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RESEARCH ARTICLE

Le Corbusier's Modulor and the Debate on Proportion in France

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Finally codified in 1945 after several years of research, Le Corbusier's Modulor is probably the most comprehensive proportional system imagined during the 20th century. Developed through contacts with consultants such as art historian Elisa Maillard, and referring to statistical measurements of the human body, the Modulor concluded decades of discourse on proportions, a theme that preoccupied Le Corbusier ever since his sojourn in Germany in 1910. Matila Ghyka's work on the golden section was one of the sources for the Modulor, but his work in general was used by other architects, such as Le Corbusier's rival André Lurçat, who proposed his own range of proportions related to the work of builders as much as to that of designers. Proportions thus became a central issue in the postwar French reconstruction, as architects struggled to maintain their status amid changing procedures in building production.

Introduction

On Friday, September 28, 1951, Le Corbusier addressed the First International Conference on Proportion in the Arts at the Milan Triennale, introducing, with affirmed modesty, the system of proportional measurements he had invented in the preceding years as if it were an elementary, prosaic tool: 'The Modulor, which I have described to you, is a simple work tool, a tool such as aviation, such as many other improvements created by men'[1] (**Fig. 1**).

But his position at the Milan event was far from modest, as he was the only contributor to have arrived armed not only with an analytical theory, but also with a structured attempt at proposing a comprehensive proportional system, which was ready for implementation at all the scales of architectural design.

One year earlier, the Paris-based architect had published a compact square volume, entitled *Le Modulor, essai sur une mesure harmonique à l'échelle humaine, applicable universellement à l'architecture et à la mécanique* (*The Modulor: A Harmonious Measure to the Human Scale Universally Applicable to Architecture and Mechanics*). His book was devoted to the presentation of an ambitious system, accompanied by an endless series of autobiographic considerations. The original neologism of the title belonged to a long series of terms assembled by him, and often edging on the oxymoron, such as the 'immeuble-villas' ('villa-apartments') or the 'cité-jardin verticale' ('vertical garden-cities'). In this particular case, the term Modulor was composed by the fusion of the notion of module with the notion of the golden section. In his 1950 volume, Le Corbusier collected not only the results of several years of research specifically devoted to the creation of his own system, as discussed below, but also those of decades spent thinking about proportions and standards, in the context of an open, and often heated debate involving painters, philosophers, scientists, as well as architects.

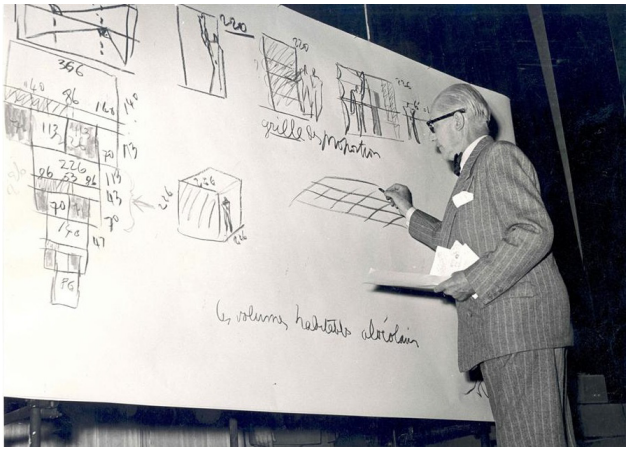

Fig. 1: Le Corbusier lectures at the Milan Triennale, 1951, Fondation Le Corbusier.

In his presentation of the Modulor, Le Corbusier insisted on measurements, proposing an analogy with music, a field he was familiar with: according to him, the Modulor was 'a tool of linear or optical measures, similar to musical script' (Le Corbusier 1950: 17; 1956: 17). This parallel with music was meant to be explored in his office in the 1950s by the young Greek engineer and composer Yannis Xenakis, who worked on key projects such as the La Tourette monastery and the Philips Pavilion at the 1958 Brussels World Fair. Yet the preoccupation of Le Corbusier with proportions predated by more than thirty years the publication of *Le Modulor*, and could be traced back to his formative journeys throughout Europe, from his contacts with German architects to his long investigation of ancient buildings. He would insist specifically on

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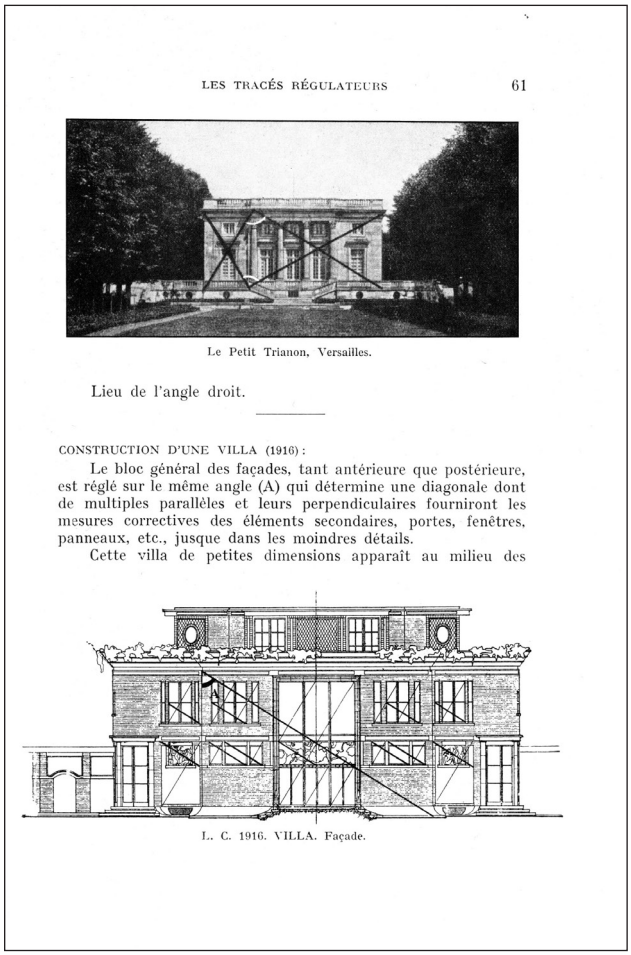

LES TRACÉS RÉGULATEURS 61

Le Petit Trianon, Versailles.

Lieu de l'angle droit.

CONSTRUCTION D'UNE VILLA (1916) :

Le bloc général des façades, tant antérieure que postérieure, est réglé sur le même angle (A) qui détermine une diagonale dont de multiples parallèles et leurs perpendiculaires fourniront les mesures correctives des éléments secondaires, portes, fenêtres, panneaux, etc., jusque dans les moindres détails.

Cette villa de petites dimensions apparaît au milieu des

L. C. 1916. VILLA. Façade.

Fig. 2: Le Corbusier, 'Regulating Lines', in *Vers une architecture*, 1924 [1923].

the matter when publishing the scandalous essays that brought him to public attention in Paris.

One of the pivotal chapters of *Vers une architecture*, a book published in 1923 and based upon essays written since 1920 for the journal *L'Esprit nouveau*, that he had founded with the painter Amédée Ozenfant, dealt with what he called the 'regulating lines', or the proportional grid used in designing buildings.

In the second edition of his manifesto, released in 1924, he illustrated his point with an elevation of Villa Schwob, the last building he had erected in his hometown of La Chaux-de-Fonds, on which he had drawn a proportional grid (**Fig. 2**), and introduced a photograph of the Ozenfant atelier and the La Roche-Jeanneret house, which he had just completed in Paris, crisscrossed with triangular patterns.

Somewhat presumptuously, he wrote in his book that he had 'not yet had the pleasure of encountering contemporary architects who had concerned themselves with this question' (Le Corbusier 1923: 63; 2007: 146). This remark provoked the ire of the Dutch architect Hendrik Petrus Berlage, who was quick to complain about the absence of any mention of his widely known analyses, such as the ones published in 1908 in his *Grundlagen und Entwicklung der Architektur* (Berlage 1908), which had probably not escaped the attention of Charles-Édouard Jeanneret, who had not then taken the pseudonym of Le Corbusier. Berlage wrote to Le Corbusier a few months after the publication of the book:

> I hasten to inform you that, since as early as 1890, this question was studied in Holland [...] and with such success that many architects then began to design their plans and facades in accordance with regulatory lines. And, as an example, I inform you that the new bourse in Amsterdam, 1897–1904, was built in accordance with a 3, 4, 5 triangle.[2]

Le Corbusier responded rather humbly, affirming that he had 'known the Bourse in Amsterdam for quite some time' and had 'always admired' it.[3] He had perhaps found in the writings of Berlage (1908: 187) the quote of a statement in which Gottfried Semper had affirmed that 'Nothing is arbitrary'. The aphorism 'the regulatory line is a guarantee against arbitrariness', published in *Vers une architecture*, appears almost as a plagiary of Berlage's mentor at the Zürich Polytechnic. In 1926, Le Corbusier maintained in an essay published in the *Journal de psychologie* that he had 'taken a stand' against Berlage's regulating lines, which the latter had reduced to 'diagonal lines', or to a simple 'framework': 'by this account', he claimed, 'all cross-stitch embroidery would be made with regulating lines' (Le Corbusier 1926: 346).

