelop them with resplendent garments” made up of decorative murals and surface ornamentation.

The call to renew ornament, however, was primarily championed by architects, many believing that experimentation in ornament would be the most expedient way of arriving at a new architecture. The thought may seem paradoxical today, especially in light of the modernist debasement of ornament by the early 20th-century avant-garde, but architects such as Owen Jones in Britain and Victor Ruprich-Robert in France, among many others, were explicit in their belief that ornament could engender a wholly rejuvenated architectural form and expression. In *Grammar of Ornament*, for instance, Jones proposed that a new style of ornament would be “one of the readiest means of arriving at a new style” of architecture.

This session will examine the production and theorization of ornament as it relates to a renewal of architecture. We seek papers that consider the role that ornament played in catalyzing a reassessment of architecture in the nineteenth century. Rather than treat ornament as a vestige of pre-modern impulses, this session is premised on the understanding that ornament in the 19th century was the privileged terrain where the issue of the “modern” was being waged. As such, we seek papers that provide new ways of narrating the history of architectural modernism, countering the canonic view that the shedding of ornament is its most conspicuous characteristic.

19th-century utopian movements, architecture and ornament Antoine Picon, Harvard University

The architecture advocated by utopian movements such as Saint-Simonianism has been often interpreted as a brand of the rationalist creed epitomized by the work of Viollet-le-Duc. A closer look at their theoretical writings on the arts and architecture reveals a different orientation. On the question of ornament, the Saint-Simonians are for instance very far away from the ambition to interpret it as an offspring of structure, as a logical development of its main articulations. What

appears instead is an ornament partially free of structural constraints, an ornament the spiritual function of which is not without analogy with Ruskin's approach to the problem.

Using sources like Emil Barrault's *Appel aux Artistes* or the *Livre Nouveau des Saint-Simoniens* the presentation will analyze the contribution of utopian thought, of Saint-Simonism in particular, to the rich nineteenth-century debate regarding architectural ornament. Traces of the Saint-Simonian attitude can still be found in the quarrel that opposes Michel Chevalier and Eugène-Emmanuel Viollet-le-Duc in the early 1850s on the use of iron in religious buildings.

From Herbal to Grammar: Theorizing Ornament Estelle Thibault, École d'architecture Paris Belleville *

“The grammar of a language is something different, as is a chrestomathy, nor should we confuse a theory of botany with a flora or a garden.”

This excerpt from the ‘essential notices to the reader’ which opens Jules Bourgoïn’s *Grammaire élémentaire de l’ornement* (1880) expresses the idea of a break with a cumulative historicist approach represented by the collection of ornaments in favor of an analytical one. Fourteen years earlier, Owen Jones’s *Grammar of Ornament* had been judged insufficiently ‘grammatical’ by Victor Ruprich-Robert, who found the geometrical analyses unconvincing and its classification excessively bound to chronology. In the introduction to his *Flore ornementale* (1866), he declared that he had abandoned ‘history’ in order to establish a thoroughgoing ‘grammar of ornament’ and that his teaching on the subject predated the Englishman’s book. However, he used the grammatical metaphor to comment on a morphological approach drawing primarily on that of the botanists: the ‘artistic herbal’ that arranged plant-derived motifs according to their formal characteristics.

With a secondary consideration for Ruprich-Robert, the grammatical analogy came to dominate Bourgoïn’s thinking, relegating botany to the background. Must we, though, read these quotations as more than mere metaphors – as an indication of more far-reaching methodological borrowings?

This paper will try to explain why both analogies—naturalist and grammatical—seemed relevant to those architects, whose reflections were oriented towards the prospect of a renewal.

PAPER

Until the 1970s, the dominant historiographical narratives linked the emergence of modern architecture and art to the ousting of the decorative. Since then research has reinstated the part played by the various theories and practices of ornament in the evolution of architecture in the 19th and 20th centuries¹ Rediscovered some ten years ago, the work of the French architect and theoretician Jules Bourgoïn (1838–1908) merits our attention². His first books approach ornament as a whole: *Les Arts arabes* (1868–1873)³ proposed a geometrical analysis of Middle Eastern output, and was followed by his *Théorie de l'ornement*⁴ (1873) [ill. 1], which set out to "encompass the universality of the arts in all times and all places⁵." Addressing ornament as the outcome of intuitive work by craftsmen, he was committed to obtaining recognition for it as a specific field of study. Then came *Grammaire élémentaire de l'ornement*⁶ (1880), his *Études architectoniques et graphiques* (1899–1901) and *La Graphique*⁷ (1905), all of which took a more pedagogical line. The aim was a revitalised body of knowledge that would form the basis of a system of craft education. Overall, these books reflect an ambitious intellectual project for a new discipline that would focus on ornament rather than fine art. The issue was to liberate its teaching from two influences Bourgoïn saw as unacceptable: that of science as practised by engineers – descriptive geometry – and that of the arts of drawing and the philosophy of the beautiful.

