THE MODULOR

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A Harmonious Measure to the Human Scale Universally applicable to Architecture and Mechanics

by

LE CORBUSIER

Translation from French into English: Peter de Francia and Anna Bostock

A CIP catalogue record for this book is available
from the Library of Congress, Washington D.C., USA

Deutsche Bibliothek Cataloging-in-Publication Data

LeCorbusier:
The modulor / by LeCorbusier. [Transl. from French into Engl.:
Peter de Francia and Anna Bostock]. - Basel ; Boston ; Berlin : Birkhäuser
Einheitssacht.: Le modulor <dt.>
Franz. Ausg. u.d.T.: LeCorbusier: Le modulor
1. A harmonious measure to the human scale universally
applicable to architecture and mechanics. - Facs.-ed. of the 1. Engl. orig. ed., 1954. - 2000
ISBN 3-7643-6188-3 (Basel...)
ISBN 0-8176-6188-3 (Boston)

Reprint, 2004

Reimpression of the first English edition published in 1954 by Faber and Faber.

This book is also available in a French language edition (ISBN 3-7643-6187-5).

Printed on acid-free paper produced from chlorine-free pulp. TCF ∞
Printed in Germany
ISBN 3-7643-6188-3 (two volumes in slipcase)
ISBN 0-8176-6188-3 (two volumes in slipcase)

9 8 7 6 5 4 3 2

INTRODUCTION TO THE SECOND EDITION

The first edition of the MODULOR *was sold out very quickly. The* MODULOR *has had a friendly reception throughout the world. Architects everywhere have recognized in it, not a mystique, but a tool which may be put in the hands of creators of form, with the simple aim, as Professor Einstein has put it so well, of 'making the bad difficult and the good easy'. The* MODULOR *is a scale. Musicians have a scale; they make music, which may be trite or beautiful.*

A significant event occurred just as the first edition of the MODULOR *was sold out: at the ninth Triennale in Milan, a book exhibition was organized with the assistance of the Italian National Libraries and of the Bibliothèque Nationale of Paris. The purpose was to compare the studies carried out in different countries through the ages in the search for the disciplines which are at the root of every plastic work, both artistically and scientifically.*

Thus it was possible to see together for the first time the works of Villard de Honnecourt (thirteenth century), Francesco di Giorgio, Piero de la Francesca, and the original editions of Luca Pacioli, Dürer, Alberti, Delorme, Campano, Barbaro, Cousin, Serlio, Palladio, Leonardo, Galilei, Descartes, etc. . . and also the highly up-to-date works of Speiser, Kayser, Wittkower, Lund, Ghyka, etc.

This exhibition ended with a graphic demonstration of the MODULOR, *at the request of the President of the Triennale, Signor Ivan Matteo Lombardo. 'The* MODULOR,*' he wrote, 'is the pivot around which revolve all the problems of proportion in modern architecture.'*

From the 26*th to the* 29*th of September,* 1951, *the Triennale organized the First International Meeting 'De Divina Proportione', attended by scholars, mathematicians, aestheticians, architects and artists from all continents. The 'International Meeting' decided, before it closed, to set up a permanent study group to continue its work and bring it to fruition. The author of this book was chosen to be the chairman of that group. At the same time, the Museum of Modern Art in New York announced by cable its intention of holding the second 'International Meeting on Proportion' in New York.*

Between the publication of the first edition of the MODULOR *and these recent events, there has been a great deal of participation by the readers; many comments, proposals and counter-proposals, criticisms and items of information have been received from all parts of the world in response to our conclusion of the first edition, in Chapter* 8: *'Let the user speak next!' We believe this participation of the public to be of very great importance, and, furthermore, we ourselves have applied the* MODULOR *since* 1948 *to large-scale works of urbanism, architecture and plastic art in Europe and America. Other technicians, too, have applied the* MODULOR *in noteworthy ways.*

We have therefore decided, in agreement with the publisher, to prepare for publication a new volume entitled MODULOR 2. *The door has not been opened in vain upon this wonderfully human problem of harmony achieved through relationships of dimensions. This kind of idea had disappeared from the stock-in-trade of the professionals, or else it had become esoterical, shrouded in mysticism. We hope that* 'MODULOR 2', *with the readers' help, will continue to develop this subject, so intimately linked to the problems of our day.*

Paris, the 8*th October*, 1951

LE CORBUSIER

CONTENTS

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(1) The table of numerical values of the MODULOR is on p. 82.

TO THE READER

1. *The word 'Architecture' here covers:*

The art of building houses, palaces and temples; ships, cars, railway trucks and aeroplanes.

Domestic and industrial equipment and the equipment of trade.

The art of typography as it is used in the making of newspapers, periodicals and books.

The word 'Mechanics' covers the construction of machines that owe their being directly to the hand of man, and the spaces which surround them. It implies that a motivated (not an arbitrary or an approximate) choice is made in determining the dimensions of the various parts which go into the construction of a machine.

2. *The life of human beings is not encyclopaedic but personal. To be encyclopaedic is to remain unmoved when faced with the multitude of facts and ideas which make up life; it is to recognize them, know them and classify them. Some men cannot remain unmoved in the face of life; instead, they throw themselves into it heart and soul. The only thing this book claims to do is to retrace, step by step, the course of a search running like a thread through the life of one man. If this search has been crowned by a solid achievement, it is because a personality—an environment—a way of life—a passion—a set of circumstances—have fitted together into a continuous chain stretching unbroken through the tumults of life, which are circumstance—passion—conflict—rivalries—the decline of some things and the rise of others—special conditions—perhaps even revolutions—and so on and so forth.*

The very opposite of an encyclopaedic bookshelf, where volumes of wisdom are tidily ranged.

PART 1

SETTING THE STAGE
THE BACKGROUND
AND
THE NATURE OF THE SEARCH

Chapter 1
Preamble

Past decisions—customs—habits—all these stay with us through the most overwhelming events, disturbing, constricting, wantonly interfering with the free play of the mind. We pay no attention to hindrances of this kind; yet a simple adjustment at the root of the trouble might change everything, opening the doors of the mind to the free flow of the imagination. Customs turn into habits, some modest, some all-powerful; and no one, in the midst of the exhausting conflicts of life, will realize that a simple decision can sweep away the obstacle, clearing the path for life. Yes, quite simply, for life.

Sound is a continuous phenomenon, an uninterrupted transition from low to high. The voice can produce and modulate it; certain instruments can do the same, the fiddle for example, or the trumpet; but others are incapable of it because they are based on an order of artificial intervals invented by man: the piano, the flute, etc.

For thousands of years men used sound to sing, or play, or dance. That was the first music, transmitted by the voice, no more.

But one day—six centuries before Christ—someone first thought of making music permanently transmissible in another way than from mouth to ear: that is, to write it down. No method or tool was available for this. Sound had to be registered at certain determined points, its perfect continuity being destroyed in the process. It was necessary to represent sound by elements which could be grasped, breaking up a continuous whole in accordance with a certain convention and making from it a series of progressions. These progressions would then constitute the rungs of a scale—an artificial scale—of sound.

How to divide into sections the continuous phenomenon of sound? How to cut up sound in accordance with a rule acceptable to all, but above all efficient, that is, flexible, adaptable, allowing for a wealth of nuances and yet simple, manageable and easy to understand?

Pythagoras solved the problem by taking two points of support capable of giving both certainty and diversity: on the one hand, the human ear, the hearing of human beings (as opposed to the hearing of wolves, lions or dogs); on the other, numbers, that is to say mathematics in all its forms: Mathematica, herself the daughter of the Universe.

Thus the first musical script was created, capable of encompassing sound compositions and transmitting them through time and space: the Doric and Ionic modes, which later became the source of Gregorian music, and so also of the practice of the Christian cult for all nations and languages. Apart from a somewhat unsuccessful attempt during the Renaissance, this practice was continued until the XVIIth century. Then the Bach family, and especially Johann Sebastian himself, created a new system of musical notation: the 'tempered scale', a new and more perfect tool, which gave a tremendous fresh impulse to musical composition. This tool has been in use for three centuries, and it has proved itself able to express that subtlest of things—musical thought, the thought of Johann Sebastian, of Mozart and Beethoven, of Debussy and Stravinsky, of Satie and Ravel, of the atonal composers of our own day.

It may well be—I take it upon myself to predict it—that the apotheosis of the machine age will demand a subtler tool, capable of setting down arrangements of sounds hitherto neglected or unheard, not sensed or not liked. . . . One thing remains: in the course of thousands of years, the white civilization has evolved only two tools for working in sound: sound being a continuous thing that cannot be transmitted in writing unless it is first divided into sections and *measured*.

That brings me to the theme of this work: how many of us know that in the visual sphere—in the matter of *lengths*—our civilizations have not yet come to the stage they have reached in music? Nothing that is built, constructed, divided into lengths, widths or volumes, has yet enjoyed the advantage of a measure equivalent to that possessed by music, a working tool in the service of musical thought.