Berlage was not the only reader who felt compelled to react to Le Corbusier's assertions. French architect Pol Abraham made fun of his assertions, noting that his alleged 'investigations' were extremely limited and that he should have known that, 'at the École des Beaux-Arts, there were scarcely any candidates for the Grand Prix who did not make use to some degree of Egyptian triangles and geometric diagonals' (Abraham 1924: 18). Nevertheless, Le Corbusier's interest in proportions never flagged, and found its expression in many statements and in his designs. The 'regulating lines' were used to comment on the large villa Stein-de Monzie, built in 1928 in Garches, and for larger projects such as the Mundaneum, conceived during the same year for a site overlooking Lake Geneva. Radical figures, such as the Russian architect and artist El Lissitzky (1929) and the Czech critic Karel Teige (1929), also made fun of him, less for having ignored the existing discourse on proportion than for having implemented it in what they considered an exceedingly monumental scheme.

In his Milan address in 1951, Le Corbusier mentioned that the *Histoire de l'architecture* published in 1899 by the French 19th-century engineer and historian Auguste Choisy (**Fig. 3**) was the main source of his interest for the regulating lines:

> During the war, in 1918, I had the opportunity to read half a book on architecture (it was the only one that I had read in my life! You must excuse me, all authors of art books, kindly excuse me! Because I've never read a book on architecture). I read half a book, that of Choisy (it is an excellent book) and in one of its chapters the book discusses regulating lines. I realized that something was happening there.[4]

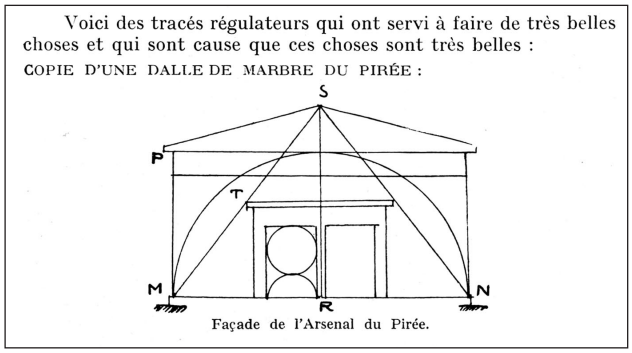

Fig. 3: Le Corbusier, regulating lines of the Pyraeus Arsenal, after Auguste Choisy, in *Vers une architecture*, 1923.

By then, he was ready to look back at his first forays into the debate on proportions. In *Le Modulor*, he had commented on his early interest for the theme, recalling the illuminating discovery he had made in 1909 in Bremen of a house by 'Thorn Brick' — in fact the Dutch painter Johan Thorn-Prikker (Le Corbusier 1950: 26).

During his German explorations, he had met Theodor Fischer in Munich. Fischer was a former student of Paul Wallot, the neo-Renaissance architect of the Berlin Reichstag, who had developed his own theories on proportions. He had also worked in Berlin with Peter Behrens, who had used proportional grids in several of his projects, for instance in a pavilion built in 1905 in Oldenburg, well known to Charles-Édouard Jeanneret (Jeanneret began using the pseudonym Le Corbusier in 1920) through its publication in 1912, or in the house Wiegand in Dahlem, which was on the drawing board when the young Swiss was working in the Berlin office. The German experience helped him to look closely at the measurements of Athens's Parthenon and of Roman structures, which he would investigate with great care during his journey to the East of 1911 (Cohen 2013a and 2013b). Francesco Passanti (2002) has shown that, when Jeanneret built his first houses in La Chaux-de-Fonds, he used schemes derived from those of Behrens. Regulating lines were also used in Le Corbusier's purist still-lifes, a precedent he did not fail to mention in *Le Modulor*, insisting on his seniority in exploring the topic.

The main sources of Le Corbusier's later reflection are two books published by Matila Ghyka in Paris. Born Matila Costiescu, of aristocratic Moldavian descent, Ghyka had a double face. A Romanian diplomat in public life, he was also a mathematician, a physicist, a critic, and a writer, who had befriended writers Marcel Proust and Léon-Paul Fargue. He would be one of the contributors to the Milan conference with an address on 'Symétrie pentagonale et section dorée dans la morphologie des êtres vivants' ('Pentagonal Symmetry and Golden Section in the Morphology of Living Beings').

Le Corbusier's personal library holds copies of *Esthétique des proportions dans la nature et dans les arts* (*Aesthetics of Proportions in Nature and the Arts*; Ghyka 1927) and *Le Nombre d'or: Rites et rythmes pythagoriciens dans le développement de la civilisation occidentale* (*The Golden Section; Pythagorian Rites and Rhythms in the Development of the Western Civilization*; Ghyka 1931).

Ghyka was a subscriber to *L'Esprit nouveau*, and had engaged in a correspondence with the journal in 1925.[5] In his *Esthétique des proportions* (**Fig. 4**), he mentioned Le Corbusier in passing, acknowledging his analysis of Michelangelo's St. Peter's, and paraphrasing him, both visually, through a parody of *Vers une architecture*'s illustrations of grain silos and iron bridges, and theoretically, when he celebrated

> a new school: furthermore, it very sensibly does not claim always to identify the pragmatic constructions of the engineer, or the Platonic creations of the architect. His iconoclastic Cubism, after having confronted geometrical truth in its tranquil but not unpleasant nakedness, after having brutally reminded us that a house is a 'machine for living in,' positively adapts to the material and social conditions of our time. He predicted that by purifying this discipline we once again will be able to produce creative work, equally in terms of the organization and regulating lines of both the parts and the whole, as well as in the contour modulations and ornamental details. (Ghyka 1927: 424 and 427)

Le Corbusier was elated not only to be mentioned but also to be challenged by Ghyka to develop further his early positions.

He also commented visually on Ghyka's figures with his pencils (**Fig. 6**). He wrote a first text on *Esthétique des proportions* in 1927, considering it a 'book of the revelation of the laws of our being and our world'.[6] In 1934, on the occasion of the second printing of the book, he wrote a second essay entitled 'Tracés régulateurs'. Both have remained unpublished until this day (see Appendix 1 and Appendix 2). In his later comment, Le Corbusier praised the author, but not without irony: 'Here M. Ghyka has almost played the role of Vignola! He has given us recipes! But on a serious note: he has opened up a window onto an attractive but perilous landscape'. He scorned past discourse on proportions as 'occult baggage', and criticized his fellow architects as being

> simple-minded, pedantic, like idiots obsessed with hermetic sketches, whose poor architectural layouts have no real connection to reality. Who cares? Wisdom is for the wise [...] That is to say that the material popularized by M. Ghyka is of a nature so noble and so inaccessible that it requires much work and a certain intellectual persistence on behalf of those who seek the truth.

In the end, he warned the readers that Ghyka's book would 'produce pedants and feed avid minds'.[7]

In *Le Nombre d'or* (**Fig. 5**), a book he sent to Le Corbusier, Ghyka proposed a broader interpretation of the origins and the extent of the golden section in nature, art, architecture, music, and literature, from Paul Valéry to Walt Whitman's poem *Mannahatta*. He proposed a genealogy of the golden section from antiquity

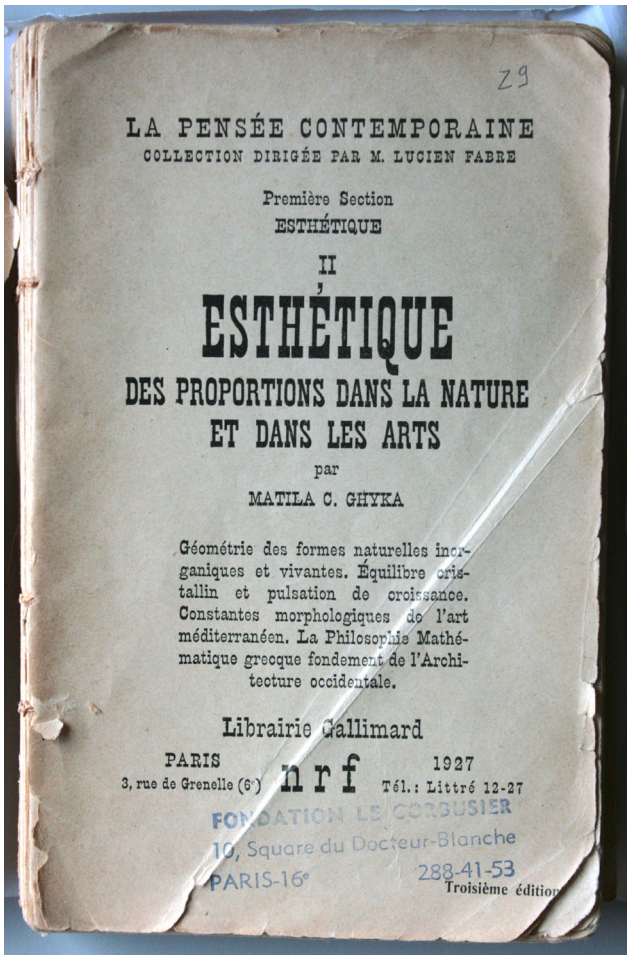

Fig. 4: Matila Ghyka, *Esthétique des proportions*, 1927, Le Corbusier's copy, Fondation Le Corbusier.

