A Typological Housing Design:
The Case Study of Quartier Fruges in Pessac by Le Corbusier

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Abstract
This paper aims to discuss the methods of form production in Le Corbusier’s housing design from a typological point of view and to explore his composite principles of rational housing. Specifically, this paper looks at how Le Corbusier produced spatial variety and unity by applying composite principles to housing design and production. We will take the Quartier Fruges housing project in Pessac as a case study. Here Le Corbusier applied his cellular concept to housing, creating a new typology that first appeared in sketches for this project. Le Corbusier’s numerically-based production rules governed the development of each unit’s space, while the constructive rules of the housing project’s five housing types show how Le Corbusier dealt with the demands of modern housing, and innovated design solutions which can be applied to the spatial design of today’s housing. Finally, this paper looks at how Le Corbusier dealt with the spatial characteristics of these five housing types under different conditions.

Keywords: Object-type, Housing design, Typology

Introduction
Housing design attracted many of the 20th century’s greatest architects. Le Corbusier (1887-1965) was one of the most influential modernistic architects of this period. His ideas were elegant and clearly expressed, and he was a prolific worker who proposed many different housing types and brought a positive outlook to the mundane field of housing design. This paper aims to study low-rise housing that Le Corbusier designed during the early years of his career for a small community, and to review the impact of this project on future housing design.

The author has chosen Le Corbusier’s design for Quartier Fruges, a worker’s housing project located in Pessac, as the subject for this case study because the architect clearly expressed his design principles in this project’s conceptual sketches. The principles of housing design that Le Corbusier applied in this project draw on concepts used in object-type industrial production, and repeated appear in all his architectural designs. Since this is first time that Le Corbusier put his idea of object-type housing design into practice with free reign granted by the owner, this case provides a unique opportunity to examine the ways in which he put his housing design principles into practice.

Furthermore, this paper studies the design process and methods that Le Corbusier applied towards housing design and particularly form production from a typological point of view. This project allows us to see how Le Corbusier developed his composite principle of rational housing. Looking at his prototypes, we can see that when these composite principles are applied to housing design and production, they create both spatial variety and unity. Since the 19th century, western architects have tried to integrate different professional concepts and theories, hoping to create a new form of architecture that meets the needs of the time and people’s values. Le Corbusier is a good example of this phenomenon. Basing his designs on an analogy between machinery and housing, Le Corbusier pioneered hyper-rational designs that continue to be very influential today, proving the feasibility of his concepts. An understanding of this particular project is essential for understanding Le Corbusier’s theories and his impact on the field of housing design as a whole.

Literature Review and Research Structure
Before embarking on an analysis of this case study, it is helpful to review existing literature on Quartier Fruges in Pessac and the ways in which it has informed the structure and the research goal of this
paper.

Critics have taken two approaches to Le Corbusier’s decision to base the design of this worker’s housing on his modernistic concept of the house as a “machine for living.”

The first approach reviews the effectiveness of Le Corbusier’s machine analogy through the lens of “post-occupancy evaluations.” These studies compare the ideal of the architect with the actual use of the housing after occupancy. For example, Boudon (1972) has provided us with an interesting observation: while residents who moved into the houses at a later period accepted the original functional space, almost all of them made changes to their houses. For instance, the color was changed; the modern flat roof was remodeled to be pitched roof; the ribbon windows was partially changed to be narrow windows; the compartment wall was moved and the passageways were changed visually or structurally. These changes showed that Le Corbusier’s sense of modern beauty did not always match up with the needs of the general public.

The second approach points out the fact that Le Corbusier’s “deliberate” housing design for the housing project in Pessac was later remodeled by occupants. Rejecting Le Corbusier’s typology is, these scholars argue that Le Corbusier’s decision to abandon existing housing types ultimately ended in failure. (Wang, 1996:33). Because the anonymous housing type is a natural product of society, housing types will naturally multiply as new houses are constructed, much in the same way that living beings develop and evolve over the generations (Wang, 1996:32). These housing types, which gradually form in response to an environment, are more likely to fit contemporary lifestyles.