Bourgoïn's work is also informative regarding the connections between studies of ornament and ways of teaching architecture. For his generation ornament was a kind of test bench for the art of building. In the hierarchical education system of the time training in ornamental design served as a preliminary to the study of architecture: one mastered geometry and acquired technical skills and an aesthetic awareness. The *École de dessin et de mathématiques* in Paris – later the *École des arts décoratifs* – was a kind of side entrance to the *École des beaux-arts* for young people of

¹ A. Payne, *From Ornament to Object. Genealogies of Architectural Modernism*, New-Haven CT, Yale University Press, 2012 ; L. Hubatová-Vacková, *Silent Revolution in Ornament : Studies in Applied Arts and Crafts from 1880-1930*, Prague, Academy of Arts, Architecture and Design, 2011.

² M. Volait, 'Jules Bourgoïn', in *Allgemeines Künstlerlexikon*, Leipzig, K. G. Saur, 1996, t. XIII, p. 381 ; M. Bideault, E. Thibault and M. Volait (ed.), *De l'Orient à la mathématique de l'ornement. Jules Bourgoïn (1838-1908)*, Paris, Picard, 2015.

³ J. Bourgoïn, *Les Arts arabes, architecture, menuiserie, bronzes, plafonds, revêtements, marbres, pavements, vitraux, etc. avec un texte descriptif et explicatif et le trait général de l'art arabe, par Jules Bourgoïn...*, Paris, V^{ve} A. Morel, [1867]- 1873.

⁴ J. Bourgoïn, *Théorie de l'ornement*, Paris, Lévy, 1873.

⁵ J. Bourgoïn, *Études architectoniques et graphiques : mathématiques, arts d'industrie, architecture, arts d'ornement, beaux-arts. Collection raisonnée d'études et de matériaux, de notes et de croquis, pour servir à l'histoire, à la théorie, à la technique des arts et à l'enseignement théorique et pratique dans la famille, dans l'école et dans l'atelier*, Paris, C. Schmid, 1899-1901, 2 vol., vol. 1, p. 26.

⁶ J. Bourgoïn, *Grammaire élémentaire de l'ornement pour servir à la théorie et à la pratique des arts et de l'enseignement*, Paris, Ch. Delagrave, 1880.

⁷ J. Bourgoïn, *La Graphique : collection raisonnée d'études et de matériaux, de notes et de croquis, pour servir à l'histoire, à la théorie, à la technique des arts et à l'enseignement dans la famille, dans l'école et dans l'atelier*, Paris : Ch. Delagrave, 1905, 3 vol.

humble origins, from Charles Percier to Hector Guimard⁸. Eugène Viollet-le-Duc and Victor Ruprich-Robert, the architects who taught ornament there, saw the subject as a small-scale equivalent of architecture which dealt with issues that could later be transposed to a higher level: modes of composition, use of symbolism and the fit between form, material and technique. In this context the study of ornament provided a theoretical workshop for stimulating the evolution of architecture.

Four decades separated Bourgoïn's own education in ornament – in Simon-Claude Constant-Dufeux's atelier⁹, not far removed from the floral references of Ruprich-Robert – from the mathematical austerity of his last books. I would like to show how, during this period, he used different morphology-inflected scientific fields of enquiry to modernise the study of formal structures.

Among the issues raised by ornament, Bourgoïn went most deeply into matters of composition. In order to codify the formal principles underpinning the creation of ornament, he worked his way through different domains. Antoine-Augustin Cournot's philosophy of science served as his main point of reference, with its concepts of order and form. In *Traité de l'enchaînement des idées*¹⁰ (1861) these concepts were taken as common to the various branches of knowledge. The concept of order had initially been developed by the mathematician Louis Poinsoit¹¹ as a means of designating the relationships in space between different objects; as such it could be readily applied to disciplines that described the spatial organisation of material objects, such as botany and crystallography. Cournot, however, increased its scope considerably, extending it to all spheres involving ideas of organisation and classification. In his wake Bourgoïn made order and form the pillars of an "architectonic science"¹² embracing the study of the industrial arts and architecture. His grounding in Cournot's epistemology then led him to an interest in different morphological systems rooted in the natural sciences and linguistics.