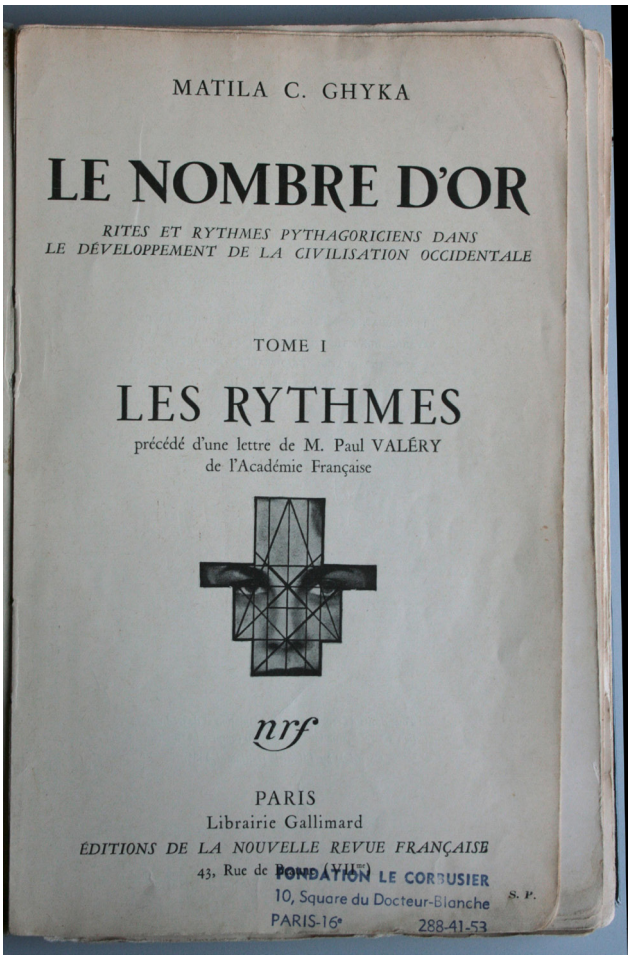

Fig. 5: Matila Ghyka, *Le Nombre d'or*, 1934, Le Corbusier's copy, Fondation Le Corbusier.

to the Renaissance, referring to modern scholars such as August Thiersch (1883), but insisting above all on Ernst Moessel's *Die Proportion in Antike und Mittelalter* (1931) on which the new book is partially based. In the 'letter to the author' that opens the book, the poet Paul Valéry pleaded for taking into account the materiality of works of art and architecture:

> The incredible attributes of this number *Phi* could seduce artists to the point where they *ignore the importance of execution, material and location* of the works. But in every building, whether it is a machine, an edifice, or a work of art, there remains the great problem of *similitude* between the project or the model and the work itself. What is possible or appropriate at a certain scale is not in another. Even in the realm of the mechanical this problem is only partially resolved. In the realm of the aesthetic I do not know whether it has ever been fully addressed. […] This number should [therefore] not be blindly and brutally used. We must view it as an instrument that does not replace the skill and intelligence of the artist. To the contrary! It must inspire the artist to develop these qualities, and it is here that the remarkable properties of the *Golden Number* come forward. (Ghyka 1931, 1: 8)[8]

In the field of architecture, Ghyka discussed the ideas of Moessel and also the Canadian-American artist Jay Hambidge (see in particular Hambidge 1924). He commented on the widely disseminated theoretical writings of the Paris-based Serbian architect Miloutine Borissavliévitch (1926) dealing with the perception of proportion (see also Borissavliévitch 1952), and declared to be looking for the 'canons of a Mediterranean architecture'. His hostility to the new architecture appears when he criticizes as 'Baukasten' — the German term for building blocks — the houses built in the suburbs of Paris by Le Corbusier. He calls the Parisian architect to the witness stand:

> Regarding the rest, as it often happens in architecture today, the only criterion used is adaptation to the goal ('fitness'), including strength and economy, and, the idea of the engineer winning, we find unity. Even in this case you can choose between several schemes of proportions. And that of the golden section is not bad […] I call on Le Corbusier. (Ghyka 1931, 1: 97)

Finally codified in 1945, and released in 1950 in book form, the Modulor results from an investigation undertaken in 1943 in Le Corbusier's office, then almost totally deprived of any serious commission. A cycle of nearly seven years

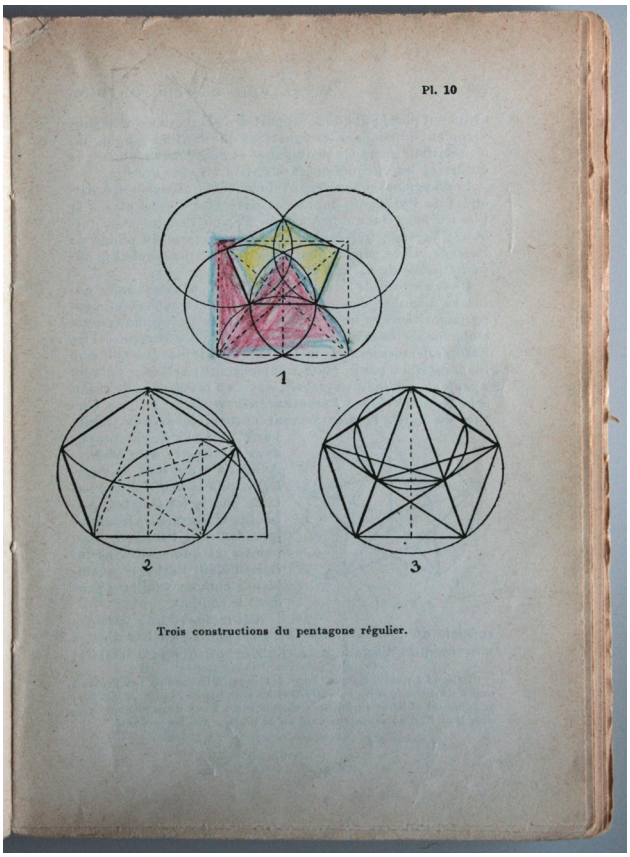

Fig. 6: Matila Ghyka, *Esthétique des proportions*, plate on pentagonal proportions with Le Corbusier's graphic additions, Fondation Le Corbusier.

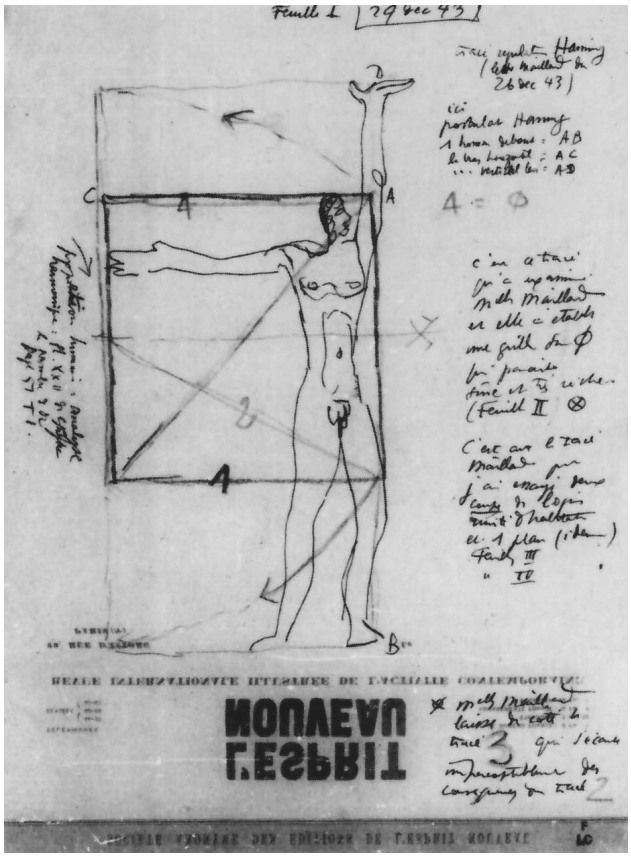

Fig. 7: Le Corbusier, sketch commenting on Gérald Hanning's early proposals, 1943, Fondation Le Corbusier.

began at that time, in which numerous collaborators and assistants were mobilized at one point or another, among whom Gérald Hanning, Elisa Maillard, André Wogenscky, Jerzy Soltan, Roger Aujame, Hervé de Looze, Jean Préveral, Marcel Py, André Maisonnier and Justino Serralta. The genesis of the system has been recounted by Le Corbusier himself in his 1950 book, and his account is in general taken at face value by most critics, with the exception of Johan Linton (2004), who has submitted this fictional account to a rigorous mathematical analysis.