However, it is inappropriate to presume that Le Corbusier’s housing project failed simply because his housing types were later remodeled. One must consider the fact that Le Corbusier lived in the mechanical era, a time of innovation and rapid change. He adopted a mechanical analogy with the intention of making housing design and production more accurate and efficient for mass production. In other words, Le Corbusier’s goal was not solely to create a new housing type, but rather to create a new method of housing design, one which transformed the housing type into a prototype used in industrial production. (Moneo, 1978: 33). McLeod (1985) echoes this view. He points out that Le Corbusier used the repetitive features of industry for efficiency, not for beauty; therefore, it is inappropriate to study Quartier Fruges simply from the aspect of aesthetic value without first clarifying its larger significance in the development of 20th century architecture and attempts to merge industrial principles with architectural design.

The author has chosen Le Corbusier’s design for Quartier Fruges, a worker’s housing project located in Pessac, as the subject for this case study because the architect clearly expressed his design principles in this project’s conceptual sketches. (Fig. 1) The principles of housing design that Le Corbusier applied in this project draw on concepts used in object-type industrial production, and repeatedly appear in all his architectural designs. Since this is first time that Le Corbusier put his idea of object-type housing design into practice with free reign granted by the owner, this case provides a unique opportunity to examine the ways in which he put his housing design principles into practice.

Hence, in the first part of this paper we will analyze the significance of Le Corbusier’s method in the context of contemporary architecture. Here we focus on the social circumstances in Le Corbusier’s time, so as to understand the origin of his theory of housing design. In the second part of the paper we will analyze his attempts to incorporate a mechanical approach to housing design by looking closer at a set of his conceptual sketches for this particular project. Here we analyze the use of space in Le Corbusier’s work (which, in this case, is the housing project in Pessac) and studies the finalized five housing types from three different aspects:

1. Le Corbusier was the first architect to use the abstract concept of “cellules” to design low-rise clustered housing. We will examine the object-type design method, in which cellular units are transformed into housing prototypes without considering environmental conditions, and larger units are then structured by combining the units in different proportional relationships. We will explore the combination and variation of basic spatial mass with a diagram of space units from the production rules of housing types.

2. We will look at the principle of constructive rules and Le Corbusier’s use of space in the five different housing types to see how he met the spatial challenges of modern housing. We will focus on the combination of exterior forms and discuss the arrangement of serial elements, the principles of basic design and plus-minus method. For the arrangement of serial elements, the floor, wall, roof garden and
special elements will be analyzed. In the principles of basic design, the authors will study Le Corbusier’s methods of combining space and structure, as seen in drawing and analytic indicators, including variations of scale, proportion, axes, symmetry, upending, devolution, penetration and overlap. We will also analyze the relationship between the functional interior space and the exterior form.

3. Because Le Corbusier emphasized the harmony between the exterior and interior elements of an architectural structure, we will look at the way he dealt with the surrounding environment when arranging the five housing types and the overall space.

The Significance of Clustered Housing for Medium and Low-Income Families

After World War I, Europe required massive amounts of reconstruction. The great demand for houses gave architects more opportunities to implement their ideas. In 1917, Le Corbusier started to practice in Paris. By using new concrete and appropriate structure, Le Corbusier tried to create a reasonable production of housing and space for low-income clustered housing.

In 1923, Le Corbusier’s proposal finally received a response. The businessman Henry Fruges (1879-1974) chose Le Corbusier to design a housing project made up of sections A, B, C and D. However, in the end, only section C and D were completed due to the high cost and financial difficulties on the part of the owner. The four roads leading to each section were connected at their base; hence, we can view section C and D as one base (Fig. 2). The owner had a lot of thoughts about this housing project and he gave Le Corbusier full authority to experiment and to be creative as long as he could control the budget and use constructive rules, such as the wall, the floor and the roof to produce standardized housing.

In addition, the owner also asked Le Corbusier to design the interior facilities within the housing to distinguish this community from traditional housing and to provide the occupants with pleasant, comfortable and convenient housing. The owner expected to provide new esthetics for a new era with the new housing (Shih, 2002: 78).