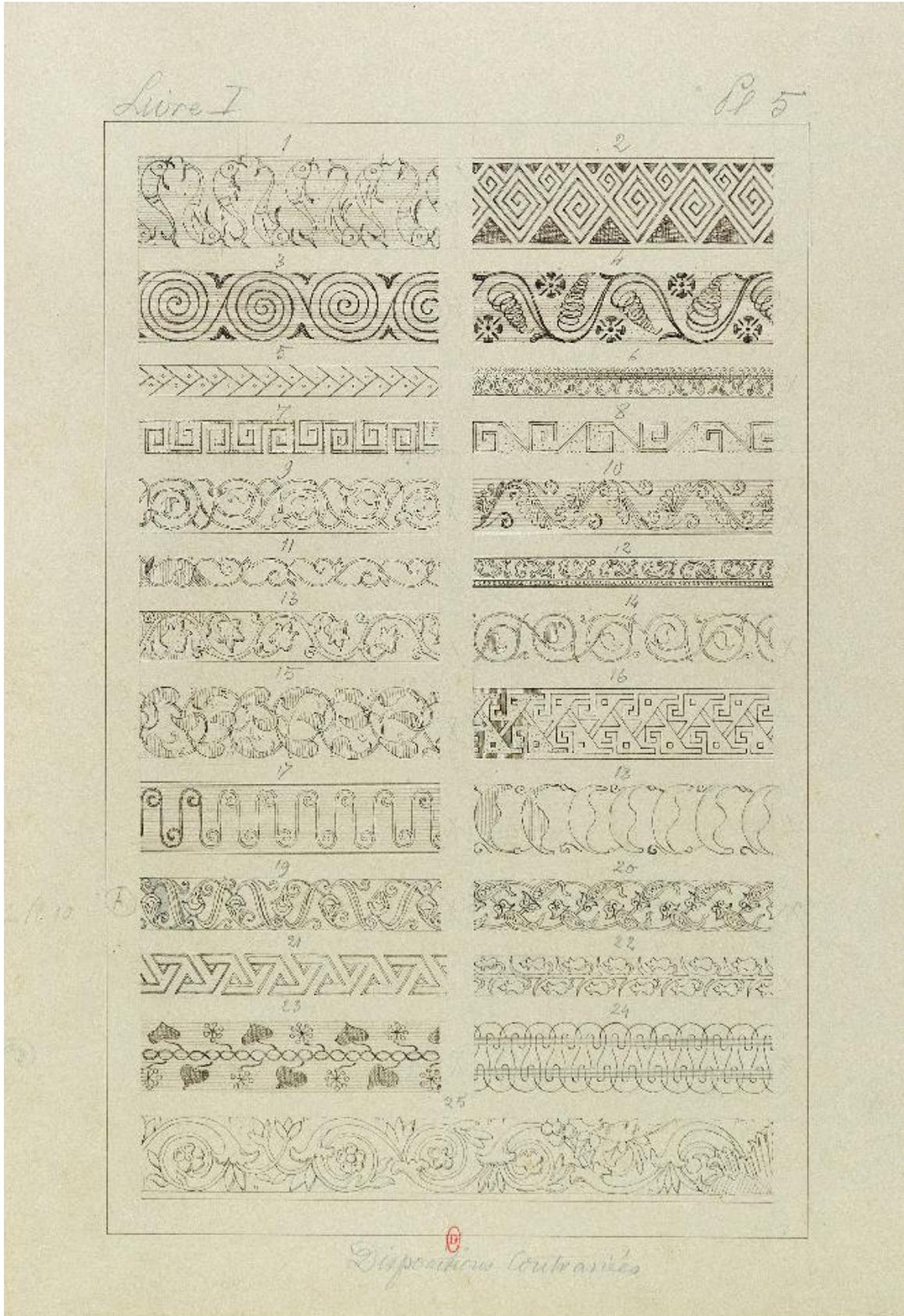
⁸ F. Ballon, 'Teaching the Decorative Arts in the Nineteenth Century: The École Gratuite de Dessin, Paris', *Studies in the Decorative Arts*, vol. 3, n° 2, Spring-Summer 1996, pp. 77-106 ; U. Leben et al., *Histoire de l'École nationale supérieure des arts décoratifs (1766-1941)*, Paris, ENSAD, 2004 ;

⁹ R. Ghoche, 'The Symbolic, the Lithic and the Litteral : Simon-Claude Constant-Dufeux and Mid-century Architectural Eclecticism', PhD Thesis, New York, Columbia University, 2014 ; id., 'Dans l'atelier de Simon-Claude Constant-Dufeux', in Bideault, Thibault and Volait (ed.), *De l'Orient à la mathématique de l'ornement*, pp. 43-60.