The context of the German occupation of France determined this rather lengthy process in several ways. Not only were scores of architects and offices idle, but also the reconstruction programs for cities bombed in 1940 by the Germans and, increasingly, by the Allies, beginning in 1943, entailed a series of public policies through which the technocrats of the Vichy government moved forward an agenda of normalization and standardization.[9] A Commissariat à la Normalisation was established to coordinate the work of the committee for standards of the Order of Architects, the organization committee for the building trade and civil engineering, and the committee for producers of materials. Shortly after its creation, the committee for standards of the Order of Architects issued the norm NFP01–001 regarding 'modulation', which was made public in September 1942, establishing a module of then centimeters, which was the first step toward deliberate policies of modular coordination.

In *The Modulor*, Le Corbusier took great care in establishing a distance with respect to AFNOR (Association française de normalisation, or French Association for Normalization), created in 1926, which developed considerably under Vichy: 'on the day on which the first standardized construction series of AFNOR were published, our man decided to set down in concrete forms his ideas on the subject of a harmonious measure to the human scale, universally applicable to architecture and mechanics' (Le Corbusier 1956: 34). At the same time, architects started discussing the ideas of Matila Ghyka in this context, considered for instance by the architect Michel Dameron as particularly relevant to the condition of a 'renovation of architecture' (1940: 44). The research undertaken in Le Corbusier's studio thus articulated two themes that were in discussion in official and professional circles: the search for modules and serial measurements for building components, and the search for a mathematical grounding of the designs meant for reconstruction.

After having spent eighteen months trying to find support for his projects in Vichy, in March 1943 Le Corbusier created the ASCORAL, or Assemblée des constructeurs pour la révolution architecturale. This rather loose organization included a committee 3B for 'normalization and construction', and engaged its debates under the spell of some of the intellectuals whose theories had found a fertile ground under the German occupation. The most important of these was the surgeon Alexis Carrel, who

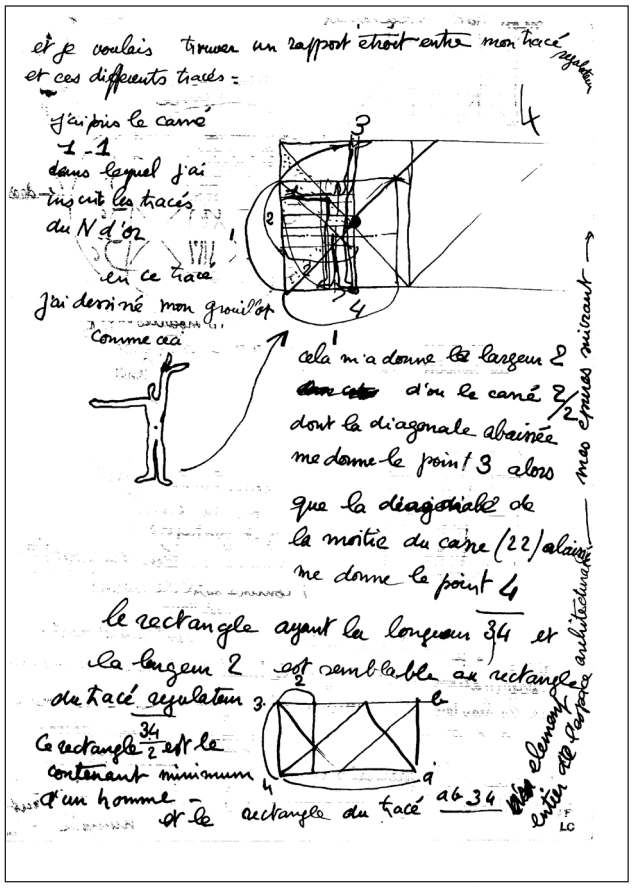

Fig. 8: Gérald Hanning, letter to Le Corbusier with an early sketch for a proportional system, 1943, Fondation Le Corbusier.

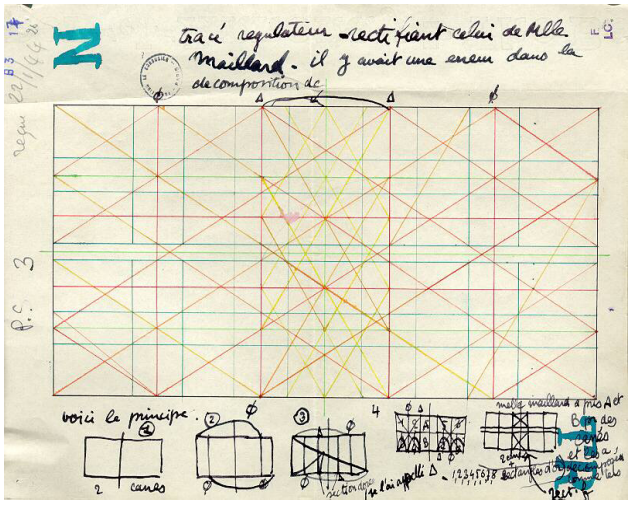

Fig. 9: Gérald Hanning, drawing correcting Elisa Maillard's proposals, 1944, Fondation Le Corbusier.

in 1935 had published the best-selling book *L'Homme, cet inconnu* (Carrel 1935). Le Corbusier was in contact with the Fondation française pour l'étude des problèmes humains, created in 1941 thanks to the support of Vichy (Drouard 1992).

Carrel's imprint can be perceived when Le Corbusier mentions in *Le Modulor* the ancient measurements related to the human body, when he evoked the 'tools' used by Egyptian, Chaldean or Greek builders:

> they were eternal and enduring, precious because they were linked to the human person. The names of these tools were: elbow (cubit), finger (digit), thumb (inch), foot, pace, and so forth. […] Let us say it at once: they formed an integral part of the human body, and for that reason they were fit to serve as measures for the huts, the houses and the temples that had to be built. (Le Corbusier 1956: 19)

The precise process leading to the creation of the system unfolded in several stages: Le Corbusier narrated in *Le Modulor* that in the summer of 1943 he instructed Gerald Hanning, according to him a 'boy', but in fact a young architect in his office, to

> set up a grid of proportions, drawn on the wall or made of strip iron, which will serve as a rule for the whole project, a norm offering an endless series of different combinations and proportions; the mason, the carpenter, the joiner will consult it whenever they have to choose the measures for their work; and all the things they make, different and varied as they are, will be united in harmony. (Le Corbusier 1956: 37)

According to Le Corbusier's 1950 account, the instructions he gave to Hanning, who was an extremely skilled draughtsman, were to

> take a man-with-arm-upraised, 2.20 m. in height; put him inside two squares, 1.10 by 1.10 metres each, superimposed on each other; put a third square astride these first two squares (**Fig. 7**). This third square should give you a solution. The *place of the right angle* should help you decide where to put this third square. // With this grid for use on the building site, designed to fit the man placed within it, I am sure you will obtain a series of measures reconciling human stature (man-with-arm-upraised) and mathematics […]. (Le Corbusier 1956: 37; italics in original)

After Hanning's initial explorations (**Fig. 8**), Le Corbusier continued the investigation with the help of art historian Elisa Maillard, then a curator at the Musée de Cluny, a place dedicated to medieval art. She had just published a book on the golden section (Maillard 1943), which included some thoughts on architecture.

As a generative principle of the measurement system he was looking for, Maillard helped him to use the Fibonacci sequence, in which every element is the sum of the two previous ones (**Fig. 9**). Finally, the young draughtsman Marcel Py, who was an avid reader of American detective stories, where handsome men were generally six foot tall, helped Le Corbusier find as the basis for the system the measure of 1.83 meter, which coincided with six feet, and allowed for a correspondence between the metric and the Imperial systems. Nonetheless, Le Corbusier would always consider the foot-and-inch system 'atrociously difficult to handle' (Le Corbusier 1956: 20).

Fig. 10: Le Corbusier showing the Modulor measuring tape, New York, 1947, Fondation Le Corbusier.