His needs matched Le Corbusier’s concepts. At that time, Le Corbusier was very interested in the application of mass production technology and standardization of housing. For him, the housing problem was “the problem of our time” (Le Corbusier, 1923/1997: 213) and finding a solution to the challenges of modern housing meant more than just changing the exterior design of traditional housing. Instead, an architect should focus on the design of the house as a whole, and the way in which it functioned as a system.

For Le Corbusier, the production of housing was similar to the production of automobiles. According to him, the house was “a machine for living” (Le Corbusier, 1923/1997: 226). He also reexamined the technical problem of production and streamlined construction procedures, creating easy-to-assemble structures that could be completed quickly using efficient tools and non-professional workers, allowing the builder to create more houses faster.

Le Corbusier’s idea for simplifying housing construction echoed Taylor’s famous principles of production efficiency (Taylorism). Frederick Winslow Taylor (1856-1915) believed that all objects can be analyzed, disassembled, reassembled, optimized while non-skilled workers can be trained to assemble this objects for production. Moreover, Le Corbusier’s idea to shorten production time for mass production took a cue from Henry Ford, who believed that the cost of automobiles could be lowered if production time was shortened. After deciding on specifications for his automobiles, Ford standardized everything from the engine to the screws and used assembly lines to achieve his goals.

The housing project in Pessac was developed in accordance with Le Corbusier’s ideas of housing standardization and industrial production of housing. In “Vers Une Architecture” (Towards a New Architecture), Le Corbusier described the design principles behind Quartier Fruges in Pessac. According to him, the main challenge was to design the housing such that the prototype of the house, the basic units and elements, standard plane, composition, and housing type all could be simplified for efficient and ideally, for mass production. This was the heart of his theory of housing design.

The Five Finalized Housing Types

In the isometric perspective drawing of Quartier Fruges we see five finalized housing types in the base (Fig. 3), which are named as staggered, Z-formation, arcade, skyscraper and free-standing by Le Corbusier. The housing types are somehow interconnected. For instance, staggered and Z-formation share the same
plane surface, but the entrance direction and clearance are different. Also, the names of these housing types are related to their plan. For example, the roof of arcade is arcade while skyscraper is the tallest landmark of the community, even though it is only a three-story building. Simply put, the five housing types share the same spatial form, that is, a single vertical building with different combinations of forms. Furthermore, the design allows occupants to experience vertical space from the ground to the roof and the design can be applied in other designs.

When we examine the spatial arrangement of the interiors of the five housing types, we can establish a link between these different types and the basic characteristic of each single housing type (Fig. 4):

1. The first housing type, “staggered,” has the largest number of houses concentrated in the center of the base. The terraced houses are connected with a long shared wall, which is similar to apartments in Taiwan, but the entrances are staggered to direct occupants to different entrance direction.

2. The second housing type, “Z-formation,” was formed early in the process. Its spatial prototype is similar to staggered, but the combination of forms is a Z-shape. The entrances and exits are all different and the entrance clearance does not alien to the axis.

3. The third housing type, “arcade,” is located near the edge of the base, close to the trees. The most distinctive feature of this housing type is the arcade roof at the entrance. Furthermore, with three 5m×5m cubic modular units, its dimensions are the largest among the five types. The terraced houses are connected with a short shared wall.

4. The fourth housing type, “skyscraper,” is the tallest building in the base with the smallest floor area (half a modular unit less). While the entrance and living space of the first three housing types are on the ground level, the living room of this type is elevated to the second floor and the ground level is used for garage and service functions.

5. The fifth housing type, “free-standing,” has a similar plan as “skyscraper,” with service space on the ground level and living space on the second floor, where the entrance is located. This housing type is basically a conceptual drawing of Le Corbusier’s cellule.