Has this absence of a tool made the spirit of man any the poorer? It does not seem so, for the Parthenon and the Indian temples, the cathedrals, and all the refinements of recent human achievement, the incredible triumphs of the last hundred years, are there to mark man's progress along the path of time.

If a tool of linear or optical measures, similar to musical script, were placed within our reach, would it help in the process of construction? That is the question I am going to discuss here, first of all by telling the story of an enterprise which sought, and attained, such an object; then by describing the nature of the invention; then by contemplating it in its present-day setting and trying to see what position it occupies. Lastly, leaving all doors open, I will throw out an appeal for help: for the ground is open to all comers, the doors are opened wide, and anyone may have the power to blaze a surer, straighter trail than mine. I shall conclude with a simple affirmation: in our modern mechanized society, whose working tools are being perfected day by day to supply mankind with new sources of well-being, a scale of visual measures has its place because the first effect of this new tool would be to unite, co-ordinate, bring into harmony the work which is at present divided and disjointed by reason of the existence of two virtually incompatible systems: the foot-and-inch system of the Anglo-Saxon world, and the metric system on the other side.

* * *

One more explanation is needed before we proceed with our task: it must be demonstrated that the necessity for a new visual measure has become really imperative only in recent years, when high-speed means of communication have worked a profound change in the relations between men and peoples. A hundred years ago, the first steam-engine introduced mechanical speed as a prelude to the collapse of a whole set of customs, accepted ideas, and needs, and therefore also of the practical means adapted to the speed of movement possible until that time, i.e. walking, which determined the rhythm of action, decreed the needs, prescribed the means and created the customs.

As I write these lines, modern aviation is transforming the world, bringing about a complete revolution (of which we have not yet chosen to take cognizance). This is not the place to develop that particular theme. The conclusion to be drawn from it is this: that everything is becoming—indeed, has already become—interdependent. Demands are shifting and conquering new space. The means of satisfying these demands are multiplying; products are manufactured, are dispatched, and travel round the world. The question is this: can the measures used in the making of these products remain local? That, and only that, is the root of the matter.

When the Roman world made itself the master of immense territories, Rome had a single language at its disposal, and it used that language as a tool of government.

When the early Church established a hold on the known world and set out, century by century, to conquer lands, seas and continents, it had a single tool for transmitting thought: the Latin language. Through the Dark Ages, when Europe, by fire and blood, was struggling to find her new bearings, Latin was the vehicle of central thought.

. . . . .

One thing remains to be explained: the Parthenon, the Indian temples, and the cathedrals were all built according to precise measures which constituted a code, a coherent system: a system which proclaimed an essential unity. Primitive men at all times and in all places, as also the bearers of high civilizations, Egyptian, Chaldean, Greek, all these have built and, by that token, measured. What were the tools they used? 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.

More than that: they were infinitely rich and subtle because they formed part of the mathematics of the human body, gracious, elegant and firm, the source of that harmony which moves us: beauty (appreciated, let it be understood, by the human eye in accordance with a well-understood human concept; there cannot and could never be another criterion).

The elbow, the pace, the foot and the thumb were and still are both the prehistoric and the modern tool of man.

The Parthenon, the Indian temples and the cathedrals, the huts and the houses, were all built in certain particular places: Greece, Asia, Europe, and so forth. There was no need for any unification of measures. As the Viking is taller than the Phoenician, so the Nordic foot and inch had no need to be adapted to the build of the Phoenician, or vice versa.

. . . One day, however, secular thought, in its turn, set out to conquer the world. The French Revolution was a struggle of profoundly human causes. A bid for progress was made, deliverance was at hand—or at least the promise of it: doors were opening upon tomorrow: science and mathematics were entering upon new and limitless paths.

Do we understand clearly enough what it meant when, one fine day, the zero—key to the decimal system—was created? Calculation is a practical impossibility without the zero. The French Revolution did away with the foot-and-inch system with all its slow and complicated processes. That being done, a new system had to be invented. The *savants* of the Convention adopted a concrete measure so devoid of personality and passion that it became an abstraction, a symbol: the metre, forty-millionth part of the meridian of the earth. The metre was adopted by a society steeped in innovation. One and a half centuries later, when factory-made goods are circulating all over the globe, the world is divided into two halves: the foot-and-inch camp and the metre camp. The foot-and-inch, steadfast in its attachment to the human body, but atrociously difficult to handle: the metre, indifferent to the stature of man, divisible into half metres and quarter metres, decimetres, centimetres, millimetres, any number of measures, but all indifferent to the stature of man, for there is no such thing as a one-metre or a two-metre man.

In the matter of building houses—or huts or temples—meant for men, the metre seems to have introduced a strange and unreal method of measurement which, if looked at closely, might well be found to be responsible for the dislocation and perversion of architecture. 'Dislocation' is quite a good word for it: it is dislocated in relation to its object, which is *to contain men.* The architecture of the 'metre men' seems to have gone a little astray: that of the 'foot-and-inchers' gives the appearance of having survived the past century, the century of clean sweeps, with some assurance and an attractive sense of continuity.

Such is the brief preamble which sets the stage for our investigation. One begins to understand what the following chapters will be all about. The first will be a faithful account, without emphasis or embellishment, showing how inventions often come about . . . how discoveries are sometimes made.

In the construction of objects of domestic, industrial or commercial use, such as are manufactured, transported, and bought in all parts of the world, modern society lacks a common measure capable of ordering the dimensions of that which contains and that which is contained: capable, in other words, of offering a solid pledge of satisfaction to supply and demand. To offer such a measure is the purpose of our enterprise. That is its *raison d'être*: to bring order.

And if, over and above that, our efforts were to be crowned with harmony? . . . Who knows . . .

Chapter 2
Chronological Review

Every discovery must, at some time, have made use of the head, the eye, the hand of a person; the right background or environment, circumstances in general, will have furthered the progress of the search and brought it to fruition. To propose the use of a new measure, meant at some time in the future to supplement the metre or the foot-and-inch, seems an extravagant claim. It is a claim that would be allowed more easily if it were put forward by a council or congress as the outcome of the official labours of that body. The idea has occurred to an ordinary man, not even a professional inventor, but a man who is the product of a certain *milieu* and one who has benefited from his environment, and has, on occasion, created an environment to fit himself. The man in question is an architect and painter, who for the past forty-five years has practised an art in which *all is measured*.

From 1900 until 1907, he studied nature under an excellent master; he observed natural phenomena in a place far from the city, in the mountains of the High Jura. The call was for a renewal of the decorative elements by the direct study of plants, animals, the changing sky. Nature is order and law, unity and diversity without end, subtlety, harmony and strength: that is the lesson he learnt between the ages of fifteen and twenty.

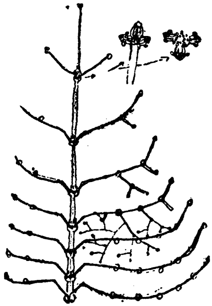


Fig. 1

At nineteen he went to Italy, to see works of art which are personal, fanciful and full of point. After that, Paris taught him the lesson of the Middle Ages, a system both rigorous and bold, and the order of the *Grand Siècle*, which is urbanity and sociability.

Note. This drawing, sketched in the woods forty-five years ago, must be corrected by the reader: it goes without saying that the intervals should not diminish towards the bottom of the drawing; these reductions were due only to the smallness of my sheet of paper.

At twenty-three, our man drew on his sketching-board the façade of a house he was going to build. A perturbing question arose in his mind: 'What is the rule that orders, that connects all things? I am faced with a problem that is geometrical in nature; I am in the very midst of a phenomenon which is visual; I am present at the birth of something with a life of its own. By his claws shall the lion be known. Where is the claw, where the lion?' . . . Great disquiet, much searching, many questions.

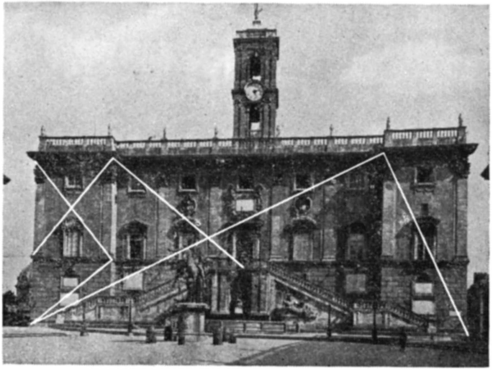


Fig. 2

Then he remembered how once, on a voyage of discovery, as he was looking over a modern villa at Bremen, the gardener there had said to him: 'This stuff, you see, that's complicated, all these twiddly bits, curves, angles, calculations, it's all very learned.' The villa had belonged to someone called Thorn Brick (?), a Dutchman (about 1909).