Traveling to the United States in late 1945, on board the Liberty ship *Vernon S. Hood*, Le Corbusier started measuring all the components of the freighter and had a sort of epiphany, which resulted in his conclusive sketch for the scheme. Several weeks after his return to Europe, he proposed the term 'Modulor' in February of 1946. According to him, the material form then given to the Modulor included three elements:

> (1) a strip, 2.26 m. (89 inches) long, made of metal or plastic; (2) a numerical table giving the appropriate series of values. The word 'appropriate' is meant to indicate that the measures will be kept within a practical range, the limits of which are decreed by actual perception, both visual and sensory. [...] (3) a booklet containing the explanation of the 'Modulor' and various combinations resulting from it. (Le Corbusier 1956: 61)

Interestingly, the first public presentation of the Modulor did not take place in Paris, but in New York, on April 25, 1947, when Le Corbusier was participating in the committee designing the United Nations complex (**Fig. 10**). The event was organized under the aegis of the National Convention of the American Designers' Association held at the Metropolitan Museum of Art. At that time, Le Corbusier was actively lobbying to disseminate the Modulor, for which he had filed a French patent application in May 1945, which would be granted in September 1951, after six years of consideration, under the perfectly dull and arcane title of: 'Perfectionnements apportés aux ensembles à usage humain constitués par la juxtaposition d'éléments' ('Improvements to systems meant for human usage, and based on the juxtaposition of elements'; see Petit 1996: 79–87).

On the basis of the size of the statistical median of human size, Le Corbusier determined a series of measurements, meant to define the proportions of building components, of entire structures, as well as of graphic layouts. Certain dimensions took on an almost magical meaning, such as the 2.26-meter height, corresponding to the statistical man with a raised arm, which determined the vertical dimension of the Unité d'habitation's apartments in Marseille. Multiple arrangements of rectangles were also proposed, 'to satisfy every temperament and every fancy, and to meet every purely rational need' (Le Corbusier 1956: 90). The combination of squares was considered as the basis of a 'Panel Exercise', a 'game [that] can be played indefinitely' (Le Corbusier 1956: 92). The 'master of ceremonies', whose 'task it is to introduce *true* measures into the building', considered 'the elements, specifically of the eye, which may give the master of the house a variety of visual delights'.

These included the regulating lines of the façades of the building, but also extended outwards, to incorporate nature into the system, to '[...] a pavement, a tree, a forest, a lake, a hill, peaks on the horizon, clouds and so forth' (Le Corbusier 1956: 76–80) (**Fig. 11**).

Le Corbusier's first major postwar commission, the Unité d'habitation in Marseille, designed and built from 1946 to 1952, was used as a full-size laboratory, both in the design process and during construction, when a 'stele of the measure' in concrete was erected on the site. The Modulor was also quickly experimented with in other types of productions, beginning with printed materials laid out in Le Corbusier's office, such as the special issue of *L'Architecture d'aujourd'hui* devoted to his oeuvre in 1948. The presentation grid he proposed to the International Congresses of Modern Architecture (CIAM), upon their sixth meeting in 1947, and which he tried to have endorsed by the organization, was generated by the Modulor. In a more private sphere, Le Corbusier used it for both his refuges.

The 'petit atelier' he built inside his Parisian office at 35 rue de Sèvres was a cube using the 2.26-meter measurement (**Fig. 12**), and the 'petit cabanon' he built in Roquebrune Cap-Martin for his summer holidays measured 3.36 x 2.26 x 2.26 meters.

Le Corbusier made compelling, and almost compulsive, attempts at measuring every object he met with his strip, from contemporary buildings to ancient ones. He returned to the early sketches of his journey to the East, feigning to discover Modulor-like proportions in the plans he had made of Greek or Roman ruins, but no more than in *Vers une architecture* did he credit any other architects for the exploration of the issue of proportion, except 'Thorn Brick'. Even before the publication of his book in 1950, he had engaged a marketing and communication campaign, mobilizing in New York the Greek architect Stamo Papadaki and in Europe Jerzy Soltan, a former Polish assistant of his, who wrote about the Modulor in *Domus* (Soltan

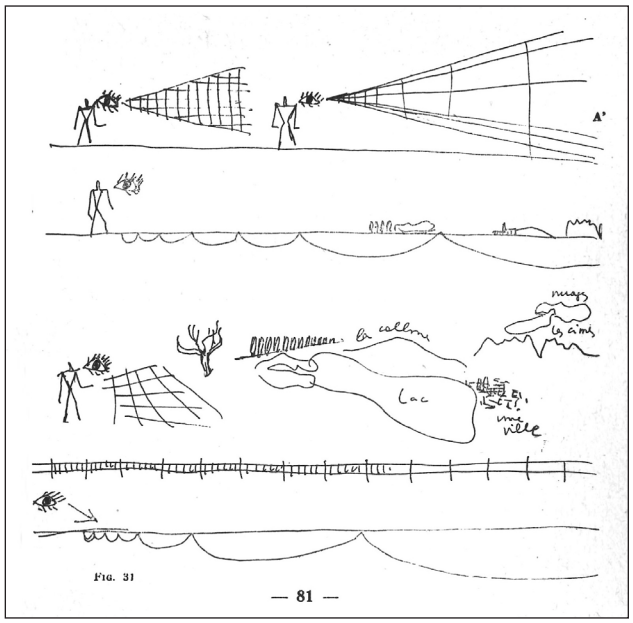

Fig. 11: Le Corbusier, proportions used to measure landscape, in *Le Modulor*, 1950.

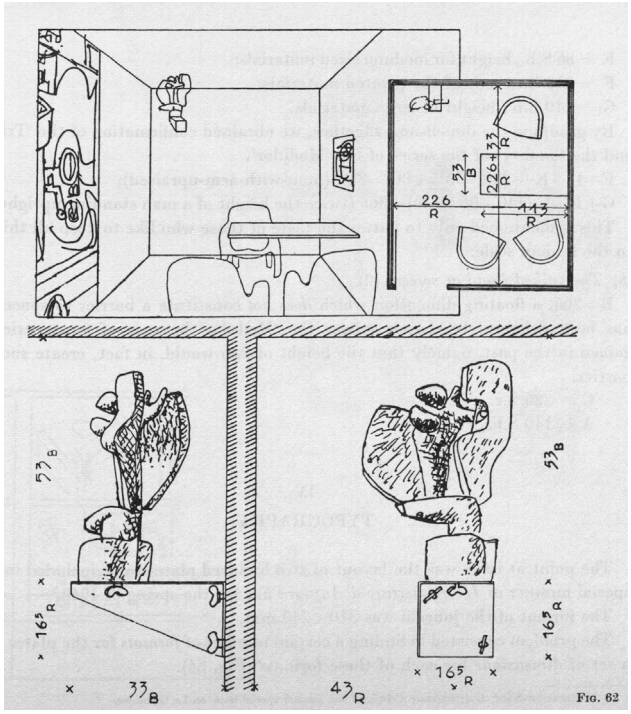

Fig. 12: Le Corbusier, 'Petit atelier', 35 rue de Sèvres, Paris, in *Le Modulor*, 1950.

1948). Matila Ghyka shared his own positive appreciation with the readers of London's *Architectural Review* (Ghyka 1948).

In 1948, in François Le Lionnais' book *Les grands courants de la pensée mathématique*, Le Corbusier published an essay in which he announced the 'discovery' he had made on board the *Vernon S. Hood*, with the following justification:

> I feel inseparable from the idea of proportioning, and both my mind and my hand continue to deal with it. In architecture, regulating lines; painting as well. You can acquire such mastery in this plastic mathematics that you are freed from having to make calculations and diagrams; your hand automatically performs them. It is the task of our modern world to dispose of arbitrary metric measurements in construction and replace them with the remarkable resources of numbers, and in particular the fruitful and inexhaustible golden section. (Le Corbusier 1948: 490)

In the end, the book published in 1950 recast the edifying story of the invention and development of the Modulor, recording only the precedents Le Corbusier considered relevant. At the same time, the question of proportions had become a central issue in the postwar French reconstruction, as architects struggled to keep their status in the process of a modernized building production in which standardization and modularity were fundamental strategies. Figures like Auguste Perret and André Lurçat, both of them rivals of Le Corbusier, also engaged in reflections on proportions, respectively in Le Havre and Maubeuge.

In *Formes, compositions et lois d'harmonie*, a theory manual Lurçat had written during the war after returning from three years spent in Moscow, where he had started reevaluating Modernism and reconsidering history and theory, Lurçat devoted significant space to the question of proportions (**Fig. 13**). He based his reflections on the theories of Moessel, discovered thanks to the German art historian Max Raphael, who had taught in his short-lived atelier in the 1930s, and also through the writings of French philosopher Charles Lalo (1925). Lurçat's materialist take is obvious when he draws a picture of the theories available for the understanding of proportions, in which he sees the vectors of 'harmony'. As their ultimate end is to be built, harmonic diagrams must, according to him, be implemented with elementary tools, such as the cord, thus excluding complex geometric shapes and systems based on arithmetic figures, in favor of a 'geometry of the circle'. Relying on Lalo's reading of the German theories of the golden section, he insisted on the material condition in which proportions were perceived (Lurçat 1957, 5: 65–67).

Discussing most of the theorists who had reflected on the theme of proportions, from Vitruvius to Borissavliévitch, Lurçat proposed a method of his own, based on simple operations executed on the building site by the architect, with a circle, and by the contractor, with a cord, to create polygons inscribed in circles, the lengths of which are related to the latter's radii. Hence, if Lurçat aspired to 'establishing automatically harmonious relationships' between the buildings' plans and elevations, it is not without a certain 'approximation' that he considers legitimate in a system which 'no longer requires the absolute servitude, which, in past times, was important to have its necessity acknowledged' (Lurçat 1957, 5: 250).