**From Cellule to the Dwelling Unit**

Based on Le Corbusier’s values and the above discussion of housing types, the authors will examine how Le Corbusier put his theory into practice. First of all, we will explain Le Corbusier’s idea that the basic unit of dwelling space is a cell as well as the variations of these units. Then, we will discuss how this idea was applied to his housing design. In particular, we will explore in detail the process through which Le Corbusier applied his core concept of dwelling space to the production rules of exterior form. Le Corbusier’s concept of “cellule” came from the monks’ room in a medieval Italian chapel (Fig. 5). When comparing LeCoburier’s drawings of units and the overall housing mass for Quartier Fruges, we can see that the dwelling units are developed from the monk’s room in the chapel. “Cellule” is the name of the spatial mass in the house and the production of a house comes from the variation and combination of these basic spatial masses.
There are basically two rules of transformation. The first one looks at a dwelling space from the aspect of “unit mass” instead of “floor area.” Hence, the cell nucleus is the basic space unit of a housing mass, and no function is given to these units in advance. This is what Le Corbusier called “1 cellule,” a unit that could be used to design different housing types. In other words, a space unit comes from the combination of the basic units and different housing types of various mass can be developed once functional needs are considered in the later period. However, a numerical and proportional relationship exists between different types. For example, the fifth housing type, “free-standing,” that was finalized in the development phase, was named “2 cellules” by Le Corbusier. Another housing type whose basic mass is twice that of 2 cellules, was then named 4 cellules, and so on.

The combination of the mass of the finalized five housing types follows the principle of basic units shown in the draft, with variations of vertical cascade and horizontal displacement. We will discuss the combination and variation later. Meanwhile, Le Corbusier applied the same concept to window openings in the housing. On the sketch, he set three standard proportional window opening units and then combined them on the vertical plane of the second housing type, “Z-formation.” The proportional relationship of the windows used a semi-fixed, semi-casement window as the basic unit, named “1 fenetre.” The other windows are half and quarter the size of 1 fenetre, so they are named as 1/2 fenetre and 1/4 fenetre. In the finalized housing types, special windows are added for interior functions, such as horizontal windows that are narrow in the outside and wide in the inside.

Another variation is the consideration of abstract conditions that can add to the variations of mass. For example, even if the masses are the same, the addition of pillars and other geometric structural units will lead to different combinations of solid and void to change the overall form and the vision. When we compare the conceptual sketch with the finalized housing form, we can see that Le Corbusier was very consistent. The rational and logical design spells out the standardized method of design of object-type advocated by Le Corbusier. By definition, standardization requires a basic unit that can be repeated. Individual units can be combined differently for different situations, but the unit cannot be changed to suit one particular situation. Hence, the unit is fixed and needs to be standardized by excluding all the other conditions. Bearing this in mind, we use the abstract concept of housing standardization to disassemble the objects with fixed conditions and exclude various external conditions so as to discuss the production relationship of the objects in the finalized housing form. Le Corbusier did consider external conditions, which is why five housing types are developed in the base, but we will discuss this later.

From Prototype to Production
1. The Significance of Typology to Housing Production

According to Anthony Vidler’s classification of “typology”, Le Corbusier’s conceptual model is based on the “mechanical” level, as he was influenced by the Industrial Revolution (Vidler, 1998: 14). The change from “imitation of the nature” to “imitation of the machine” reflected the social situation in Europe after the war, i.e., high housing demand. Hence, how to standardize mass housing gradually became the main issue of housing design.

Modernistic architects tried to establish cluster rules that would be acceptable to the general public and could be produced with existing modes of production. Le Corbusier’s goal was to create a new housing type to solve the housing problem, and his solution heavily influenced the architecture debate over “cluster” and “individual” space. Typology organizes rules; hence, it can develop unlimited possibilities using common features. When we examine the five housing types from a typological point of view, we can see similarities between all the housing types even though they appear very different in their exterior form.

Here we need to spend some time to explain the concept of standardization. Standardization requires the use of modular units and standardized proportions. What Le Corbusier wanted was a set of rules to organize visual forms on both the exterior and interior of the structure. With these rules, architects could achieve standardized results, even in different situations. Similarly, the use of modular units could enhance the internal consistency of the housing.

