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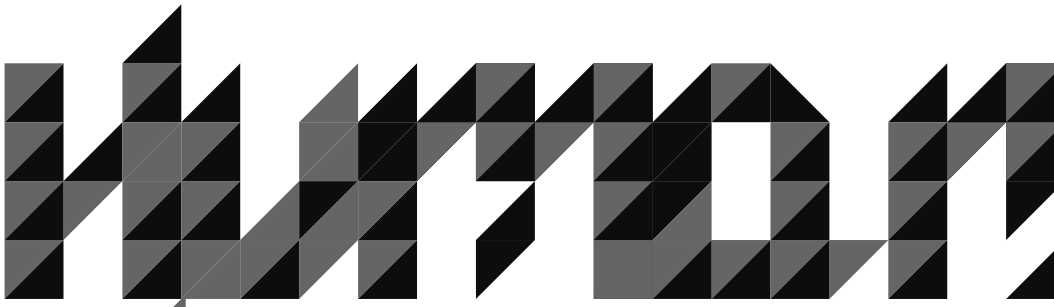

RETHINKING THE HUMAN
IN TECHNOLOGY-DRIVEN ARCHITECTURE

EDITORS MARIA VOYATZAKI | CONSTANTIN SPIRIDONIDIS

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International Conference

Rethinking the Human in Technology Driven Architecture

Transactions on Architectural Education No 55

Editors
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Constantin Spiridonidis

Cover design: Emmanouil Zaroukas

Layout design: Dimitris Apostolidis

Printed by: Charis Ltd, Thessaloniki, Greece

ISBN 978-2-930301-53-2

Despite the attempt to transcribe with accuracy the debates from the workshop, the editors wish to apologise in advance for any inaccuracies of the interventions of individuals that could be attributed to the quality of recording.

(Re)thinking a critically responsive architecture

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House-as-Machine: the Influences of Technology during early Modernism

By focusing on the concept of *house-as-machine*, machine's early adaptations to the house are compared to the socio-cultural context of early modernism. A set of variations of *all-electric house* developed in Europe and the US is presented along with the cultural differences between these two geographic areas. Meanwhile, in response to the economic crisis of the Thirties, *house-as-machine* was adapted into case studies on the minimum dwelling [*Existenzminimum*]. Rooms having specific mechanical function such as the kitchen and the bathroom were symbolic ones concerning economy and competence. Additionally, the machine became a reference to a more systematic understanding of architectural design. Ernst Neufert's book *Architect's Data*, first published in 1936, is a comprehensive guide about the integration of machine's characteristics into architecture, whereat the house is given a prominent place. Le Corbusier's *Dom-ino House* and *Citrohan House* are concise manifestations of the architect's related interest. Upon comparison, it is claimed that the designs are not always automatic translations of the machine into architectural space; in that case, they rather carry contradictious qualities.

House-as-machine

In early modernism, the machine was appointed as a multifaceted reference for the definition of the modern house. The related research focused on the technological evolution of domestic appliances, also on efficient and ergonomic design, the development of new typologies for the house unit and the housing complex, the standardization of construction using prefabrication and the building industry, the new materials and the highly sophisticated solutions and techniques in the construction site. These studies were framed by an upraising interest in building development, including its market. In the present paper, machine's influences to the house are organized according to an evolutionary schema. First, technology is viewed as a cue being supportive to domesticity. Then, ergonomics and functionality are being discussed in relation to the design of the house. Finally, the machine is examined as a model of organization in the modern house, with respect to architectural space and construction. This set of references of the machine represents the spectrum of metaphors between technology and architecture, which has been established since modernism, as it stands to the present.