In addition to Lurçat, other architects contributed to the discussion opened in France. Amongst them was Alfred Neumann, a former student of Perret in Paris, who

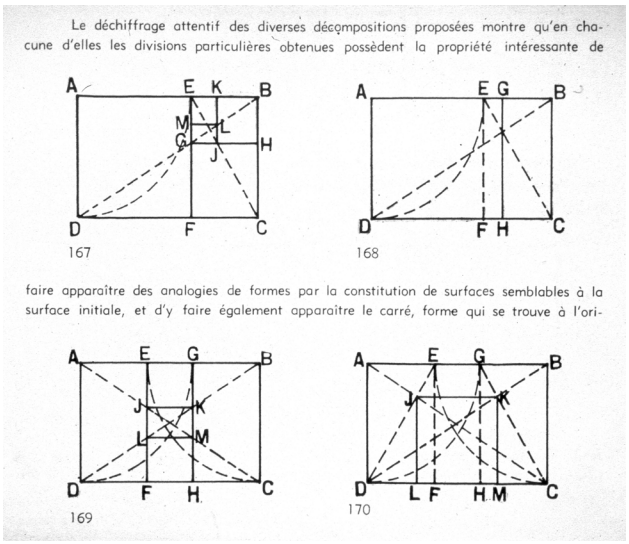

Fig. 13: André Lurcat, the golden section as featured in *Formes, composition et lois d'harmonie*, 1953.

Fig. 14: Alfred Neumann, *L'Humanisation de l'espace*, 1956.

had emigrated to Palestine, where he taught at Haifa's Technion. In 1956 he published in French a book entitled *L'Humanisation de l'espace*, in which he proposed his own general interpretation of proportional grids (**Fig. 14**). Considering that the golden section, which offered 'the greatest number of combinations', could become 'the instrument of a synthesis', he suggested an extension of it (Neumann 1956: 11). Considering that the 'diverse organs and functions of the human body are articulated in an integrated system of proportions', he strove to achieve the 'humanization of space' through the 'articulation of the most heterogeneous elements of our habitat with an analogous structure' (Neumann 1956: 7). Neumann's efforts were infinitely more prosaic than Le Corbusier's, and have to be perceived in the context of the massive production of postwar housing, which prompted the search for an alternative to the hegemony of AFNOR's specifications.

One of the conclusions of the Milan conference of 1951 was the creation of a Comitato internazionale di Studio sulle Proporzioni nelle Arti, which immediately elected Le Corbusier as its president. But the attention of the Paris architect seems to have been rather limited during the conference itself. In his pocket sketchbook, Le Corbusier took only three pages of notes, apparently reacting to the contribution of Charles Funck-Hellet on 'La Proportion divine dans la peinture de la Renaissance italienne,' which remarked on the development of Titian. He wrote down his intention of 'asking Funk in Paris what he understood by the T-square of the Italian builders' (*Le Corbusier Sketchbooks* 1981, 2 [sketchbook E 22]: 558; see also Funck-Hellet 1932). What his notes convey is the frustration left by his New York adventure. He was still in a ruminating mood, not complaining for having been excluded from the design process of the United Nations complex, but reproaching the Americans for not having used his system: 'Harrison wanted to have nothing to do with the modulor, hence he lost the opportunity of not making mistakes' (*Le Corbusier Sketchbooks* 1981, 2 [sketchbook E 22]: 556). He would entertain a hope of revenge with a second conference then planned in New York, for which Sigfried Giedion proposed as a theme 'Proportion et Réalité'. Le Corbusier would report in 1955 that the theme selected for further discussion was 'Harmony' (Le Corbusier 1955: 153–155). In the months following the Milan event, he engaged in a correspondence relative to the Comité provisoire d'étude et d'application de la proportion dans les arts et la vie contemporaine.[10]

Five years after his first tome, Le Corbusier published *Le Modulor 2*, with the subtitle 'Let the user speak next', a rare attempt at recording the feedback about one of his creations (**Fig. 15**). In this volume, he collated letters of support from engineers and architects, and declarations by celebrities such as Albert Einstein, who had kindly affirmed, 'it is a scale of proportions which makes the bad difficult and the good easy' (Le Corbusier 1955: 58–59; 1956: 58). He also included some negative feedback, such as a perplexed letter sent to him by Le Lionnais following the 1951 Milan Triennale, where the mathematician expressed his doubts about the relevance of the golden section (Le Corbusier 1955: 145–146). And he reproduced the mocking postcard of his fellow countryman of La Chaux-de-Fonds, poet Blaise Cendrars, who had written him: 'I don't give a hang for your Modulor. It must be wrong because nowhere in the world can one find a flat' (Le Corbusier 1955: 160).

Stuffed with justifications found in Le Corbusier's works built after 1950, the second volume showed that the Modulor had by then become an instrument with which Le Corbusier tried to maintain his hegemony over postwar production, by becoming a sort of master of measure. A third volume planned in the late 1950s remained in limbo. At any rate, the Modulor allowed Le Corbusier to maintain control of the design work his office was developing, with an increasing number and magnitude of commissions, from the Capitol Project of the new Indian capital city of Chandigarh, to the convent at La Tourette, where Xenakis

Fig. 15: Le Corbusier, *Le Modulor 2*, 1955.

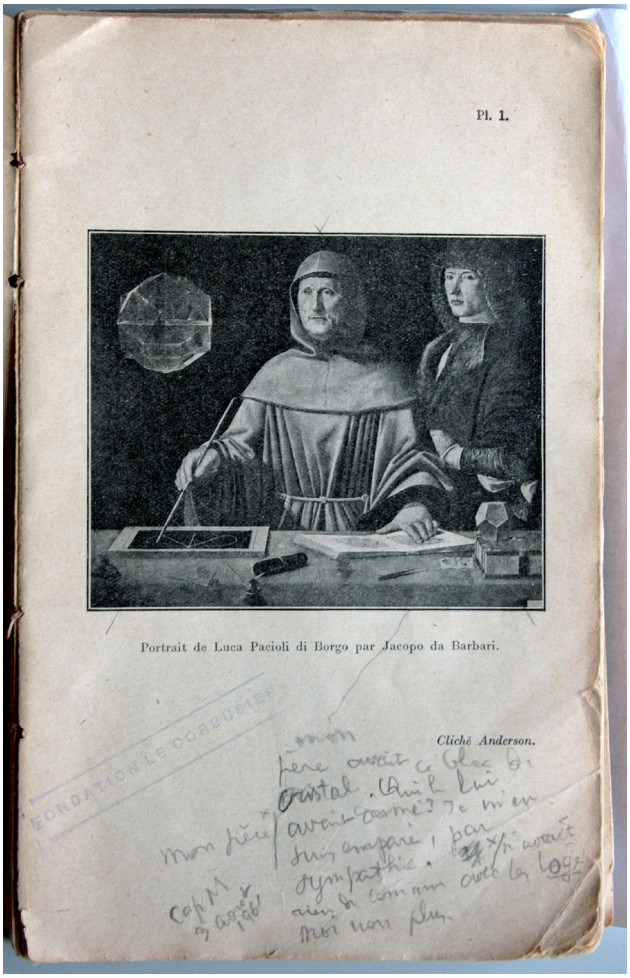

Fig. 16: Le Corbusier, handwritten notes in Matila Ghyka's *Esthétique des proportions*, Fondation Le Corbusier.

used the measurement charts to create 'undulating' walls of glass, in which the panels' width was based on a range of Modulor sizes.

A final episode to an intrigue that had lasted for thirty years occurred in the summer of 1961, when Le Corbusier reread his copy of Ghyka's *Esthétique des proportions* while staying in his shack facing the Mediterranean. On the page containing a reproduction of Jacopo de' Barbari's painting of Luca Pacioli a propos the crystal featured on the upper left corner of the picture, he wrote, 'My father had this block of crystal. Who gave it to him? I am filled with sympathy. My father had nothing to do with the Freemasons. Me neither'.[11] (**Fig. 16**) With this statement, he tried at once to dismiss the rumors concerning his affiliation with occult societies that his passion for the golden section had generated, and to insist on the rational, objective character of his approach to a problem that had mobilized his energy for so much time.

Appendix 1

A Timely Book (1927), by Le Corbusier

Translated by Genevieve Hendricks[12]

After 1925, we saw the collapse of the 'Decorative Arts'. Concerns of a more rational order have led the 'decorators' to other work (the word itself devoid of airs tends to fade).

Simple appearances, mechanized appearances, multiply around us, and a general progression toward architecture is proposed to our eyes, rather than 'moving' decoration (doves, etc.), forms where geometry reigns; a sudden tiredness occurs in this way: abandon one formula to adopt another and exhaustion quickly arrives, fashion fades, because the simple aspects given by geometry situate the question on a higher ground where the 'recipe', contrary to appearances, is no longer a given.