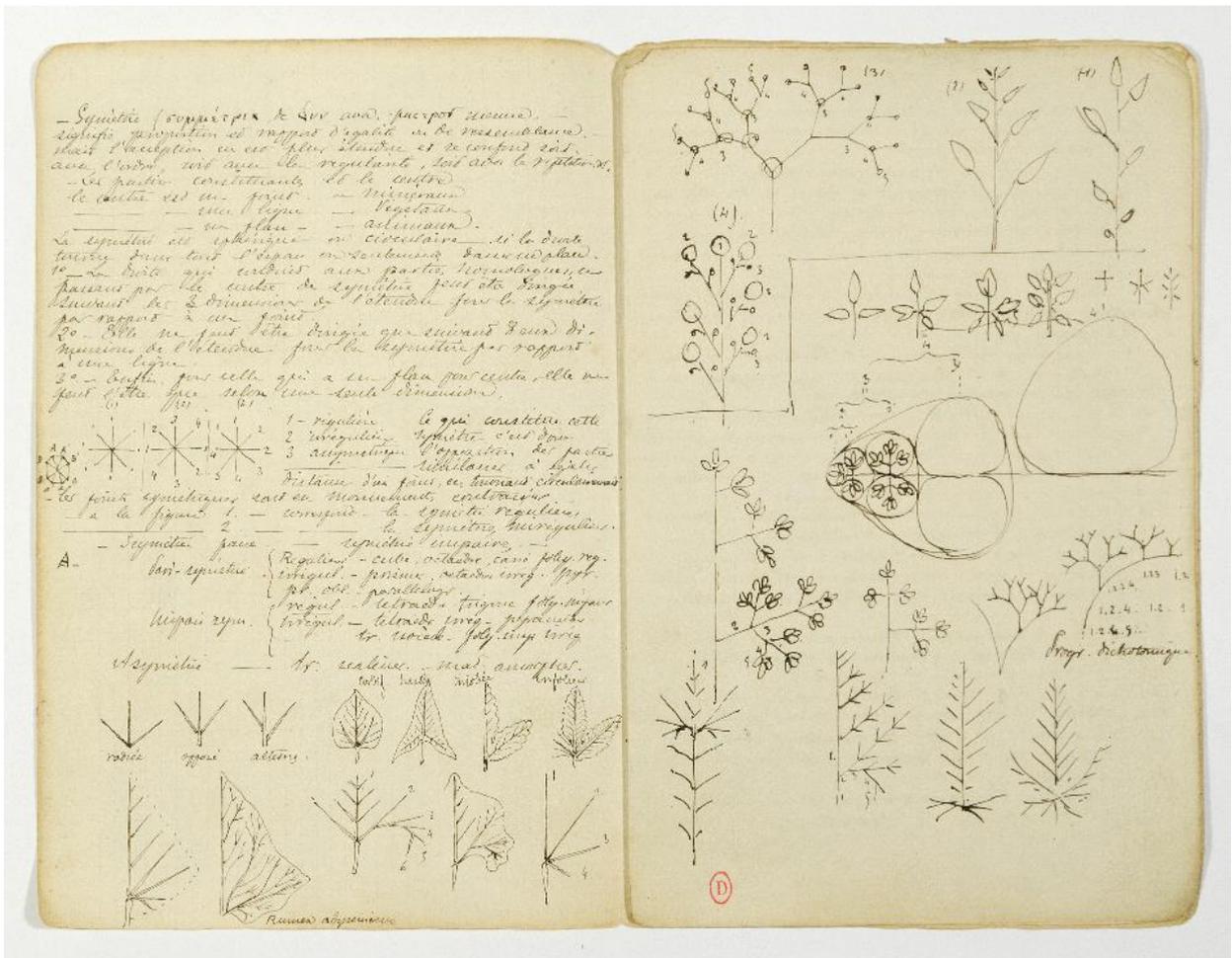
¹⁰ A.-A. Cournot, *Traité de l'enchaînement des idées fondamentales dans les sciences et dans l'histoire*, Paris, L. Hachette et C^{ie}, 1861, 2 vol.

¹¹ J. Boucard and C. Eckes, 'La théorie de l'ordre de Poinsoit à Bourgoïn: mathématiques, philosophie, art ornemental', *Revue de synthèse*, t. 136, n° 3-4, 1995, pp. 403-447.

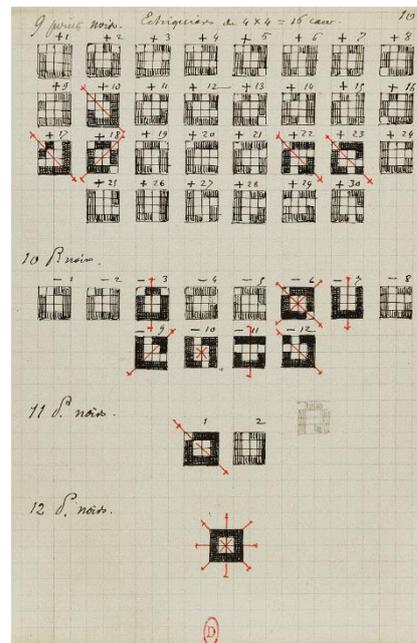
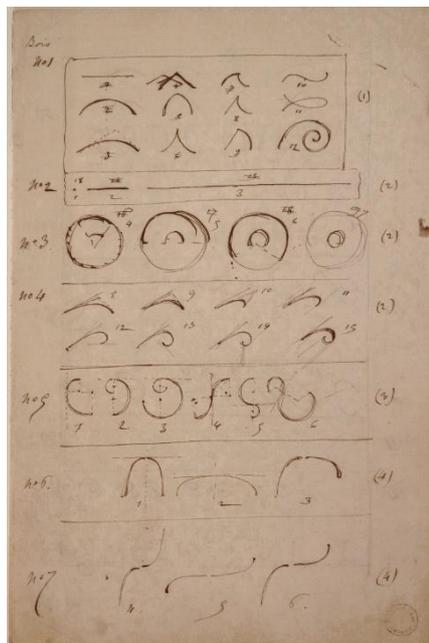
¹² J. Bourgoïn, *Théorie de l'ornement*, p. 24.