The support of domesticity by technological means was possible due to a variety of technological innovations of electrical appliances, whose aim was to modernize common operations. One of the first technologically equipped houses was presented in the IV Triennial Exhibition of Monza, Italy, in 1930 (Fig. 1, 2). The *Electric House*, [*La Casa Elettrica*] designed in Milan by Luigi Figini, Auido Frette, Adalberto Libera, Gino Pollini of Gruppo 7 and Piero Bottoni, is an exemplary case of *machine-house* offering a variety of typologies, with potential for mass-production. Apart from the desire to incorporate a number of appliances in the household, the proposal demonstrates a new architectural view about technique, manufacturing and efficient arrangement of space, being expressive of modern life. Technology was present in the form of new building materials and techniques, also of contemporary queries on the problem of dwelling, mainly with the rearrangement of the plan. There are apparent differences between the *Electric House* and the folk Italian house. The traditional ways of living were closely attached to the Mediterranean climate, and so it was difficult to adapt the new technological achievements, the international standards and the modern

Fig. 1 & 2

The *Electic House* [La Casa Elettrica], designed in Milan in 1930, by Luigi Figini, Auido Frette, Adalberto Libera, Gino Pollini of Gruppo 7 and Piero Bottoni.

aesthetics to what had existed before. The *Electric House* proposes a dialectical relationship between new technologies and the special character of traditional life. In respect, special attention was given to unite the interior with the exterior through wide openings, also with the placement of greenery to the interior and the positioning of semi-open spaces in the building's volume. Overall, the *Electric House* demonstrates a mechanical logic responding variously to a set of timely contemporary challenges about space organization, advanced manufacturing and construction methods, high-tech equipment and a wholly new approach to aesthetics.

During Interwar, industries such as General Electric Company and Westinghouse Electric & Manufacturing Company promoted a series of all-electric houses built across

USA, aiming to conquer the related market. In 1933, at the Chicago Century of Progress exhibition featuring fully electrified houses, General Electric Company introduced the *Talking Kitchen* as this (Fig. 3):

> *"'There are no attendants in this kitchen, but ... a voice from an unseen source announces that this is the last word in kitchen equipment. As if by magic the door of the electric refrigerator opens and the voice, coming apparently from the refrigerator, relates how the refrigerator saves money for the owner. Then a spotlight falls on the electric range, the oven door lowers,' and a voice explained its operation, and so on through the rest of the appliances. By eliminating the attendant, the company seemed to say that the kitchen worked by itself"* (1933, as cited in Nye, 1990, pp. 357-358).

Fig. 3
The Talking Kitchen, by General Electric Company designed in 1933.

An interest on the matter was growing rapidly and in 1935, General Electric Company in cooperation with Federal Housing Authority sponsored the *Home of the Future* architectural competition. Westinghouse Electric & Manufacturing Company's dynamic response was to promote its first *All-Electric Home* in Mansfield, Ohio, in 1934 and later, in 1939, to publish a proposal on *The Electric Home of the Future* (Fig. 4) in *Popular Mechanics* magazine, asserting full automation of every function and maximized practicality in design. More ideas followed in the following years and in 1949 "Science Illustrated" magazine hosted an advanced version of the *Electric House* (Fig. 5), which, apart from automation —using equipment from Touch Plate, Square D. and General Electric Company— was equipped by a central control system operating through a wireless network, with the prospect that a large part of the market embraces these technological advancements within ten years (Science Illustrated, May 1949, pp. 66-69).

Taken together, the various companies' views on the *house-as-machine* are domestic expressions of the "technological sublime" (Nye, 1990, pp. 359-360). Ideally, the domestic activities would be programmed so that the *machine-house* functions as a sort of self-decisive mechanism controlling all aspects of everyday life. However, the proposed relationship between the dweller and technology was not unresistingly accepted by the public; rather, the consumer felt a loss of control in his own sphere of control, a probable reason for its marketing failure in the first place. In retrospect, the venture had much more complex implications. The psychosocial significance of the house as a symbol of tradition and of customary habits being transferred essentially unchanged from one generation to the next, had to be replaced by a modern view of the house being at the center of technological advancement. To this end it took a long campaign, so that any of the resident/consumer's hesitation due to the invasion of technology in the household was eventually alleviated. As an example, in

Fig. 4

Hybrid body with mutable extensions in evolving space (drawing by author).

Fig. 5

A technologically advanced example of *The Electric House*, published in *Science Illustrated* magazine in 1949, using equipment from Touch Plate, Square D. and General Electric Company.