One day, under the oil lamp in his little room in Paris, some picture postcards were spread out on his table. His eye lingered on a picture of Michelangelo's Capitol in Rome. He turned over another card, face downward, and intuitively projected one of its angles (a right angle) on to the façade of the Capitol. Suddenly he was struck afresh by a familiar truth: the right angle governs the composition; the *lieux* (*lieu de l'angle droit*: place of the right angle) command the entire composition. This was to him a revelation, a certitude. The same test worked with a painting by Cézanne. But he mistrusted his own verdict, saying to himself that the composition of works of art is governed by rules; these rules may be conscious methods, pointed and subtle, or they may be commonplace rules, tritely applied. They may also be *implied* by the creative instinct of the artist, a manifestation of an intuitive harmony, as was almost certainly the case with Cézanne: Michelangelo being of a different nature, with a tendency to follow preconceived and deliberate, conscious designs.

A book brought him certainty: some pages in Auguste Choisy's book on the History of Architecture devoted to the *tracé regulateur* (regulating lines). So there were such things as regulating lines to govern composition?

In 1918 he began to paint in earnest. The first two pictures were composed haphazardly. The third, in 1919, was an attempt to cover the canvas in an ordered manner. The result was almost good. Then came the fourth painting, reproducing the third in an improved form, with a categorical design to hold it together, enclose it, give it a structure. Then came a series of pictures painted in 1920 (exhibited at the Galerie Druet, 1921); all these are firmly founded on geometry. Two mathematical expedients were used in these paintings: the place of the right angle and the golden mean (A).

Those were productive years, years of ceaseless intellectual ferment. The review *L'Esprit Nouveau* was founded, directed and edited by our man together with some others. He wrote several series of articles, all theoretical, for at the end of the first Great War it seemed necessary to come to terms with fundamentals once again. That precisely was the work accomplished by *L'Esprit Nouveau.*

In 1922, our man had not been practising architecture for six years; then he began to build again, having, since 1920, prepared in *L'Esprit Nouveau* certain fundamental positions without which such a resumption of work would have been impossible. The first of his new houses bore witness to a new conception of architecture; it expressed the spirit of an era. The façades of those buildings (only the façades) all bore the imprint of the regulating lines. His studies were complex and far-reaching: basic measures of urbanism ('Ville Contemporaine de trois millions d'habitants', 1922), determination of the cellular unit (capacity of dwellings), the mesh of communications (network of roads and transport lines): in reality, a process of fundamental architectural organization which he had already experienced once, fifteen years earlier, at the Charterhouse of Ema in Tuscany (individual freedom and collective organization) [1907].

In the course of his travels he had noticed the constant recurrence, in all harmonious architectures, whether primitive or highly intellectual, of a height of about 2·10 to 2·20 metres (7 to 8 feet) between floor and ceiling: houses in the Balkans and in Turkey, Greek, Tyrolean, Swiss, Bavarian houses, old French Gothic wooden houses and the '*petits appartements*' of the Faubourg Saint-Germain and of the Petit Trianon itself—Louis XV, Louis XVI; also, the tradition of the Paris shops from Louis XV to the Restoration, with their attics repeating the same height of 2·20 m. The height of a man with arm upraised (B), a height very much to the human scale.

In his own buildings he felt bound to introduce this very attractive dimension, often against municipal regulations. One day, one of the town councillors of a large Paris district told him: 'We authorize you to go against regulations, because we know that you are working for the good of man.'

L'Esprit Nouveau was sub-titled 'International Review of Contemporary Activities'. In it, the *mutual dependence of phenomena* had been assessed, appreciated and discussed, and it had been found that in our time *nothing is governed by any rule.* An enterprise devoted, in reality, to the development of a contemporary aesthetic had become mixed up with the economic factor. One day, there was a great fuss over an article entitled 'Building by Mass Production'. This article dealt with houses, which it described as 'machines for living in'. Mass production, machine, efficiency, cost price, speed, all these concepts called for the presence and the discipline of a system of measuring (1921) (C).[1]

(1) Ideas of this kind caused a scandal: in 1935, on my first visit to the U.S.A., the Press unanimously upbraided me for them. . . . (The U.S.A. thought: this is blasphemy . . .). Today, in 1949, the watchword is: mass production, machines, efficiency, prices, speed!

L'Esprit Nouveau had appointed itself the exponent of cubism, a word which covers one of the most creative and revolutionary moments in the history of thought. It was not a technical invention causing an upheaval in the social and economic spheres, but a liberation and a flowering of the spirit. It was a beginning: the way ahead . . . a time of radical reform in the plastic arts. At the moment of which I speak, this reform penetrated into architecture (D).

Our man was a self-taught man. He had always fled from formal teaching. He therefore had no knowledge of the canonical laws, the principles codified and dictated by the Academies. Being free from the academic spirit, he had an open mind and an alert eye. Being a cubist, he had a bent for plastic phenomena, and his reasoning was *visual*. He came from a family of musicians, but he could not even read music; yet he was a musician through and through, and knew just how music is made; he could speak about music and pass judgment upon it. Music, like architecture, is *time and space*. Music and architecture alike are a matter of measure.

When, many years after his article on 'The Regulating Lines' was published in *L'Esprit Nouveau* (1921), Matila Ghyka's books on proportion in nature and in art and on the golden number made their appearance, he was not equipped to follow the mathematical argument of these books (algebraic formulae and so forth), but he was able to grasp at once the meaning of the figures which are, in point of fact, the chief object considered in them.

One day, Professor Andreas Speiser, of the University of Zurich (now at Bâle), who was engaged on important research into the question of groups and numbers, showed him a treatise on Egyptian ornaments, on Bach and Beethoven, in which all demonstrations and proofs were supplied by algebra. 'I agree,' he replied to the Professor, 'nature is ruled by mathematics, and the masterpieces of art are in consonance with nature; they express the laws of nature and themselves proceed from those laws. Consequently, they too are governed by mathematics, and the scholar's implacable reasoning and unerring formulae may be applied to art. The artist is a medium of infinite, extraordinary sensitivity; he feels and discerns nature and translates it in his own works. He is both the victim and the interpreter of his fate. Thus, for example, you in your treatise have taken an Egyptian ornament in order to demonstrate the dazzling quality of its composition. I am a worker in the plastic arts; if you tell me to design a border of this kind to go on an ornament, I am bound at some time to hit upon this particular ornamental arrangement because it is one of the inevitabilities of ornamentation; it forms part of a very short series of groups of solutions, the key to which is geometry itself, conditioned by the spirit of geometry which is in man as it is also in the very law of nature.'

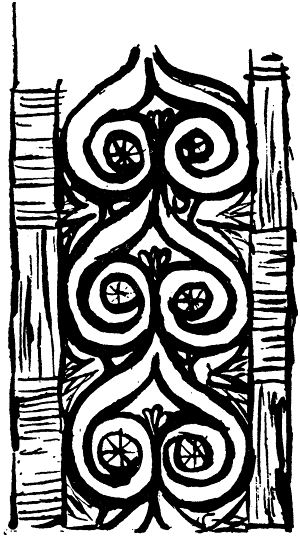


FIG. 3

His strong interest in these matters brought upon our architect a wholly unexpected honour in about the year 1933: at the celebration of the sixth centenary of the University of Zurich, he was awarded the degree of Doctor Honoris Causa in mathematical philosophy, in recognition of his research on the organization of forms and space. This distinction took him unawares, but still. . . . In 1945, after years of enforced silence, he expressed the essence of his feelings in the phrase '*L'Espace Indicible*', formulating it in these words:

'To take possession of space is the first gesture of the living, men and beasts, plants and clouds, the fundamental manifestation of equilibrium and permanence. The first proof of existence is to occupy space.

'The flower, the plant, the tree, the mountain, all these are upright, living in an environment. If the true greatness of their aspect draws attention to itself, it is because they seem contained in themselves, yet producing resonances all around. We stop short, conscious of so much natural harmony; and we look, moved by so much unity commanding so much space; and then we measure what we see.

'Architecture, sculpture and painting are, by definition, dependent on space, tied down to the necessity to come to terms with space, each by its own means. The essential point I wish to make is that the key to aesthetic emotion is a function of space.

'*Effect* of a work of art (architecture, statue or painting) on its surroundings: waves, outcries, turmoil (the Parthenon on the Acropolis at Athens), lines spurting, radiating out as if produced by an explosion: the surroundings, both immediate and more distant, are stirred and shaken, dominated or caressed by it. *Reaction* of the surroundings: the walls of a room and its dimensions, the city square with its differently accentuated façades, the planes and slopes of the landscape, yes even the bare horizons of the plain and the twisted outlines of the mountains, the whole environment brings its weight to bear upon the place where there is a work of art, expression of the will of man; it impresses upon that place its depths and peaks, its textures, hard or flaccid, its violence and its gentleness. A kind of harmony is created, exact like a mathematical exercise, a true manifestation of the acoustics of plastic matter. It is not out of place, in this context, to bring in music, one of the subtlest phenomena of all, bringer of joy (harmony) or of oppression (cacophony).

'Without wishing to put forward any ambitious claims, I have something to say about the "magnification" of space first attempted by the artists of my generation during the marvellously creative early days of cubism, around 1910.

They spoke of a *fourth dimension*, some with a little more intuition and insight, some with a little less, no matter. A life devoted to art, and most particularly to the quest for harmony, has enabled me, through the practice of three arts—architecture, sculpture and painting—to learn something about it in my turn.