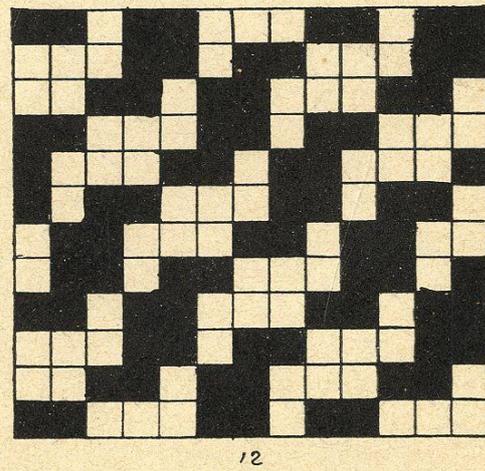
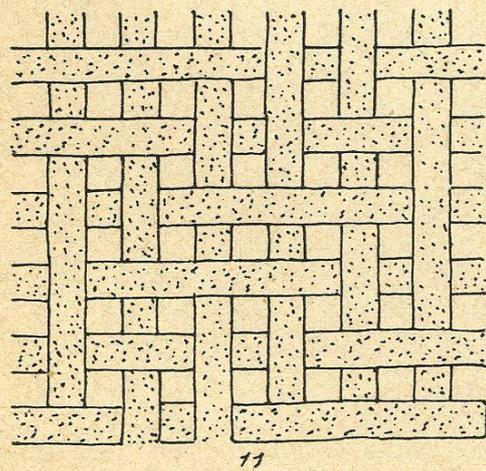
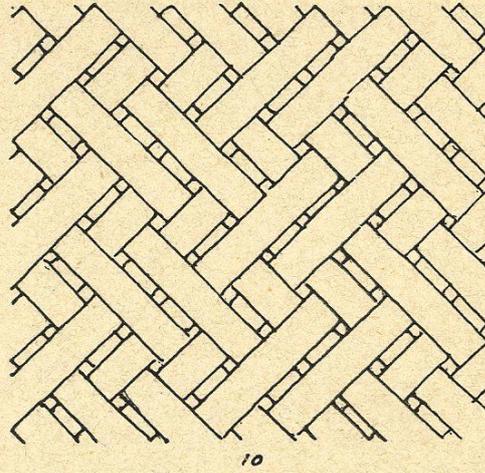
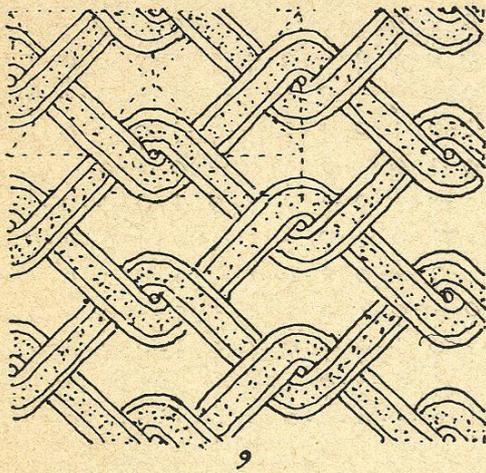
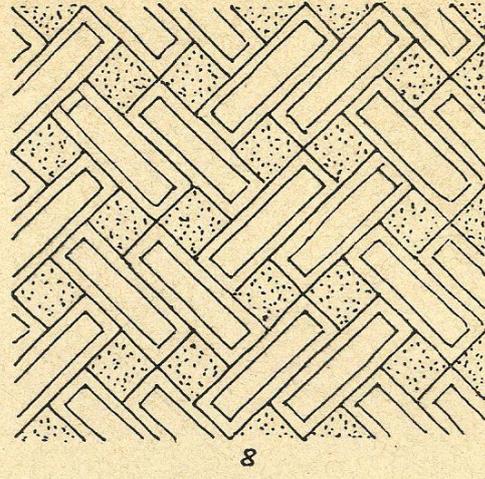
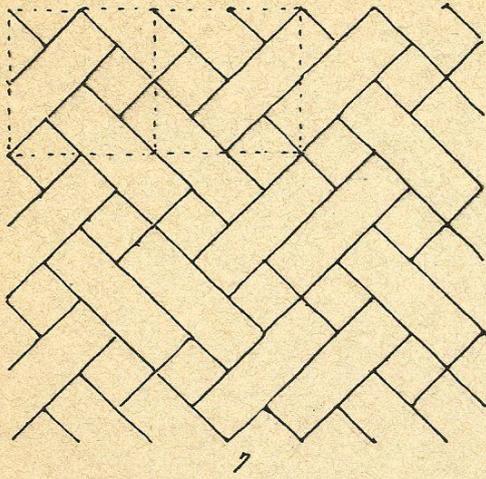
Ill. 1 : J. Bourgoïn, *Théorie de l'ornement*, study for Pl. 5 (Paris, Bibliothèque de l'Institut national d'histoire de l'art - collections Jacques Doucet, Arch. 67.15).