The Electric Home of the Future article, the three-dimensional artistic image depicts the living standards of tomorrow: a highly equipped kitchen adds to the domestic coziness, being united to the extended living room, where the children play happily and the husband reads his newspaper, while the wife/mother is serving coffee. Advertising images of similar content gradually altered the state of consciousness for the consuming public and technology was related to intimacy, privacy, control, individuality and character. This friendly and technologically advanced domestic environment would be expressive of the new values such as utility, luxury, sophisticated style, or a combination of them. From then on, the modern view of dwelling would be about a stylishly equipped household functioning tirelessly, also with safety, comfort and economy, in so doing providing more spare time for relaxation and wellness (Ross, 1996, p. 89). Over the years, the industry and the market of domestic appliances have managed to be very successful to the updated standards. Designing the *machine-house* of the future would be about the seamless integration of all sorts of appliances into a unifying total. Technology would serve every domestic activity, while its presence, refined, contemporary, modern, simple and friendly, suggested a sense of progress towards a better future. Technological evolution has continued since then, being supported by research in engineering, industrial design, electronics and computer science, also under the objective to take hold of the market. Seen from this perspective, the *machine-house* is better understood as a case study for a new lifestyle, for which technological innovation responds to the daily needs, even those being artificial.

In architecture, *machine-house* would infer a total redesign of the house as an "apparatus for living." For that purpose, it was firstly important to identify those everyday activities also offering an updated understanding of them; then, to address these activities with regard to spatial relevance and to the relationships among them, in order to outline the new design principles. This new trend is reflected in the *House that Works article*, published in *Fortune* magazine, in 1935: "a building, whether it be a dwelling or a factory or a post office, is a tool. That is to say, the house is an instrument fabricated for a purpose" (Fortune 12, Oct. 1935, p. 59-65, 94, as cited in Nye, 1990, p. 359). The view of *machine-house* as an instrument refers to all of the functions assigned to the household, with a generalized intent for maximized efficiency. Such requirements highlight the importance attached to the relationship between a task and the time needed for its execution. The aim for optimal time-management is typical of modern life. Richard Buckminster Fuller describes time as a new dimension that must be taken fully into account in the design of the house. Time-saving is accomplished by the segregation of functions "being individually solved," (Fuller, 1928) thus being translated to a dominant philosophy often requiring specialized design and technological support. Overall, the *machine-house* responds to the idea of a house that "performs" as effectively as possible, under the premise of maximum functionality.

In Response to the Economic Crisis
The Minimum Dwelling

The definition of functionality in the house was influenced by broader social factors, even by historical upheavals. For example, in the early thirties, functionality was viewed as a possible response to the economic crisis. Architecture's socially driven mission was to meet the living needs of the less privileged layers of population. Thus,

functionality would be translated to efficiency in space utilization. A growing interest on *Existenzminimum* being about the house on a minimum size would represent a new culture of everyday life in Europe (Heynen, 1990, p. 41). Existenzminimum was part of a broader survey under the name Das Neue Frankfurt, first presented in 1926 and then published in 1929 for 2nd CIAM held in Frankfurt, whose theme was The Minimum Subsistence Dwelling [*Die Wohnung für das Existenzminimum*] (Heynen, 1999, pp. 43-8 and Mumford, 1999, pp. 33-4) (Fig. 6, 7). The study was to set the minimum standards of quality and comfort for a house unit, then to incorporate this unit into housing complexes and so to make up entire neighbourhoods, all following the same principle. It took place during the Twenties in Central Europe and especially in Germany, where many housing assemblies were built known as *Siedlung*. Hilde Heynen explains how in a short time period from 1927 to 1931, due to the economic crisis, the objectives of the design research on the minimum dwelling were in total harmony to the qualities of the machine (Heynen, 1990, pp. 48-63). Indeed, the dimensions of the constituents of a house unit and the relationships between them would have to be assertive of efficiency. The same intention is evident in the functional definition of rooms being typical of domestic living such as the living room and the bedroom, also in an effort for the minimization of supportive areas such as the entrance hall and the corridors.