'The fourth dimension is, I believe, the moment of boundless freedom brought about by an exceptionally happy consonance of the plastic means employed in a work of art.

'It is not the effect of the subject chosen by the artist, but a triumph of proportioning in all things—the physical properties of the work as well as the fulfilment of the artist's intention, controlled or uncontrolled, tangible or intangible, but existing in any case, and owing its being to intuition, that miraculous catalyst of knowledge, acquired, assimilated, perhaps even forgotten. For a finished and successful work holds within it a vast amount of intention, a veritable world, which reveals itself to those who have a right to it: that is to say, to those who deserve it.

'Then a fathomless depth gapes open, all walls are broken down, every other presence is put to flight, and the miracle of *inexpressible space* is achieved.

'I have not experienced the miracle of faith, but I have often known the miracle of inexpressible space, the apotheosis of plastic emotion.'

During the productive years between 1925 and 1933—a time of building in France, before the war and the alarms of wars—our man had felt the desire, the urge, the need to build to the human scale. This made him draw, on the wall of his studio, a metric scale four metres in height, in which he could confront himself, against which he could measure his own stature, drawing across it a set of true measures, those of resting, sitting, walking and so forth. . . . This experiment showed that the metre is nothing but a number, fortunately governed by the decimal system, but an abstract number all the same, incapable, in architecture, of qualifying an interval (a measure in space). Indeed it is a dangerous tool, for, starting out from its abstract obedience to numbers, one is tempted, by negligence or laziness, to perpetuate it in other convenient measures: metre, half-metre, quarter-metre, etc. . . . a development which has taken place gradually during the past hundred years, much to the detriment of architecture.

And so, at a certain hour of his life, our man came face to face with the '*normalisation AFNOR*', an encounter which was to bear fruit, several years later, in the form of the present work.

The AFNOR had been set up under the Occupation as an aid to the reconstruction of the country; industrialists, engineers and architects had banded together to perform the necessary task of standardizing everything pertaining, in particular, to building. Our man was not invited to sit at that table, despite the fact that, twenty years earlier, he had been criticized for having written:

'We must strive towards the establishment of a standard in order to face the problem of perfection.

'The Parthenon is the product of selection applied to a standard.

'Architecture is a process based on standards.

'Standards are the products of logic, of analysis and painstaking study; they are evolved on the basis of a problem well stated. In the final analysis, however, a standard is established by experimentation.'

('Des yeux qui ne voient pas'
L'Esprit Nouveau, 1920
and 'Vers une architecture nouvelle', 1923.)

‘Building should be the concern of heavy industry, and the component parts of houses should be mass-produced.

‘A mass-production mentality must be created:

‘a frame of mind for building mass-produced houses,

‘a frame of mind for living in mass-produced houses,

‘a frame of mind for imagining mass-produced houses.’

(‘Maisons en série’
L’Esprit Nouveau, 1921)

. . . .

And, in order to do that, it is necessary to *standardize.*

There’s a lot of dangerous ideas for you!

On the day on which the first standardized construction series of AFNOR were published, our man decided to set down in concrete form his ideas on the subject of a harmonious measure to the human scale, universally applicable to architecture and mechanics.

* * *

Figs. A, B, C, D and E are reproductions of paintings and architectural designs based on regulating lines dating from the years following 1918. ‘Place of the right angle’, golden mean, logarithmic spiral, pentagon. . . . Geometrical groups, each with its own specific kind of equilibrium, which in turn gives each its own character. The regulating lines are not, in principle, a preconceived plan; they are chosen in a particular form depending on the demands of the composition itself, already formulated, already well and truly in existence. The lines do no more than establish order and clarity on the level of geometrical equilibrium, achieving or claiming to achieve a veritable purification. The regulating lines do **not** bring in any poetic or lyrical ideas; they do not inspire the theme of the work;

they are not creative; they merely establish a balance. A matter of plasticity, pure and simple.

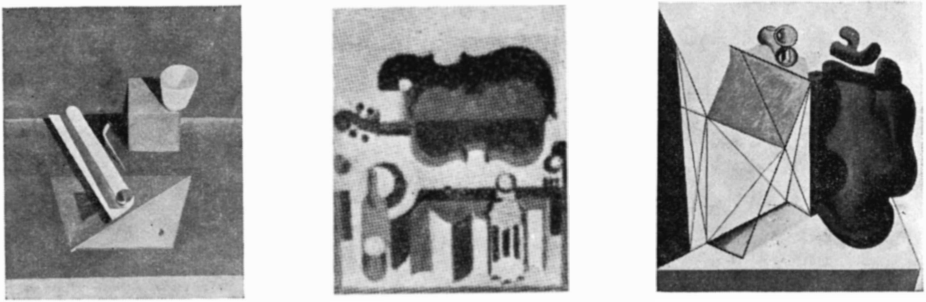
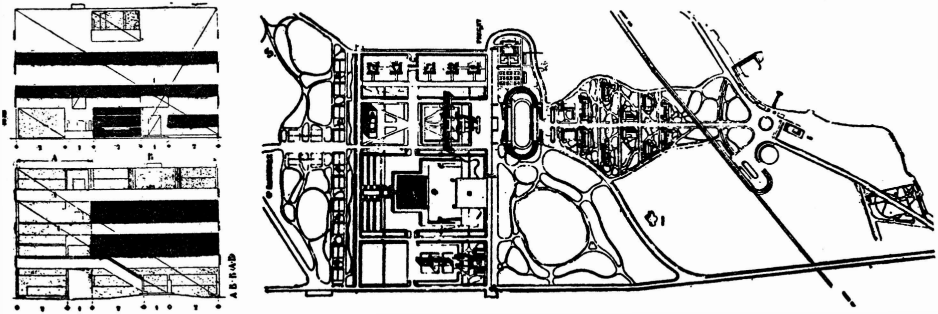


FIG. 4 A B C

Here are the façades of some houses and buildings designed at the same time as the paintings—small houses, public buildings, complex architectural groups:



D E FIG. 5

Both the paintings and the architectural designs make use of the golden section, the 'place of the right angle', the height of 2·20 m. (man with arm upraised).

* * *

Then came the occupation of Paris, with France cut in two by the demarcation line. My studio was closed from the 11th of June 1940. For four years no reconstruction work of any kind was entrusted to me; this led me to engage in intensive theoretical research work, in particular on behalf of an association founded to that end in 1942, the ASCORAL, each of whose 11 sections and subsections met twice a month in a spot tucked well away from prying eyes. Enough material to fill a dozen books was prepared. Section III, on 'The Science of Housing', was divided into three subsections:

(*a*) housing equipment,

(*b*) standardization and construction,

(*c*) industrialization.[1]

One of my young collaborators, Hanning, was obliged to cross the demarcation line into Savoy (that was in 1943). He asked me to set him a problem to occupy his mind. The boy had been working with me since 1938, he knew the order and spirit of the investigation into the problem of proportioning on which I had been engaged for so long. 'Here you are,' I said to him: 'the AFNOR proposes to standardize all the objects involved in the construction of buildings. The method they are proposing to employ is somewhat over-simplified: simple arithmetic, getting a simple cross-section of the methods and customs used by architects, engineers and manufacturers. This method seems to me to be an arbitrary and a poor one. Take trees: if I look at their trunks and branches, their leaves and veins, I know that the laws of growth and interchangeability can and should be something subtler and richer. There must be some mathematical link in these

(1) The following books were published or are awaiting publication: *Sur les 4 routes*, N.R.F. 1941; *Charte d' Athènes*, Plon 1942; *La Maison des Hommes*, Plon 1942; *Entretien avec les étudiants*, Denoël, 1942; *Manière de Penser l'Urbanisme* (Ascoral 1943-46), Edit. L'Architecture d'Aujourd'hui; *Les Trois Etablissements Humains*, Denoël (1943-46); *Propos d'Urbanisme* (1945), Bourrelier, 1946. Several of these have been translated into English, Spanish, Italian, Danish, etc.

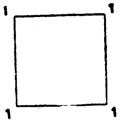
things. My dream is to set up, on the building sites which will spring up all over our country one day, a "grid of proportions", drawn on the wall or made of strip iron, which will serve as a rule for the whole project, a norm offering an endless series of different combinations and proportions; the 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. That is my dream.

'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. This third square should give you a solution. The *place of the right angle* should help you to decide where to put this third square.

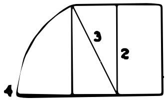
'With this grid for use on the building site, designed to fit the man placed within it, I am sure you will obtain a series of measures reconciling human stature (man-with-arm-upraised) and mathematics. . . .'

Those were my instructions to Hanning.

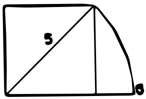
On the 25th of August, 1943, arrived a first proposal:



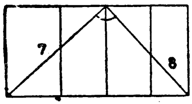
a square



the golden section



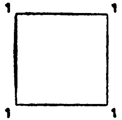
the diagonal



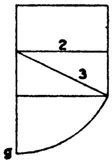
the whole, (A) the angle of which passes through the centre line of the initial square.