Ill. 2 : J. Bourgoïn, notes on *Essai de phytomorphie* (1864) by Charles Fermond and other botanical works, undated (Paris, Bibliothèque de l'Institut national d'histoire de l'art - collections Jacques Doucet., 67.11)



Ill. 3 (left): J. Bourgoïn, study for the illustrations of the *Grammaire de l'ornement* (Library of Joigny, 64.10)
 Ill. 4 (right): J. Bourgoïn, 'checkerboard figures', study for *La Graphique* (Paris, Bibliothèque de l'Institut national d'histoire de l'art - collections Jacques Doucet, Arch. 67.8).



Ill. 5 : J. Bourgoïn, 'Textile figures', *Études architectoniques et graphiques*, vol. 2, pl. 57.

Other theorists of ornament – Victor Ruprich-Robert, Gottfried Semper, Owen Jones and Christopher Dresser¹ – also drew on models like these and fruitful analogies with botany and linguistics were further enriched². Bourgoïn was not working in isolation, but the extensive notes from scientific works to be found in his archives³ provide a clearer understanding of how the transfers to his own field were effected. His writings and drawings, both published and unpublished, throw useful light on the effects of different methodological models – botanical, linguistic, mathematical – on the evolution of formal questions in the technical arts. In Bourgoïn's case they formed the most general of guides in shaping an "elementary" grammar of ornament and of the "elements" of Arabic art. These terms reference both the identification of linguistic units and the *Théorie élémentaire de la botanique*⁴ defined by Augustin Pyramus de Candolle as the outline of the principles and fundamental components of the botanical science.

Botanical science: forms and functions

Where plant sciences were concerned, these incursions into the most recent research shifted the focus of thinking about ornament from naturalistic copying of floral motifs towards assimilation of an abstract science of form. From Ruprich-Robert to Bourgoïn, this increasingly abstract turn can be correlated with the schematisations of Christopher Dresser, himself trained in botany by John Lindley⁵. In Germany, a few decades later, Moritz Meurer's books⁶ deployed related approaches, with their borrowing of diagrams summing up the spatial arrangements of inflorescences.

The botanical theories outlined in, for example, the writings of Jean-Baptiste Payer and Emmanuel le Maout⁷, raised the question of the connections between the function of organs and their form. Architectural discussion in the second half of the 19th century often drew on questions

¹ R. Ghoche, 'On the Philosophical Foundations of V.M. Ruprich-Robert's Flore Ornementale', Master's paper, New York, Columbia University, 2006 ; H. F. Mallgrave, *Gottfried Semper Architect of the Nineteenth Century*, New Haven CT, Yale University Press, 1996; C. A. Hvol Flores, *Owen Jones : Design, Ornament, Architecture & Theory in an Age of Tradition*, New York : Rizzoli, 2006 ; M. Whiteway (ed.), *Christopher Dresser, a Design Revolution*, London, V&A Publications, 2004.

² D. Schaffer, *The Order of Ornament, the Structure of Style: Theoretical Foundations of Modern Art and Architecture*, Cambridge, Cambridge University Press, 2003 ; R. Labrusse, 'Grammars of Ornament: Dematerialization and Embodiment from Owen Jones to Paul Klee', in G. Necipoglu and A. Payne (ed.), *Histories of Ornament : from Local to Global*, Princeton, Princeton University Press, 2016, p. 320-333.

³ Paris, Library of the Institut national d'histoire de l'art [Arch. 67].

⁴ A. P. de Candolle, *Théorie élémentaire de la botanique*, Paris, Deterville, 1813.

⁵ S. Durant, 'Christopher Dresser and the Use of Contemporary Science', in *Christopher Dresser in context. Papers of the Symposium held jointly by the Victoria and Albert Museum and the decorative Art Society*, London, 2004; Id., 'Dresser's Education and Writings', in M. Whiteway (ed.), *Christopher Dresser*, pp. 47-59.

⁶ L. Hubatová-Vacková, *Silent Revolution in Ornament*, p. 25.

⁷ E. Le Maout, *Atlas élémentaire de botanique, avec le texte en regard, contenant l'organographie, l'anatomie, et l'iconographie des familles d'Europe*, Paris, Fortin, Masson, Langlois et Leclercq, 1846 ; J. B. Payer, *Éléments de botanique : organographie*, Paris, Langlois et Leclercq, 1857.

of animal anatomy as already debated by Georges Cuvier and Étienne Geoffroy Saint-Hilaire⁸, but the world of ornament seemed more inclined towards plant-based thinking. In Bourgoïn's case this interest in "organography" and "phytomorphism" [ill. 2] is clearly present in the synopsis for an unpublished essay on the "science of buildings"⁹. He divides his subject into two parts: the first is "morphological" and involves comparative analysis of forms, while the second, "physiological" section looks into the functional interactions between architectural "members" and between buildings and their broader environment.