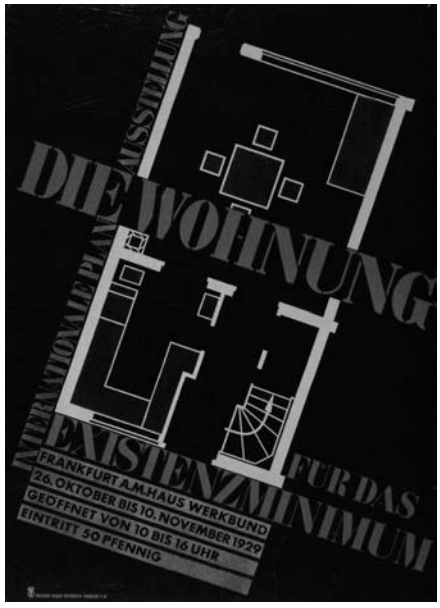

Fig. 6

Poster of the exhibition *Die Wohnung für das Existenzminimum*, held in Frankfurt, in 1929.

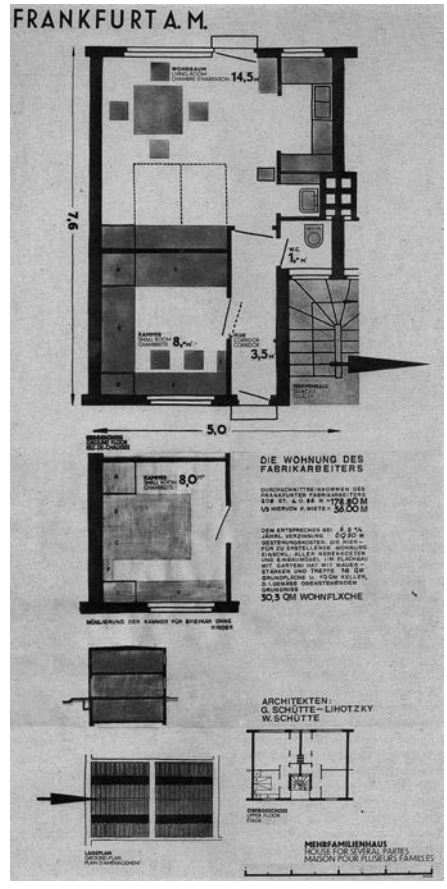

Fig. 7

Design by Grete Schütte – Lihotzky and Wilhelm Schütte, standard worker's apartment house in Frankfurt, (2nd CIAM, 1929).

In particular, the machine model is applied in full in rooms with advanced mechanical requirements, such as the kitchen and the bathroom. Because of their engineering and technological specifications, these rooms were viewed as symbols of the mechanical operations in the domestic environment and they were often given a hi-tech aesthetics, as in the scientific laboratory. A typical example of this is *The Frankfurt Kitchen* [Die Frankfurter Küche] (Fig. 8) by Grete Schütte – Lihotzky in 1926, designed to be in every household. The project was included in the extended survey of *Das Neue Frankfurt* on the minimum dwelling. As Schütte – Lihotzky explains,

> *"we regarded the kitchen as a kind of laboratory, which, because so much time would be spent there, nevertheless had to be 'homey.' The time required to carry out the various functions was measured using a stopwatch ... in order to arrive at an optimum, ergonomic organization of the space. ... The cost savings resulting from the reduced size of the kitchen remained significant, however, so that the Frankfurt Kitchen offered the double advantage of lower construction costs and less work for the occupants. Only by arguing in these terms, was it possible to persuade the Frankfurt city council to agree to the installation of the kitchens, with all their sophisticated work-saving features. The result was that, from 1926 to 1930, no municipal apartment could be built without The Frankfurt Kitchen"* (Schütte – Lihotzky, n.d.).

Fig. 8
The *Frankfurt Kitchen* [Die Frankfurter Küche], designed by Grete Schütte – Lihotzky, in 1926.

In the above description, the conditions of efficiency and performance are evaluated through a combinatory compromise between optimal work in shortest time and lowest cost. Functionality is directly related to economy and is implemented along with technological support of the domestic activities, size minimization and industrialized fabrication using standardized measurements. In general, machine's nominative characteristics would be fixed up as a set of principles outlining the new ideal about dwelling, and then be transferred to a more systematic design of the house.