FIG. 6

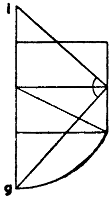
Meanwhile, the ASCORAL, too, was hard at work, and in particular Mlle Elisa Maillard.[1] An improved version of (A), completed on the 26th of December 1943, suggested



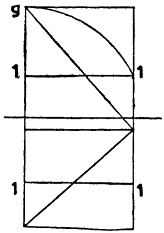
a square



its golden section

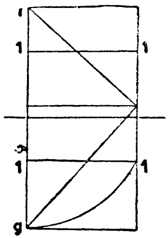


right angle set on the axis of the original square gives point 'i'



the line g-i is divided into two equal parts

or



the result is two contiguous squares, each equal to the initial square[2].

Fig. 7

Along the line g-i there appear certain significant measures, the relationships between which are infinitely rich in possibilities, but which did not yet seem to us to represent a system.

---

(1) Attached to the Musée de Cluny and author of an excellent book on regulating lines, *Du nombre d'or*, published by André Tournon et Cie.

(2) It will be seen at the end of this work that the absolute equality of the three squares evolved by this process is subject to certain reservations.

We may read as follows (Fig. 8):

abcd=initial square;
ef=median;
the right angle to *fg* at *f* gives
i on the line g-b produced;
bdji=a rectangle, within which
bi and *dj* stand in relationship Φ[1]
to *iq* and *qj*;
the horizontal median of ghji=kl;
mn is in image of kl about ef;
klnm divided in two by the vertical median
op gives kopm and olnp, the diagonal and the
half of which stand in relationship Φ to each other.

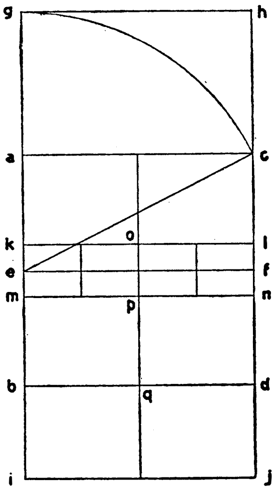


FIG. 8

On gi we observe an augmenting progression of five elements:

km;	gk=ki;
ka=mb=bi;	gb.
ga=am=kb;	

If gk=ki, gklh and klji are two contiguous and equal squares, both of which are equal to the initial square abcd.

Thus we have solved the problem set to us, namely to insert in two contiguous squares containing a man-with-arm-upraised a third square at the 'place of the right angle'.

(1) Φ is the golden section ratio, i.e. approximately 1 : 1·618.

This drawing can be reversed, in which case the result will be as follows:

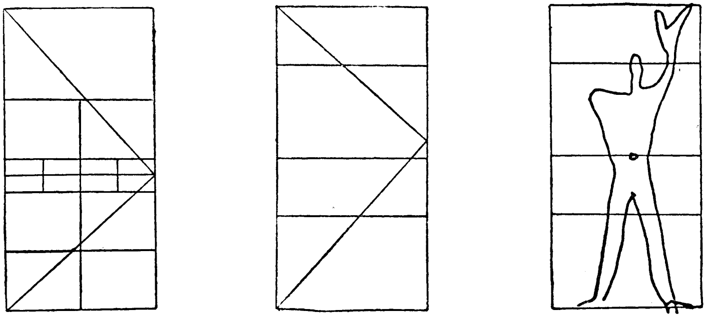
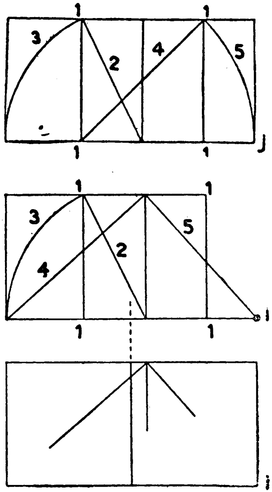


FIG. 9



We are then in the presence of two diagrams, almost equal in appearance but evolved by different processes: the Hanning diagram using the two diagonals of the initial square;

the Maillard diagram using the relationship Φ (arising from the first diagonal and leading to the establishment of the right angle, which gives point 'i').

Point 'i' establishes the presence of two contiguous squares equal to the initial square.

FIG. 10

The Hanning diagram gave a point 'j' which did not exactly coincide with point 'i'.

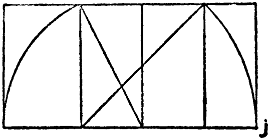


FIG. 10 (*continued*)

And so the GRID was born (not without some uncertainty as regards points 'i' and 'j'): a proportioning grid meant to be installed on building sites in order to supply an abundance of harmonious and useful measures for the planning of rooms, doors, cupboards, windows, and so on and so forth . . . to lend itself to infinite combinations of mass production, to take in the elements of pre-fabricated buildings, and to join them without difficulty.

At the studio in the rue de Sèvres we resumed work on the models of the 'Housing Units of Proportional Size', shown for the first time in 1922 (type *Immeuble-Villa*) and again in 1925 (pavilion of *l'Esprit Nouveau* at the International Exhibition of the Decorative Arts), and finally in 1937 (L'Ilot Insalubre No. 6). The Proportioning Grid gave us an extraordinary sureness in determining the dimensions of the objects in our scheme. What we had created was an *element of surface*, a grid in which mathematical order is adapted to the human stature. We used it, but we remained dissatisfied: we still lacked a *definition* of our invention!

To tell the truth, we were not yet in full agreement. On the 10th of March 1944, Hanning wrote to me from Savoy saying that the Maillard-Le Corbusier diagram was a mathematical impossibility: the place of the right angle could only be situated on the line joining the two squares, at S: . . . 'Only one right angle is possible, namely that formed by the diagonals of the two squares.' This assertion

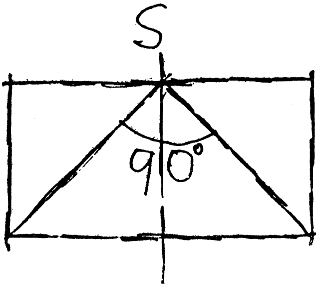


Fig. 11

was inconsistent with the occurrence of the oblique line 7-8 in his own drawing of the 25th of August 1943. That oblique line was to make another appearance in August 1948, and was then to find its proper explanation.

The reader should try to imagine the circumstances in which this work was done. The Germans were in Paris. People were either away altogether or could only meet with difficulty. In the wretched atmosphere of occupied Paris, an argument on architecture between professionals was a difficult matter indeed. A new law obliged me to submit my candidature to the Order of Architects created by the Vichy Government at the end of 1940. My application remained under examination by the Order for a full fourteen months, until the moment when English guns could already be heard at Versailles (summer of 1944). At the daily meetings of the various commissions of the ASCORAL, we worked by candlelight, without heating or telephone, in the dusty abandoned studio at 35, rue de Sèvres. Section IIIb on Standardization ploughed ahead with its work. Sometimes we got word of the official work of the AFNOR. The director of Section IIIb of the ASCORAL, himself a member of AFNOR, kept me informed, writing to me, among other things, on the 16th of October 1943: 'There is a fundamental difference between the standpoint of the ASCORAL and theirs (i.e. of the AFNOR): the one wants the best of what can be, the other the average of what *is*.'

1944, and the Liberation.

In the autumn I sat on the 'Commission on Doctrine' of the National Front of Architects, having won a victory on the point that the 'Athens Charter' of the C.I.A.M. should serve as the basis for discussion. Reconstruction, building, establishment of the elements of mass production, harmonization . . . the Proportioning Grid was more than ever on the agenda.

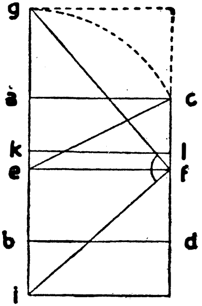


Fig. 12

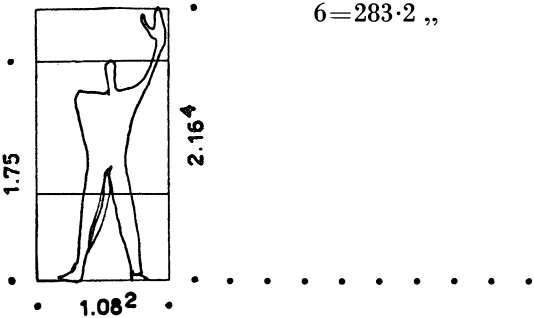
On the 7th of February 1945, Mlle Maillard and I went to pay a visit to M. Montel, Dean of the Faculty of Sciences at the Sorbonne, and showed him our design of the grid. His reply was: 'When you succeeded in setting the right angle within the double square, you introduced the mathematical function of $\sqrt{5}$, thus producing an efflorescence of golden sections.'