Plant metaphors also led to consideration of forms not as completed entities, but in terms of their generative dynamics, with a simple, schematic focus on cycles of growth or metamorphosis. Bourgoïn's illustrations of variations stress this dynamic aspect: the botanical literature, while certainly concerned to describe types, put more emphasis on the potential for transformation and modalities of development. Analogously, his "science of buildings" urges an appreciation of stylistic types in the course of their evolution: not only "at their most perfect and stable, at adulthood, at the truly historical, definitive phase of full completion", but "through their successive states from the outset to the definitive state, and on through their decline to their withering"¹⁰. It also investigated the workings of the ambient setting and the external conditions that influenced this process.

The appeal of the sciences of language

While plant sciences stress form/function interaction and the dynamic character of structures, the sciences of language situate analysis of ornamental forms with the humanities, between anthropology and history, starting out from the concept of style. The work of Gottfried Semper is emblematic of the pull exerted by the linguistic model¹¹. The naturalistic paradigm of his earliest writings was, by the 1860s, having to compete with his interest in the comparative history of languages. Bourgoïn's research followed a similar way [ill. 3]. In his *Éléments de l'art arabe*, he suggests the possibility of stylistic divisions reflecting nature's three kingdoms¹² – animal, vegetable, mineral– but at the same time he was concerned that this kind of analogy might be

⁸ C. van Eck, *Organicism in Nineteenth Century Architecture: An Inquiry into its Theoretical and Philosophical Background*, Amsterdam, Architectural & Natura Press, 2004; B. Bergdoll, 'Of Crystals, Cells, and Strata : Natural History and Debates on the Form of a New Architecture in the Nineteenth Century', *Architectural History*, vol. 50, 2007, pp. 1-29.

⁹ J. Bourgoïn, 'La science des édifices', manuscript [Arch. 67.11], undated, Paris, Library of Institut national d'histoire de l'art.

¹⁰ J. Bourgoïn, 'La science des édifices'.

¹¹ H. F. Mallgrave, *Gottfried Semper*, pp. 156-164.

¹² J. Bourgoïn, *Les éléments de l'art arabe*, Paris, Firmin-Didot, 1879, pp. 5-6.

superficial. Alerted to linguistic matters by Cournot¹³, himself a reader of Max Müller and August Schleicher, Bourgoïn envisaged deeper connections between the grammatical structures and ornamental patterns of any given people. Thus ornamental studies became part of more far-reaching history of civilisations. There emerged from this a notion of form no longer bound solely by spatial configurations – relative arrangements of lines, types of symmetry – but also taking account of the derivations and syntactic markers. The study of ornament was thus seeking its model in a morphological typology characteristic of inflected, agglutinative and isolating languages. Bourgoïn began thinking in terms of a "comparative grammar of Greek art – of Arabic art – of Japanese art"¹⁴ that began with the system richest in "plastic inflections" and worked its way down to Japanese motifs, brought together "without order or symmetry" and governed by "no definite syntax".

Bourgoïn also investigated the relationship between fine arts and crafts, initially advancing a comparison between cultivated and wild plants, then between scholarly language and the vernacular.

Sparked by figures like Bourgoïn, the mirror-image interplay between the sciences of language and the science of ornament can in fact be observed over a long period between the 19th and 20th centuries. If we are to believe French literary historian William Marx, the "formalist revolution"¹⁵ that swept through literary criticism in the first half of the 20th century had its roots in a concept of form that originally took shape in the field of art history. We know, for example, that Paul Valéry had read Bourgoïn¹⁶ when reflecting on a methodology for a stylistic study combining formal analysis and ethnological enquiry. More than in the history of the fine arts, the idea of a science of anonymous forms was developed in studies of ornament.

Mathematics: combinatorics and textile notations

On the mathematical side, Bourgoïn's attempts at describing and organising motifs drew on geometry of position and combinatory analysis. The quantity of reading notes found in his archives testifies to a deep, wide-ranging scientific culture. He went first of all to the mathematical works of Cournot and Poincaré, then to the problems of position examined by Alexandre-

¹³ A. A. Cournot, *Traité de l'enchaînement des idées*, t. 2, pp. 53-118.

¹⁴ J. Bourgoïn, manuscript for a lesson at the École des beaux-arts [Arch. 67.02.03], undated, Paris, Library of Institut national d'histoire de l'art.

¹⁵ W. Marx, *Naissance de la critique moderne : la littérature selon Eliot et Valéry*, Arras, Artois Presses Université, 2002, pp. 14-16.

¹⁶ J. Jallat, *Introduction aux figures valéryennes. Imaginaire et théorie*, Pise : Pacini Editore, 1982, p. 255.

Théophile Vandermonde, and to Johann Heinrich Lambert's *Essais de taxéométrie*¹⁷. Using what he learnt from these texts and their graphic notations, he described serial arrangements with a system of circles, squares, stars and triangles. From the mathematicians Charles-Eugène Catalan and Nicolas-Joseph Lidonne he learned about the arrangements of polygons and polyhedrons. As a reader of reviews such as *Philosophical Transactions*, Bourgoïn acquainted himself with current visual representations of complex configurations. His notebooks show how he appropriated schematisations for summarising ornamental arrangements, while also mastering the accompanying terminology: series, recurrence, period, alternation, etc.