A focus on systematic design grew along with the development of ergonomic standards and guides describing human activities, as it was extended in designing other building types, too. For example, Ernst Neufert's *Architect's Data* handbook guide provides an essential reference for the design and planning about a building project, as a comprehensive collection of data about requirements, criteria, considera-

tions of function and site adaptation. Neufert's book, originally published in Berlin in 1936 (with the title *Bauentwurfslehre*), has been a prominent contribution to the survey on efficient space design. Neufert addresses the subject using detailed tables and schematic explanations, so that every decision would be taken in response to fully measurable data, also clearly specified descriptions and methodologically controlled design operations. In the same logic, the book outlines detailed listings about every space type, function and activity, aiming to lay down any possible case. Specifically for the house, the schematic proposals refer to each room in relation to function, such as the living room, the bedroom, the auxiliary room, the circulation areas and the engine room, even to outdoor areas, the garden, the pool, the parking lot and every other one. Additionally, a series of alternatives is presented, such as sites with different characteristics, cabins, villas, apartment buildings and housing complexes. The variations are exhaustingly analyzed and accurately designed, with specific dimensions relating to every description, including construction solutions, details, amenities, interior layout and furniture design.

The author extends the ideal of efficient design by suggesting an all-systemic approach for the house, as well as for any other functional program and building type. Additionally, he offers solutions about the static behaviour of the building, also sustainability, energy efficiency, even aesthetics. In fact, the chapters "The Eye", "Man" and Colour" are devoted to visual perception (Fig. 9). A set of comparative criteria is given to study the aesthetic effects of various sizes, shapes and colours (Neufert, 36th ed., 2004, pp. 37-43). The chapter "Proportions" is devoted to the geometric construction of *Golden Section*, which, in subsequent editions of the book, is compared to Le Corbusier's *Modulor*. In Neufert's book, architectural design is treated as a decision-

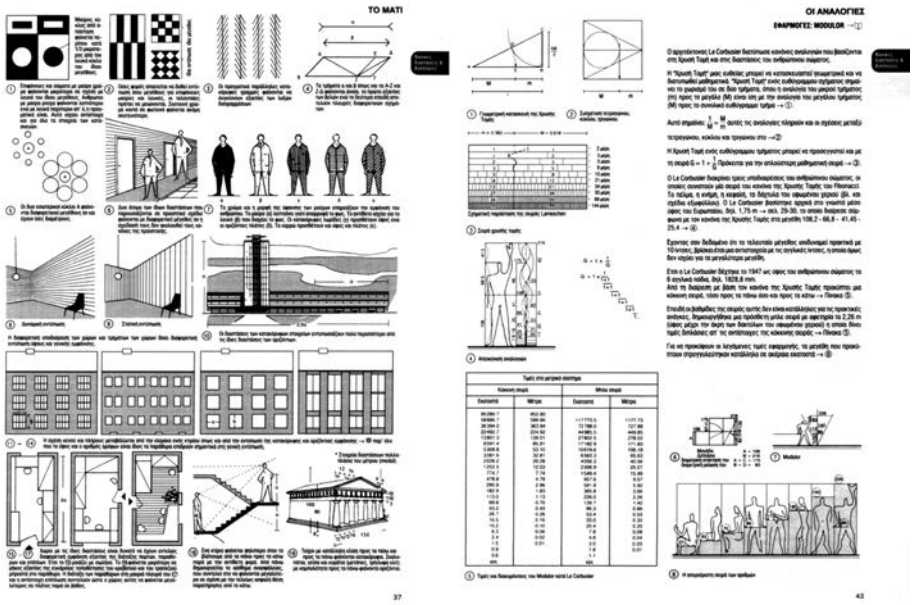

Fig. 9

Ernst Neufert, The eye and Proportions: Modulor, in *Architect's Data*, 36th edition (in Greek), 2004.

making process, whereby the building's space and the final form arise through firmly rationalized steps being related to predefined imperatives and problems, leading towards their best resolution. Systemic approaches in architecture are notably rooted on this part of modern tradition, whereat the machine model with its symbolic meanings and connotations is infused in every design decision.