On the 30th of March 1945, I resumed serious work on the proportioning grid. Wogensky, Hanning, Aujame and de Looze worked with me. The Department of Cultural Relations of the Ministry of Foreign Affairs had asked me to organize and preside over an architectural mission to the United States. I was anxious to bring the Proportioning Grid to the United States as a possible measuring aid to prefabrication. We worked out a series of drawings which, in our own eyes, demonstrated the Grid's whole wealth of possible combinations.

At that point we invested the geometrical combination discovered by us with a human value, adopting for that purpose a man's height of 1·75 m.

Thenceforth the Grid was given the dimensions 175 - 216·4 - 108·2. These measures correspond to the augmenting series Φ: 1, 2, 3, 4, 5, 6, etc. . . . , where

$$\begin{aligned} 1 &= 25{\cdot}4 \text{ cm.} \\ 2 &= 41{\cdot}45 \text{ ,,} \\ 3 &= 66{\cdot}8 \text{ ,,} \\ 4 &= 108{\cdot}2 \text{ ,,} \\ 5 &= 175{\cdot}0 \text{ ,,} \\ \hline 6 &= 283{\cdot}2 \text{ ,,} \end{aligned}$$



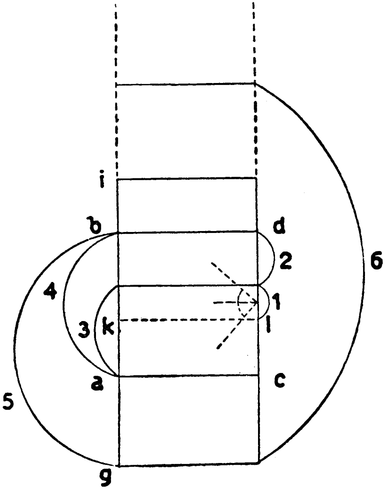


Fig. 13

It will be seen that the series in question is the one known as the Fibonacci series, in which the sum of two consecutive terms supplies the following term.

At that point we took out the patent.

It may be of interest if I give a few details on this subject.

I found it very difficult to give a succinct, simple and quick explanation of the Proportioning Grid. You are talking to a man you do not know, the director of a patent agency, an engineer by training, whose mind is not yet open to ideas of this kind. How to make him understand that, following a long personal experience of matters connected with architecture—furniture, town planning, building, economics, the plastic phenomenon and so forth—you have struck out on a road which seems to have brought you to a first result? That you are standing at a door on the other side of which something is taking place, but you have not yet got the key that will let you understand what it is? And so there I was, talking —in his office, where the clock on the wall marks each passing second of precious time—to an engineer filled with courtesy and good will (he gets to hear a thing or two, in his profession!), the head of a large office dealing with inventors' patents. I told him: 'My dear sir, let me say before anything else that I have no liking for inventors' patents, for a thousand and one reasons drawn from my own experience. Nevertheless, I am going to talk to you about a Proportioning Grid, etc., etc. . . . which is expressed in numbers, figures and diagrams, but for which I have not yet found a definition, or, if you prefer, an explanation. You won't understand a word of what I am going to tell you. I shall be glad to repeat my remarks a second and a third time, if necessary. If, after the third time, you positively fail to see anything of interest in this matter, you will turn me out.' And so it was done: first explanation, second explanation. 'I am afraid I don't understand . . .'. Third explanation: 'Hold on a minute, I am beginning to see, this seems to be something extraordinarily interesting, very important,' etc., etc. When I was leaving, this man said to me: 'In my life as a patent engineer, this hour spent with you shall be a landmark.'

The head of the patent agency saw in our invention a matter of indisputable importance and considerable financial interest.

Weeks passed; a year passed, in the course of which I granted a concession to an extremely intelligent and cultured man with a view to putting the invention on the market as an aid to post-war production of prefabricated houses. My feelings about the matter, though not my ambitions, were becoming clearer: I felt that the Proportioning Grid, if it was destined one day to serve as a basis for prefabrication, should be set above both the system of the foot-and-inch and the metric system.

The businessmen told me: 'You have a right to claim royalties on everything that will be constructed on the basis of your measuring system.' What a colossal, what an infinite prospect! My agent extended the application of the patent to many countries in Europe and America. He was thinking of setting up agencies in a large number of places. . . .

. . . .

To put it briefly, the whole affair was beginning to get me down. The patent engineer, the soul of kindness, watched me with alarm. 'You are,' he said, 'your own enemy No. 1.'

The agent established contacts at all points of the globe. One day he told me: 'Your figures are too rigid. They cannot be adjusted to the "round" figures of the metric system or the foot-and-inch, and they do not fit in with the figures of the AFNOR. But if you would agree to allow just a little latitude in your scales of numbers—not more than 5 per cent either way—then everything would be all right, everything would be easy, everyone would agree. . . .'

Dreadful suggestions which overshadowed the year 1945!

Next came the voyage to the United States, starting with the Atlantic crossing on board the cargo boat *Vernon S. Hood*.

One day in 1946 I asked my friend André Jaoul, of the Electro-Chemical Department at Ugines, to come with me to the office of the patent engineer. 'I have come,' I said to that excellent man, 'to tell you in front of a witness that I do not mean to make a fortune out of my invention. Money should not enter into the question. Please understand me: I want to go on in peace with my work on the Grid, to apply it in practice, to discover its virtues and its faults in the midst of everyday conditions and with my own eyes and hands, to improve it and develop it. I have no need of a commercial organization and I do not need publicity. The nature of my invention is such that, if it is any good, my friends the modern architects the world over will want to use it, and their periodicals—the best in all countries—will devote their pages to studying it and making it known. I am clearly aware of my responsibility in this matter. It would be wrong to introduce into it the evil, violent, savage and unscrupulous element of money. In this affair, I am full of scruples, I am conscience itself. I foresee that architects and builders will want to employ this useful measuring tool. Congresses will discuss it and, later, if it proves its worth, it may come up for consideration by the Economic and Social Council of the United Nations. And—who knows?—if we allow that the obstacles and obstructions, the rivalry and opposition created by the antagonism of the two systems of measurement now in force—the foot-and-inch and the metre—must one day come to an end, then our measure might join together what was once divided, and become an instrument of unification. You understand now that I cannot pursue this task, which may become a kind of apostolic mission, if I know that behind each one of my exhortations, my pleas, my successes, there is a cashier handing out and receiving money in my name. I am not a toll-gatherer.'

This interview settled the matter, and I can assure my readers that once that was done, once the year 1945—that year of brilliant economic prospects—was over, I felt at ease, with a clear conscience and at rest with myself, which after all is the ultimate satisfaction.

. . . .

Back at the studio, I had set André Wogensky and Soltan to work on the preparation of papers I was to take with me on my forthcoming visit to the United States. Soltan was new to the job, having taken no part in the preliminaries . . . the two squares to which a third is added, etc. . . . After the first few days he had a strong reaction against the whole thing, saying 'It seems to me that your invention is not based on a two-dimensional phenomenon but on a linear one. Your

"Grid" is merely a fragment of a linear system, a series of golden sections moving towards zero on the one side and towards infinity on the other.' 'All right,' I replied, 'let us call it henceforth a *rule* of proportions.'

After that we were out of the doldrums and things began to move very fast.

Soltan made me a splendid strip of strong glossy paper, going from zero up to 2·164 m., based on a man 1·75 m in height.

On the 9th of December 1945 I made a first attempt towards an expression of that rule:

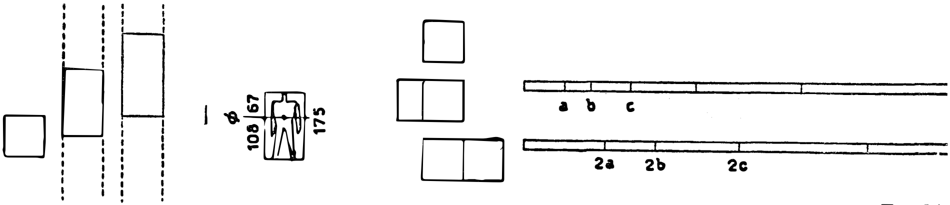


Fig. 14

—The unit
—By Φ
—By doubling

Then came the Liberty ship *Vernon S. Hood*, sailing from Le Havre in the middle of December 1945 and arriving in New York after a nineteen-day crossing. During the first six days there was a frightful storm and for the rest of the time a strong swell. The American company had told us that the crossing would take seven to nine days. On the second day, when the previous day's run was announced, it became obvious that it would take eighteen or nineteen. Imagine the rage of the twenty-nine passengers! We slept in dormitories, the cabins being occupied by the crew. I said to Claudius Petit, who was travelling with me: 'I am not going to leave this confounded boat before I have found the explanation of my golden rule.' A helpful passenger appealed to the ship's officers; the cabin belonging to one of them was put at our disposal from 8 to 12 each morning and from 8 p.m. until midnight. There, to the roaring of the storm, I tried to work out a few ideas, each one arising from the last. In my pocket I had the graduated strip made by Soltan, which I kept in a little aluminium box from a used Kodak film: that box has not left my pocket since. I am often seen in the most unexpected places taking the magic snake from its hiding-place to make a verification. Here is an example: once, on the boat, a few of us were squatting on the captain's bridge, enjoying the sea air and finding the things we saw agreeably and sensibly proportioned. Out came the strip from its box and a test was made, incidentally with triumphant success (Christmas 1945). In the spring of 1948, another verification. I was sitting on the Economic Council, in the section on reconstruction, town planning and public works; the item on the agenda was the bill on housing rents. The height of dwelling-houses was being discussed. I advocated using the height of the man-with-arm-upraised, single and double. The meeting was being held at the Palais-Royal in Paris, on the floor where the '*petits appartements*' are (end of XVIIIth century and Restoration, beginning of XIXth). The measure would suffice for small dwelling-houses because, in the rooms where we were meeting, it sufficed for us. I unrolled my strip, measuring the space between ceiling and floor. Our chairman, M. Caquot, confirmed that the figure suggested by me and the height of the room were exactly the same.