So, some, having accepted this present stage of 'simplicity' as a purge they had been administered, have let the fortune tellers announce that a new ornament, a new décor are imminent: we have tolerated undressing a little bit, but simply in order to change jackets.

Let us admit that the intense, total revolution incited by the machine has given us a new conception. It creates for us a new spirit.

The current architectural phenomenon established on astounding technical acquisitions (in the annals of architecture — construction in metal being admitted as a corollary — reinforced concrete introduced in a perfect way the rigorous classification of static problems and their exact solution through calculation) expressed by means of the purest geometry (the execution of reinforced concrete proceeds only through surface and the volumes of straightforward geometry), the modern architectural phenomenon brings us to the heart of the mathematic domain.

And it is there that, according to the quality of the spirit that animates them, those who await the next décor and those who pursue the pure expression of the present age will be separated.

Nature is revealed to us in its mathematics more and more every day by science and its popularization.

The fundamental reasons for the arts of the past begin to appear to us with strangely precise causes, conditioned

by true relations. For years we have perceived and sought regulating lines.

Now there is a book: *Ésthétique* of Mr. Matila Ghyka at the N.R.F. filled with schemas deploying the elegant game of algebra. Read this book, take it in, and reflect on each case, it is fairly short and deep enough to give you the key to the world.[13] Scholars side by side are discovering a principle, a hypothesis: the principle of harmony.

(Law) in the natural phenomenon — the hypothesis on the constancy of these principles. This mathematics finds its expression in algebra, and it draws on geometry. The spirit of man and his inexorable constructions, nature — plants, the human body, the movement of the stars, etc. — constantly meet and overlap on precise formulas which are the formulas of greater efficiency, inevitable functionality, more beautiful proportion. The 'divina proportione' appears in mathematical relationships that are one and all, in whole and in part, in the facts and in the hypothesis, in the calculation, in geometry, in natural objects and in the paintings and architecture of major epochs (the Egyptians, Greeks, the Gothic, the Renaissance, French Classicism, etc.).

Simplicity? The great pyramid scrutinized by scholars reveals to us a staggering scientific potential. Here we are very far away from the very idea of décor. Everything is proposition and a radiating light, because everything exists in quantities and relationships. Our judgment established on relationships. Our emotion born of the harmonious quality of these relationships. Proportion, divine proportion. And the natural world that surrounds us, and the creative world of man issuing forth from the mind, are walking hand in hand on the same line of harmony: the one explains the other, expresses the other, united.

This is where the architectural evolution born from scientific discovery leads us, guided by the mathematical spirit, which animates our time. This is where this book revealing the laws of our being and of our world brings us.

Recipes? Less than ever! The mathematic spirit opens its limitless fields to the imagination. By writing this book, Mr. Ghyka offered us something similar to the skull that Hamlet held in his hands.

Le Corbusier

[Un livre opportun][14]

On a vu s'effondrer après 1925, les «Arts décoratifs». Des préoccupations d'ordre plus rationnel ont incliné les «décorateurs» vers d'autres travaux (le mot lui-même, dépourvu d'affectation tend à s'effacer).

Des aspects simples, des aspects mécanisés se multiplient autour de nous, et une évolution générale vers l'architecture propose à nos yeux, au lieu des décors "émouvants" (Colombes, etc.) des formes où la géométrie règne; le coup de barre est donné dans ce sens: on quitte une formule pour en saisir une autre, l'épuisement ici aussi viendra plus rapide encore, la mode durera moins, car les aspects simples portés par la géométrie situent la question sur un terrain autrement plus élevé, ou la "recette" contrairement aux apparences, n'est plus gratuite.

Alors, d'aucuns, ayant admis comme une purge qui leur fut administrée, ce stade actuel de la "simplicité" font annoncer par les augures, qu'un nouvel ornement, un nouveau décor sont imminents: nous avions bien toléré de nous dévêtir un peu, mais simplement aux fins de changer de veste.

Admettons que la profonde, totale révolution fomentée par la machine nous a dotés d'une autre conception. Elle nous a forgé un autre esprit.

Le phénomène architectural actuel établi sur des acquisitions techniques bouleversantes (dans les annales de l'architecture, - la construction métallique étant admise comme un corollaire - le béton armé introduit d'une façon idéale la classification rigoureuse des problèmes statiques et leur exacte solution par le calcul), et exprimé par la plus pure géométrie (l'exécution du béton armé ne procède que de surface et de volumes de géométrie simple), le phénomène architectural moderne nous introduit au cœur du domaine mathématique.

Et c'est là que, suivant la qualité d'esprit qui les anime, se partageront ceux qui guettent le prochain décor et ceux qui poursuivent l'expression pure de l'époque présente.

La nature nous est révélée dans sa mathématique tous les jours davantage par la science et sa vulgarisation.

Les raisons fondamentales des arts du passé commencent à nous apparaître avec des causes étrangement précises et conditionnées par des rapports exacts. Depuis des années nous avons perçu et cherché les tracés régulateurs.

Or voici un livre: Ésthétique de

Mr. Matila Ghyka

à la N.R.F.

bourré de schémas et où se déploie le jeu si élégant de l'algèbre. Lire ce livre, le reprendre par dedans, réfléchir sur chaque cas, c'est assez succinct et assez profond pour vous donner la clef du monde. Les savants les uns à côté des autres découvrent un principe, [sentent] une hypothèse: principe d'harmonie

(Loi) Dans le phénomène naturel, - hypothèse sur la constance de ces principes. Cette mathématique trouve son expression dans l'algèbre, et de suite elle se dessine par la géométrie. L'esprit de l'homme et ses constructions fatales, la nature, les plantes, le corps humain, le mouvement des astres, etc, — se rencontrent et se recoupent constamment sur des formules précises qui sont des formules de plus grand rendement, de plus fatal fonctionnement, de plus belle proportion. La "divina proportione" apparaît au sein de rapports mathématiques qui sont un et tous, dans l'entier et dans la partie, dans les faits et dans l'hypothèse, dans le calcul, dans la géométrie, dans les objets naturels et dans les tableaux, les architectures des grands époques. (les Égyptiens, les Grecs, les Gothiques, la Renaissance, le classicisme français, etc.)

Le Simple? La grand pyramide, scrutée par les savants, nous révèle un effarant potentiel scientifique. Que nous voici loin de l'idée même d'un décor. Tout est proposition et une lumière irradiée, car tout est quantités et rapports. Notre jugement établi sur des rapports. Notre émotion nait de la qualité harmonieuse de ces rapports. Proportion, divine proportion. Et le fait naturel qui nous entoure, et le fait créatif de l'homme sorti de notre cerveau marchant de pair, sur la même ligne d'harmonie : l'un explique l'autre, exprime l'autre dans l'unité.

Voilà où nous conduisait l'évolution architecturale née des découvertes scientifiques, guidée par l'esprit mathématique animant l'époque. Voici où nous arrête ce livre de la révélation des lois de notre être et de notre monde.

Des recettes? Moins que jamais! L'essence mathématique ouvre à l'imagination ses champs illimités. En écrivant ce livre, M. Ghyka nous offrait quelque chose d'analogue à ce crâne qu'Hamlet tient dans ses mains.
Le Corbusier

Appendix 2

Regulating Lines (1934), by Le Corbusier

Translated by Matthew A. Cohen and Maarten Delbeke

(regarding the reissue of *L'Ésthetique des proportions dans la nature et dans les arts* [*The aesthetics of proportions in nature and the arts*])

(by Matila Ghyka)

This book appeared in 1927, followed by the two-volume *Le Nombre d'or* [*The Golden Number*] and had a happy life; it sold out much more quickly than expected.[15]

It is the case that important problems concern young architects and that the position of necessity in which they find themselves of having to create an entirely new architecture puts them in a sometimes harrowing position of deprivation. Until now our good teachers used to teach us the 'rules of architecture'; it was 'the three orders of architecture' of Mr. Vignola. Happy times when imaginative needs were sometimes limited to pulling recipes from a drawer.

And now M. Ghyka has nearly played the role of Mr. Vignola! He has furnished recipes! But let's be serious: he has opened wide a window onto an attractive and perilous landscape.

Actually, there is, in the search for laws of proportion, the most honest and the most loyal demonstration of that to which an artist can devote himself. I place the architect of today in the camp of the artists. By this I mean to convey that beyond the countless practical tasks he is obliged to carry out it is an imperative necessity to create grace, that is to say, proportion.

Because proportion brings about grace. What then is this proportion?

Proportion is to confer the principle of unity upon multiple organs of a construction. This unity can apply to the most immediate perception, such as that of the facade, up to a deeper perception, provided by the plan and section. The past leaves us examples of this profound and radiant unity. Proportion may extend its effects infinitely far, because here, as in all areas of art, it is about the fairness of the game, the richness of the established game, and 'the spirit' that one brings to setting the rules of the game.