Le Corbusier's Trajectory on the *machine-house*

Since early modernism, Le Corbusier developed laborious studies on the *machine-house*, finally leading to a complete redefinition of the house. Initially, he focused on space organization with regard to efficiency and ergonomy; soon, however, he sought for an entirely new approach, for which the *machine-house* aimed at establishing the design principles about modern architecture. Le Corbusier's architectural vision presented in his influential book *Toward an Architecture* in 1923 is based on the machine model. As in manifesto style, the architect/author compares the values of modern architecture to those a machine is built. His view of the house as a *Machine for Living* [Machine à Habiter] (Le Corbusier, 1923), was revolutionary in the sense that contemporary dwelling is defined as a problem needing rational solution. For Le Corbusier, the house is a central case: "To study the house for the common man, for 'all and sundry,' is to recover human foundations: the human scale, the typical need, the typical function, the *typical emotion*. There you have it! That's crucial, that's everything" (Le Corbusier, 1923). After attempting to pose "right at last" the problem of dwelling —as it was still pending, he states— Le Corbusier sets the daily necessities as the basis for rational resolution. Then, he establishes a list of "conveniencies" upon which he composes a *Housing Manual* (Le Corbusier, 1923). In his comprehensive work, Le Corbusier records in detail the requirements of dwelling, also mentioning the significance of every room and element in the house, including the terrace as a place for sunbathing, the outdoor space, the garage for the car, the bicycle and the motorcycle, the maid's room and the bathroom. The list goes on with the walls, the exercise equipment and furniture such as tables, chairs, storage units and drawers, the gramophone and the ventilating panes. The author responds to the problem of dwelling by a set of standards based on the logic of practicality, functionality, economy, prediction, regulating lines and standardization of construction (Le Corbusier, 1923). The machine contributes in the solution as a model that directs, enhances and improves both the design of the house and the experience of dwelling.

Two years before, in 1921, Le Corbusier had presented *Citrohan House* (Fig. 10), as a typical solution for the mass-produced house based on economy. The name invokes the French automaker Citroën, as with it Le Corbusier compares the house to a car. The *house-as-car* concept introduces two more principles: first, Le Corbusier prefers using the term "equipment" [outillage] rather than "furniture;" second, he exerts the importance of mass-production, affecting price, availability and fabrication in short time (Le Corbusier, 1923 and Banham, 1960, pp. 221, 233). Spatial arrangement responds to efficiency and practicality of function. Special attention is given to natural lighting about each room regarding orientation and occupation, also to the maid's room and the bathroom. The solutions given reflect a long time period of research and were based on standardization of design, also of the plan and construction, under the aim to keep costs as low as possible. The proposal brings up a combination of

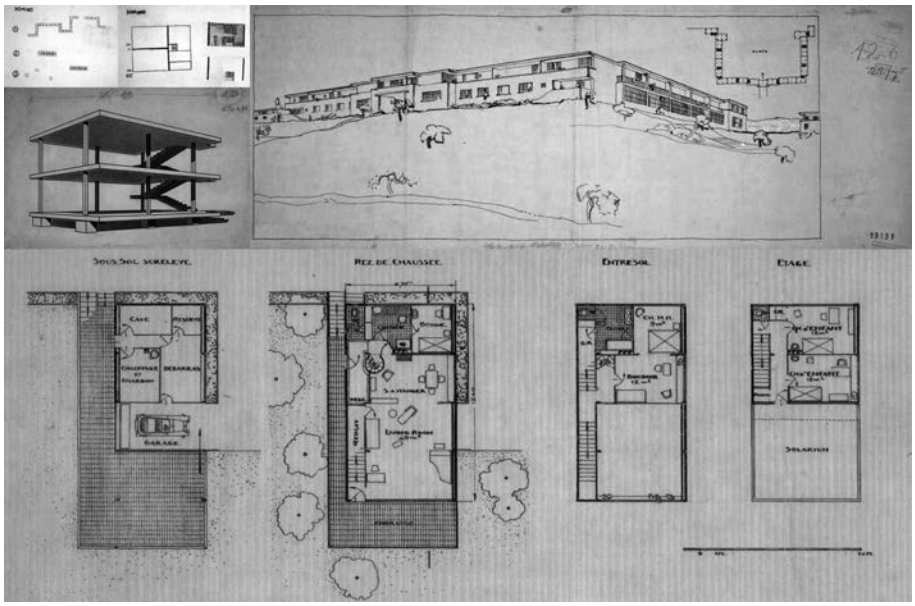

Fig. 10
Le Corbusier, *Citrohan House*, 1921 and *Dom-ino House*, 1914.