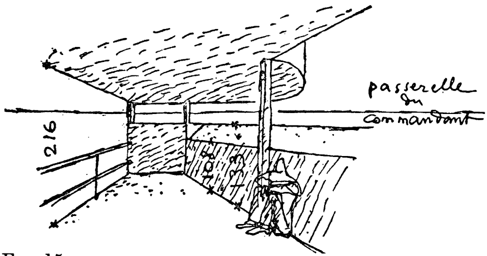


FIG. 15

But let us return to our cargo-boat.

While the boat rolled and tossed heavily, I drew up a scale of figures:

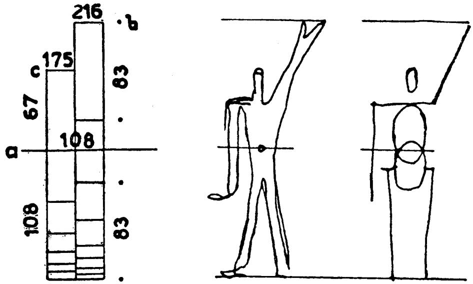


Fig. 16

These figures pin down the human body at the decisive points of its occupation of space: they are therefore *anthropocentric.*

Do these figures occupy any special or privileged position in mathematics?

The unit .... A (=108)
The double unit ...... B (=216)
The relationship Φ of A=C (=175)
(108+67)
The relationship Φ of B=D (=83)
(143+83)

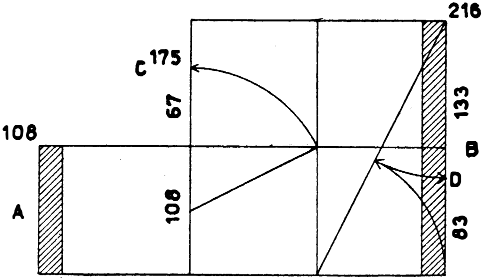
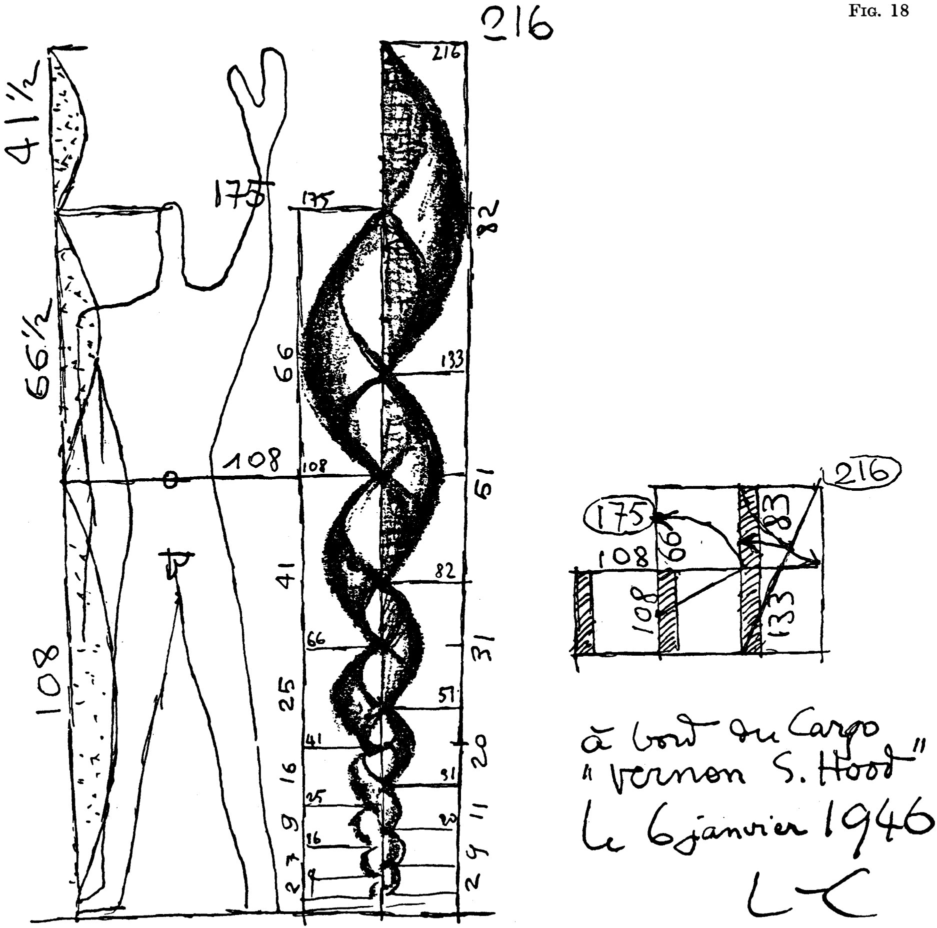


Fig. 17

We may, therefore, say that this rule pins down the human body at the essential points of its occupation of space, and that it represents the simplest and most fundamental mathematical progression of a value, namely the unit, the double unit, and the two golden means, added or subtracted.

We were now in a much stronger and more advanced position than when we simply inserted a third square at the place of the right angle in two contiguous squares, all three squares being equal to each other. By incorporating both con-

FIG. 18


216
41½
175
66½
108
66
41
25
16
9
133
82
51
31
20
11
175
216
108
66
83
133
à bord du Cargo
"Vernon S. Hood"
le 6 janvier 1946
LC

clusions in a single drawing I obtained a very fine picture. I called the Fibonacci series arising from the relationship Φ based on the unit 108 the *red series*, and that series based on the double unit 216 the *blue series*. I drew a man of a height of 1·75 m. engaged at four points: zero, 108, 175, 216. Then the red strip on the left, the blue on the right, the series of Φ going towards zero below, and that progressing towards infinity above.

Disembarking from my cargo-boat in New York on the 10th of January 1946, I had an interview with Mr Kaiser, the famous constructor of Liberty ships during the war. His latest project had been to construct 10,000 houses a day in the United States. But, he told me, I have changed my mind, I am going to make motor cars instead. . . ! ! ! What I told him about the purpose of my visit is related farther on in this book. Let us leave our calculations aside for a minute and make a digression into economics and sociology.

The U.S.A. gives Mr Kaiser, a businessman of genius and a leading industrialist, full authority to produce three million houses a year. These houses are to be mass-produced, in other words they are to be family dwellings. They will cover a certain amount of ground; they will be erected along streets; these streets will not be in the towns, where there is no room, but in the country. The towns will be expanded to enormous size by suburbs, vast, tremendous suburbs. It will be necessary to create huge transport systems to make these suburbs accessible and mutually connected: railways, underground railways, trams, buses, etc. . . . This will involve the construction of innumerable roads, a huge network of mains (water, gas, electricity, telephone, etc.). What boundless activity, what wealth this will bring! Or don't you think so? *I* think this is just another example, carried to disastrous lengths, of the Great American Waste which I had already observed and analysed in 1935.[1] No one is entitled to breathe a word of warning

(1) *Quand les Cathedrales étaient blanches*, Plon 1936.

in Mr Kaiser's ear, no one may even dream of calling a halt to his activities, no machinery is set on foot to channel his indomitable energy towards social and economic ends. . . . And then it so happens that after six months of cogitation, when all is said and done, Mr Kaiser decides, quite off his own bat, that he is not going to make houses after all, but motor cars. Now motor cars are used for transport, they are an aid to transport, they make it possible for the unnatural phenomenon of the American town to appear tolerable. Here, the problem is quite a different one: cheapness and efficiency of the motor car itself, efficiency in general. But the competition in the United States is tremendous, gigantic. The makers of a new motor car must bid for the public's favour, they must outbid all other bidders. People must be told that a car is a sign of importance, the first rung on the ladder of social position. Therefore, let us flatter the public taste: a stream-lined body, a car as large as any of the most fashionable makes, a manifestation of power, yes, of magnificence. The new car is splendid, glittering, a standard-bearer of optimism and an ambassador of strength. But it is huge, it has a bonnet and a radiator which is like the face of a god of Power with gigantic chromium-plated jaws. That American streets are congested is a well-known fact. The car is twice as long as it need be. It blocks the road when it turns; it lies upon the ground like a carapace. Efficiency? Speeds prohibited by the regulations, double consumption of steel and paint and petrol. And so there we are again, face to face with the problem of the human scale. . . . I end my digression and return to the 'Modulor'.