On a purely plastic level, regulating lines, already, can bring the benefits of order, and tear us away from the inconsistency of perforated 'soap boxes' that young architects unfortunately have made us accustomed to (very quickly, unfortunately) and who have rushed toward modernism with the dangerous illusion that the simple was the sparse.

So M. Ghyka again gives us, in a volume of four hundred pages, regulating lines used in all epochs. He thus offers us the fruits of knowledge of the illustrious ancients. These questions of regulating lines, which often refer to higher mathematics, represent precious crystallizations of thought; once these truths constituted the occult baggage transmitted by secret societies: one did not want to defame matters of the spirit by 'casting pearls before swine'.

Let us admit, then, that today when a whole new era of civilization prodigiously opens up, this occultism becomes annoying, even disturbing; and that it is better to speak frankly, and to speak over the waves this book emits to those unknown people who are one knows not where; and who will discover, one knows not when, the wealth contained in the book.

That the simple-minded, the pedants, the idiots, cover their pitiable architectural drawings with hermetic diagrams and without links to any reality, so what? Wisdom is for the wise. This is true of all things.

Let us say simply that the material popularized by M. Ghyka is of such a noble and remote nature that it imposes much work and requires a certain intellectual resonance on the part of he who searches here for a truth.

The world of artists has strongly protested against the dissemination of regulating lines in the last few years. It favors the touching naïvete and sublimity of ignorance. A thousand regrets. At least in our profession of architect we are committed to a more difficult effort.

Thus, the new edition of *L'Ésthetique des proportions dans la nature et dans les arts* will make its way around the world, creating pedants and nourishing avid minds.
Le Corbusier
24 February 1934

Tracés Régulateurs[16]

(à propos de la réédition de *L'Ésthetique des proportions dans la nature et dans les arts*)

(par Matila Ghyka)

Ce livre a paru en 1927, suivi des deux volumes *Le Nombre d'or* il eut une vie heureuse; il fut épuisé beaucoup plus rapidement qu'on eut pu le supposer.

C'est donc que les problèmes de qualité inquiètent les jeunes architectes et que la nécessité dans laquelle ceux-ci se trouvent de devoir créer de toute pièce une architecture nouvelle, les met dans une situation de dénuement parfois angoissant. Jusqu'ici nos bons maîtres nous apprenaient les 'règles de l'architecture'; c'était 'les trois ordres de l'architecture' de Monsieur Vignole. Temps heureux où les nécessités imaginatives se limitaient quelques fois à prendre des recettes dans un tiroir.

Et voici que M. Ghyka a joué presque le rôle de Monsieur Vignole! Il a fourré des recettes! Mais, soyons sérieux: il a ouvert grandement une fenêtre sur un paysage attirant et périlleux.

En effet, il y a, dans la recherche des lois de la proportion, la plus honnête et la plus loyale manifestation à laquelle un artiste puisse se vouer. Je place l'architecte d'aujourd'hui dans le camp des artistes. J'entends exprimer par là qu'au delà des innombrables tâches d'ordre pratique qu'il est obligé d'accomplir, s'inscrit comme une

nécessité impérative celle de faire de la grâce, c'est-à-dire de la proportion.

Car la proportion apporte la grâce. Qu'est-ce donc que la proportion?

La proportion, c'est de conférer aux multiples organes d'une construction le principe de l'unité. Cette unité peut aller de la perception la plus immédiate qui est la façade, jusqu'à celle beaucoup plus profonde qui est fournie par le plan et la coupe. Le passé nous laisse des exemples d'une telle unité profonde et rayonnante. La proportion peut étendre ses effets infiniment loin, car ici, comme en tous les domaines de l'art, c'est de la justesse du jeu qu'il s'agit, de la richesse du jeu instauré, de 'l'esprit' qu'on apporte à fixer les règles du jeu.

Sur le plan exclusivement plastique, le tracé régulateur, déjà, peut apporter les bienfaits de l'ordre et nous arracher à l'incohérence des 'caisses à savons' perforées auxquelles nous ont accoutumés hélas (bien vite, hélas), tant de jeunes architectes qui se sont précipités vers le modernisme avec l'illusion dangereuse que le simple c'était l'indigent.

Donc M. Ghyka nous donne á nouveau dans un volume de quatre cents pages, des tracés régulateurs employés à toutes les époques. Il nous offre ainsi le fruit de la connaissance d'illustres anciens. Ces questions de tracés régulateurs, qui se réfèrent souvent aux mathématiques supérieurs, représentent des cristallisations précieuses de la pensée; autrefois ces vérités constituaient le bagage occulte transmis par les sociétés secrètes: on ne voulait pas vilipender les choses de l'esprit en 'jetant ses perles aux pourceaux.'

Admettons donc qu'aujourd'hui où s'ouvre si prodigieusement une ère toute neuve de civilisation, cet occultisme devienne gênant, même inquiétant, et que mieux vaut parler franchement et s'adresser par les ondes qu'émet le livre à ces inconnus qui se trouvent on ne sait où et qui découvriront on ne sait quand cette richesse contenue dans le livre.

Que des simples d'esprit, que des pédants, que des idiots couvrent d'épures hermétiques et sans raccords avec aucune réalité leurs pauvres tracés architecturaux, qu'importe? La sagesse est pour les sages. Il en est de toutes choses ainsi.

Disons simplement que la matière vulgarisée par M. Ghyka est de nature si noble et si distante qu'elle impose beaucoup de travail et réclame une certaine résonnance intellectuelle de celui qui vient y chercher une vérité.

Le monde des artistes a beaucoup protesté contre la divulgation des tracés régulateurs en ces dernières années. Il plaide la naïveté touchante et le sublime de l'ignorance. Mille regrets. Du moins dans notre métier d'architecte sommes-nous tenus à un effort plus difficile.

Ainsi, la nouvelle édition de *L'Ésthetique des proportions dans la nature et dans les arts* s'en ira-t-elle par le monde, faisant des pédants et nourrissant des esprits avides.

Le Corbusier

24 Février 1934

Notes

[1] Le Corbusier, 'Conférence de Milan', 1951; FLC [Fondation Le Corbusier, Paris], U3–10-282, p. 1. On the conference itself, see Irace and Cimoli (2007). All translations by Genevieve Hendricks.

[2] Hendrik Petrus Berlage, letter to Le Corbusier, 30 December 1923; FLC, E1(7)11.

[3] Le Corbusier, letter to Hendrik Petrus Berlage, 11 January 1924; FLC E1–7-113.

[4] Le Corbusier, 'Conférence de Milan', 1951, FLC, U3–10-282, pp. 2–3. A two-page preparatory handwritten note can be found in his archives: FLC U3–10-335. He is referring to Choisy (1899). See Irace and Cimoli (2007: 92).

[5] For Ghyka's subscriber's record, see FLC A2–8-289. Matila Ghyka, letter to the editor of *L'Esprit nouveau*, March 18, 1925, FLC A1–8-307.

[6] Le Corbusier, 'Un livre opportun', FLC A3–1-50 (manuscript) and A3–1-52 (typescript).

[7] Le Corbusier, 'Tracés régulateurs (à propos de la réédition de *L'Esthétique des proportions dans la nature et dans les arts* par Matila Ghyka,' typescript, February 24, 1934, FLC U3–5-191.

[8] On Paul Valéry's relationship to architecture, see Maak (2011).

[9] See the issue on 'Normalisation' of *Techniques et Architecture*, vol. 3(1–2), 1943.

[10] See the materials contained in the box at FLC: U3–10.

[11] Le Corbusier, handwritten note on Ghyka (1927: pl. 1), FLC, personal library of Le Corbusier.

[12] This translation is based on a manuscript draft of this essay composed on the *verso* of blank pieces of letterhead from the journal *L'esprit nouveau* (FLC A3–150). An untitled, four-page typescript of the same essay is conserved at the Fondation Le Corbusier, Paris (FLC A3–152, A3–153, A3–154, and A3–155). A transcription of this typescript appears after this translation of the manuscript. See also note 14.

[13] Le Corbusier refers to Matila Ghyka's book that was published in 1927: *Esthétique des proportions dans la nature et dans les arts* (Paris: Gallimard).

[14] The title has been added for clarity. This typescript varies in minor ways from the original handwritten manuscript on which the translation is based.

[15] Le Corbusier refers to Matila Ghyka's books of 1927, *Esthétique des proportions dans la nature et dans les arts* (Paris: Gallimard (reprint 1934)) and of 1931, *Le Nombre d'or: Rites et rythmes pythagoriciens dans le développement de la civilisation occidentale* (2 vols, Paris: Gallimard).

[16] Typescript, FLC U3–5-191. Le Corbusier's numerous hand-written corrections made in the typescript have been incorporated into the following transcription and translation, made by Matthew A. Cohen.

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