adaptability of the general design to specific requirements, along with compatibility of the construction elements and the possibility of fabrication and assembly on the site. In 1914, Le Corbusier had responded to these issues with *Dom-ino House*, a framework structure that could be repeated also permitting a great variety in the grouping of the houses. The frame is made of elements of reinforced concrete. It supports the walls (cavity walls with 20 cm voids enclosed by 3 cm skins made of cement sprayed onto stretched sheet metal), the floor slabs and the stripes of factory window frames, all to the same module. Most of the propositions of *Dom-ino House* are present in *Citrohan House*. *Citrohan House* is highly innovative for its time for the way it readdresses the problem of dwelling under the premise of standardization.

With *Citrohan House*, the machine model conveys a mechanical quality to the processes of design, also to construction and domestic living. First, new techniques are invented for the systematization of fabrication, along with the designing of the prefabricated walls, the framing system and the foundations (Banham, 1960, p.244). The structure exploits the potential of new materials and of reinforced concrete, also of the advancements brought by building technology and industry and so it proposes a new view on flexibility in regards to construction and spatial organization. Furthermore, the house meets the challenges of modern living as a "utensil" carefully designed, also being subtle, compound and adjustable. Modern house's lifetime is defined by the time period that a house satisfies its operational requirements, as it may be repaired even be replaced, much like when a machine, a car, or a tool does not work, does not fit, or is not sufficient anymore and so this would be the time to throw it away (Banham, 1960, p. 241). *Citrohan House* may be mass-produced as a system that is repeated horizontally and vertically as well. It may also be in great variety,

responding to the individual's requirements, social status and budget, from factory housing to artists' studios to villas and to mansions for the rich (Le Corbusier, 1923). As Frederic Migayrou comments, "by linking the name *Maison Citrohan* to the field of automobile production, Le Corbusier had definitely caused a seminal break in the understanding of dwelling. The house became a true product, an object entirely organized by a system of processes, finite, circumscribed and valued in terms of cost and return on investment" (Migayrou, 2002, p. 18). The rationale of the machine model yields its qualities to the produced object: the design of the house follows closely the emerging technological capabilities, meanwhile setting the aesthetic trends for the house of the future. Le Corbusier's extended survey on standardization includes the *Village of Pessac* (1925). By taking advantage of the recent advancements in the industry of prefabrication, new methods of standardization were applied for the production of architectural elements such as walls, floors, ceilings and beams. The whole village was completed in less than a year at low cost, using reinforced concrete and prefabricated components, also following preplanned methods of assembly.

In respect, Le Corbusier's study on the *machine-house* would induce to an abandonment of the romantic idea of the traditional home that was expressive of the owner's customs and personal style, promoting instead the values of the machine, along with up-to-date requirements such as hygiene, comfort, utility and practicality. Soon, similar issues would set the main guidelines for the design of the modern house, further establishing a whole new culture. Architecture's main interest would be to supervise all of the individual parameters and the decisions along the processes of design and construction. In this course, Le Corbusier went as far as to compare the *machine-house* to a tool. Meanwhile, he treated architectural qualities and aesthetics as being more permanent, reflecting the true values and the essential preconditions of life; in so doing, he would ensure livingness and sustainability for the house and for architecture as well. Le Corbusier's research trajectory manifests an evolutionary transition towards a completely original conception about architecture, for which the machine represents an integral model about space in regards to function, order of organization and the modes of production.

Conclusion

In the course of modernism, the concept of *house-as-machine* is reflected into a set of variations. Initially, it is identified as a plain support of the domestic activities by technological means; then, it is extended to ergonomic design of the house, in response to every possible design issue. Rooms with mechanical requirements favour a more integrated implementation of the machine, whereas rooms such as the living room and the bedroom are more flexible, as these may change in house's lifetime. Studies on the house of that era would focus on a special kind of variableness permitting transformations through standardization. The machine offered itself as a main reference to a radical revision of the design principles and a new philosophy about architecture. Compound structural models may offer more complex properties and may better respond to space's total behavior; in that case, machine's qualities such as efficiency and performance may be combined to other ones such as openness, flexibility and adaptability.

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