Various systems of notation caught his attention. The most abstract of them were the "checkerboard figures"¹⁸ with their infinite alternations of black and white squares [ill. 4]. This type of checkerboard was also used in the textile industry for schematising satin weave, and in mathematics for representing abstract problems in number theory. In the 1860s Bourgoïn was reading technical books including manufacturer Pierre Falcot's *Traité encyclopédique de la fabrication des tissus*¹⁹, and his *Théorie de l'ornement* borrows Falcot's simplified renderings of squared networks, useful for symbolising the quincunx fabric patterns called *contre-semplages*. At the same period industrial draughtsman Édouard Gand and mathematician Édouard Lucas were working together to rationalise production of punch cards for different types of weaving²⁰. In taking inspiration from both standard textile practice and Lucas's permutations, Bourgoïn extrapolated from exchanges between the technical arts in quest of abstract conceptual tools, and mathematicians and their search for concrete applications [ill. 5].

The scientific path to abstraction

What exactly is the place of Bourgoïn's work in a history of abstraction in architecture? Unquestionably his books, together with other contemporary works using formal elementarisation, contributed to the joint abandoning of the figurative and the decorative. Some of his 20th-century readers, among them André Lurçat, were striving for a paring-down of visual language, but Bourgoïn himself was far from having opted for simplification of architectonic form; on the contrary, he extolled the infinite variety of humanity's ornamental interpretations. He explored the

¹⁷ J. Boucard and C. Eckes, 'Théorie de l'ordre et syntactique chez Jules Bourgoïn', in M. Bideault, E. Thibault and M. Volait (ed.), *De l'Orient à la mathématique de l'ornement*, pp. 281-297.

¹⁸ J. Bourgoïn, *La Graphique*, vol. 3 'Figures d'échiquier'.

¹⁹ P. Falcot, *Traité encyclopédique et méthodique de la fabrication des tissus*, Elbeuf, l'Auteur, 2^e édition, 1852. See E. Thibault, 'La graphique, une science des figures pour l'école et l'atelier', in M. Bideault, E. Thibault and M. Volait, *De l'Orient à la mathématique de l'ornement*, pp. 255-280.

²⁰ A.-M. Decaillot, 'Géométrie des tissus. Mosaïques. Échiquiers. Mathématiques curieuses et utiles', in *Revue d'histoire des mathématiques*, vol. 8, 2002, pp. 145-206.

"very essentials"²¹ of ornament, i.e. order and form, independently of colour, contour and materials; for him only the geometrical roots of the question could be pinned down scientifically. The abridged schematisations that dominate his last published volumes betray no loss of interest in the elaborateness of the ornamentation whose subtleties are recreated in the plates of *Précis de l'art arabe*²² in 1892 – and which it was his intention to enlarge on in the illustrations accompanying *La Graphique*.

The increasing abstractness of Bourgoïn's works reflected a broader evolution in architecture publishing. His successive ventures followed the evolution of the genre, as hefty, luxurious albums gave way to more modest educational formats. This change especially affected the imagery, with documentary plates being replaced by illustrations directly related to the text and focusing less on tangible recreation than on types and structures. This modernisation of the image had little to do with artistic abstraction, if we take that to mean a quest for pure forms capable of embodying a spiritual, expressive or symbolic content. On the other hand it was part of an attempt at visual illustration observably at work in scientific publications since the middle of the century: examples were the analytical illustrations in the books by botanists Jean-Baptiste Payer and Emmanuel Le Maout, far removed from the realism of Pierre-Joseph Redouté²³. In a broader sense this recourse to schematic illustration and diagrammatic notation was characteristic of the literature Bourgoïn's research drew on so heavily in stereochemistry, acoustics, phyllotaxis and other fields. Thus when it came to describing not just individual examples, but the types and processes of generation of forms, his books had their sources in a history of scientific and technical abstraction.

This quest for abstract schematisation was driven by the needs of an increasingly mechanised world, as signalled by Bourgoïn's interest in the abridged notations used in the textile industry. The shift in figurative renderings also reflects pedagogical concerns conducive to a pendular movement between schematic and concrete interpretations. The point was to boost creative autonomy through formal gymnastics, swinging from the abstract to the concrete and back again. With this juxtaposition of the documentary and the schematic, Bourgoïn was out to trigger the "capacity for abstraction"²⁴ which contemporary educational theorists – Ferdinand Buisson, for example – intended to inculcate into future generations

²¹ J. Bourgoïn, *Les éléments de l'art arabe*, p. 5.

²² J. Bourgoïn, *Précis de l'art arabe et matériaux pour servir à l'histoire, à la théorie et à la technique des arts de l'Orient musulman*, Paris, F. Leroux, 1889-1892.

²³ W. Wheeler, *L'illustration botanique*, Paris, L'Aventurine, 1999.

²⁴ F. Buisson, 'Abstraction', *Dictionnaire de pédagogie et d'instruction primaire*, Paris, Hachette, 1887, t. 1, pp. 9-11.