My second visit was to Knoxville, to see Mr Lilienthal, the Director-General of the Tennessee Valley Authority and the guiding spirit of that great harmonious plan, sponsored by President Roosevelt, which built the dams on the Tennessee River and the new towns, rescued American agriculture and gave it new life.

Our conversation was a friendly one indeed, for my golden rule speaks of harmony, and harmony is the aim of all Mr Lilienthal's work. His face lit up at the delightful thought of establishing a reign of harmony . . . by undertaking the most gigantic works and co-ordinating the most immense projects: water, motive power, fertilizers, agriculture, transport, industry. The end result: a territory as large as France snatched from the grip of erosion, which, with a terrifying speed, was laying waste wide stretches of arable land. Now, victorious life was regaining possession of the salvaged land, performing upon it one of the greatest syntheses of modern organization. It is in enterprises of this kind that both the U.S.S.R. and the U.S.A. have shown the full extent of their power.

At that time I met in New York one of my former assistants, Wachsmann, who, with admirable energy, had founded the 'Panel Corporation' with the object of supplying the housing industry with the elements of mass production. Our mutual friend, Walter Gropius, holder of the Chair of Architecture at Harvard University in Boston, was helping him to guide his enterprise towards a true architectural dignity.

I arrived too late to take part in the work of these friends. The question remains open: Wachsmann adopted a standard in the form of a chessboard, ruled on the basis of the single modulus of a square. It has been the Japanese tradition through the ages to construct their admirable wooden houses on a modulus which is certainly much subtler than this: the plait (the *tatami*).[1]

I should have liked to bring to the United States, the home of mass-production, the assurance of unlimited variety which I believe our harmonious rule is able to provide.

On my return to Paris in February, a chance encounter enabled me to tell

(1) The *tatami* is one *ken* long and a half *ken* wide. The *ken* varied according to the province. The Kioto *ken* is the peasant *ken*: 1·97 m. The Tokyo *ken* is 1·82 m.; it came into general use when the Emperor came to live in Tokyo. Today it is used only as a measure for traditional houses; in all other forms of building, the metric system is employed.

someone from the U.S.S.R. of the existence of our rule. Nothing has developed so far in that direction.

In the studio in the rue de Sèvres, I instructed Préváral to put in order my notes made on board the *Vernon S. Hood.* The necessities of language demanded that the golden rule should be given a name. Of several possible words, the 'MODULOR' was chosen. At the same time the 'trade mark', the label, was decided upon, the drawing itself supplying an explanation of the invention.

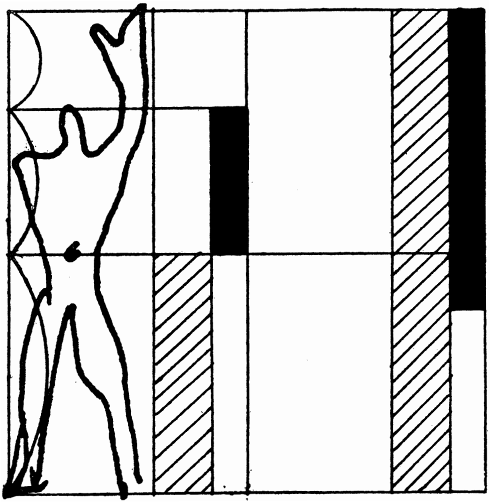


FIG. 19

This time, it was a simple matter to give a description: the 'Modulor' is a measuring tool based on the human body and on mathematics. A man-with-arm-upraised provides, at the determining points of his occupation of space—foot, solar plexus, head, tips of fingers of the upraised arm — three intervals which give rise to a series of golden sections, called the Fibonacci series. On the other hand, mathematics offers the simplest and also the most powerful variation of a value: the single unit, the double unit and the three golden sections.

The combinations obtained by the use of the 'Modulor' have proved themselves to be infinite. Préváral was given the job of preparing a series of demonstration panels. The splendid result was the natural gift of numbers—the implacable and magnificent play of mathematics.

Next, we were asked to round off our figures so as to bring them closer to certain others in current use. The criticism addressed to us was, in substance, this: the figures appearing on the first strip (the one made by Soltan) and in the first numerical table were based on the metric system, e.g. 1,080 mm. for the solar plexus. Ill luck so had it that almost all these metric values were practically untranslatable into feet and inches. Yet the 'Modulor' would, one day, claim to be the means of unification for manufactured articles in all countries. It was therefore necessary to find *whole values* in feet and inches.

I had never anticipated having to round off certain figures of our two series, the red and the blue. One day when we were working together, absorbed in the search for a solution, one of us—Py—said: 'The values of the "Modulor" in its present form are determined by the body of a man 1·75 m. in height. But isn't that rather a *French* height? Have you never noticed that in English detective novels, the good-looking men, such as the policemen, are always six feet tall?'

We tried to apply this standard: six feet$=6\times 30{\cdot}48=182{\cdot}88$ cm. To our delight, the graduations of a new 'Modulor', based on a man six feet tall, translated themselves before our eyes into round figures in feet and inches!

It has been proved, particularly during the Renaissance, that the human body follows the golden rule. When the Anglo-Saxons adopted their linear measures, a correlation was established between the value for a foot and that for an inch; this correlation applies, by implication, to the corresponding values in the body. From that moment onwards, we were dedicated to translating our new 'Modulor', based on a human height of six feet (182·88 cm.), into round figures. We were thrilled. Soltan drew a new graduated strip, this time in its final form, which replaced the old one in the little aluminium box at the bottom of my pocket.

Exact value in metres	Practical value	Exact value in inches	Practical value
101·9 mm.	102 mm.	4·012″	4″
126·02	126	4·960″	5″
164·9	165	6·492″	6½″
203·8	204	8·024″	8″
266·8	267	10·504″	10½″
329·8	330	12·98″	13″
431·7	432	16·997″	17″
533·9	534	21·008″	21″
698·5	699	27·502″	27½″
863·4	863	33·994″	34″
and so forth . . .		and so forth . . .	

Overcoming this obstacle brought us unhoped-for encouragement: we felt that the Modulor had automatically resolved the most disturbing difference separating the users of the metre from those of the foot-and-inch. This difference is so serious in its practical effects that it creates a wide gulf between the technicians and manufacturers who use the foot-and-inch system and those who work on the basis of the metre.[1] The conversion of calculations from one system into the other is a paralysing and wasteful operation, so delicate that it makes strangers of the adherents of the two camps even more than the barrier of language.

The 'Modulor' converts metres into feet and inches automatically. In fact, it makes allies—not of the metre, which is nothing but a length of metal at the bottom of a well at the Pavillon du Breteuil near Paris[2]—but of the decimal and

(1) I speak from personal experience, having suffered the tortures of the damned at the United Nations in New York in 1947 when I was drawing up the plans for the new Headquarters on the East River. No one who has not felt the maddening and discouraging effects of the incompatibility of numbers can appreciate the seriousness of the situation here described.

(2) A correction: the absolute value of the metric standard has now been replaced by the wavelength of a particular colour.

the foot-and-inch, and liberates the foot-and-inch system, *by a decimal process*, from the necessity for complicated and stultifying juggling with numbers—addition, subtraction, multiplication and division.

'How grateful we should be to the method of numeration by position, and to the use it makes of the zero. Without it, arithmetic would doubtless never have emerged from its Greek chrysalis. . . . Does not its happy influence make itself felt in all the mechanisms, not only of the mathematical apparatus, but also of those techniques on which the power of the great modern State is founded?'[1]

On May 1st, 1946, I took the plane for New York, having been appointed by the French Government to represent the cause of modern architecture at the United Nations on the occasion of the building of the U.N. Headquarters in the United States.

I had the pleasure of discussing the 'Modulor' at some length with Professor Albert Einstein at Princeton. I was then passing through a period of great uncertainty and stress; I expressed myself badly, I explained the 'Modulor' badly, I got bogged down in the morass of 'cause and effect' . . . At one point, Einstein took a pencil and began to calculate. Stupidly, I interrupted him, the conversation turned to other things, the calculation remained unfinished. The friend who had brought me was in the depths of despair. In a letter written to me the same evening, Einstein had the kindness to say this of the 'Modulor': 'It is a scale of proportions which makes the bad difficult and the good easy.' There are some who think this judgment is unscientific. For my part, I think it is extraordinarily clear-sighted. It is a gesture of friendship made by a great scientist towards us who are not scientists but soldiers on the field of battle. The scientist tells us : 'This weapon shoots straight: in the matter of dimensioning, i.e. of proportions, it makes your task more certain.'

In his consulting engineer's office on Broadway, I had explained the 'Modulor' to Mougeot, founder, in Paris, of the C.O.E. (Committee of Economic Organiza-

(1) François Le Lionnais: *La Beauté en Mathematiques*, Cahiers du Sud, 1948.