Le Corbusier chose to use modular units and standardization. In the book “Modulor” (Modular), he pointed out that the goal of “standardization” is to find principles that can be used as rules. “Standards” are the rules that govern the various aspects of an object (Le Corbusier, 1968: 60). Based on this concept, we will analyze the production rules of the housing in this project, keeping in mind their intimate relationship with industrial production.

2. Embodiment of the Concept

As we mentioned earlier, when Le Corbusier designed Quartier Frugés, his main considerations were suitability for mass production and efficiency. We can therefore examine the production rules of the five housing types from a number of various aspects, including the standardized specifications of modular units, types of object combinations, and operation procedures. Hence, this paper attempts to reverse the design process of the five finalized housing types, with the goal of producing a diagram of their production process (Fig. 6).

Before we begin, we first need to distinguish between the “basic unit” and the “special unit”. As
Fig. 6. Dendrogram of the production organization of objects

mentioned before, the establishment of the specification of objects is the first step towards “standardization”. The “basic unit” is a fundamental unit that can be used as a standard. Other objects can then change their size according to or in proportion to the fundamental object. As such, it is a fixed unit. If an object does not meet the requirements of the basic unit, it is considered a “special unit”. According to these principles, three basic units can be distinguished: 1 cellule (a 5m×5m mass unit), 1/2 cellule (a 5×2.5 mass unit), and 1/4 cellule (a 2.5×2.5 mass unit). We can also distinguish seven special units according to three spatial elements (entrance, roof and staircase).

If the relationship between solids and voids is considered, we can add 6 more units. These object-types make up the “basic model” for phase 1 of the operation procedure. Phase 2 is “form variation,” change to the proportions of the basic model. In the last phase, the 26 object-types generated from the previous two phases are combined, and symbols are used to show different combinations of the objects, and thus the forms of the five finalized housings.

Through this process of disassembly and inference, we can sort out two design rules related to the housing types in Quartier Fruges:

1) Housing Design Echoes Assembly-Line Prototype

From this diagram, we can see that the forms of the five housing types are generated using assembly-line logic. First, the dimensions of the basic unit are established, then two forms, one solid and one void, are generated from the basic unit. With the process of congruence and addition, variations are created. When special units are added for systematic combination, the five housing types are produced.

If we look at the combination of the five housing types as assembly-line products, we can see that two basic units, A and B, exist in all five housing types, but that differences in the combination of units change the exterior appearance of each type. For instance, the third type adds the third basic unit, C, to simplify the production process while other types use A and B to create more complicated units, and to special units developed with systematic elements. In other words, the process uses combinations to create complexity.

2) Internal Consistence of Different Housing Types is Integrated using Proportional Relationships

The rules that Le Corbusier was searching for should be based on numerical relationships, which are also the rules used to organize visual forms. The most well-known numerical relationship is the “Golden Proportion” which can be found in most of Le Corbusier’s works. In the housing project in Pessac, the golden proportion is applied on the segmentation and arrangement of the base while the basic units are combined with a geometric progression (1:2:4). The plane surface and the measurement numbers of the mass show a step forward from the ratio shown in Maison Citrohan (2:2), as some space is added for transition, creating a rhythm of 2:1:2. A few years later, when designing Villa Garches in 1924, Le Corbusier used ABABA (1:2:1:2:1) for the intervals from side to side. As for this project, he designed the entrance, the kitchen and the living space of the “staggered” housing type with the ratio of 2:1:2. Later, we will discuss the rational arrangement of space function and rules derived from such arrangements.

The Spatial Organization of Quartier Fruges

We have discussed the abstract concept behind the five housing types in Quartier Fruges and the transformation of the design process from the perspective of “prototype production”. Now we need to turn to the spatial features and the
organization to further understand the principles of the form variation. In this section, we will look at the overall relationship formed by spatial organization and systematic elements to examine how Le Corbusier dealt with the spatial organization of each of the five housing type and the rules that he used. Based on the variations in the mass of each type, the authors have reconstructed the overall rules of spatial organization by looking at the exterior characteristics as various unit combinations and comparing them with the interior spatial functions (Table 1).

1. Arrangement of Individual Housing Types under the Same Conditions

The first housing type, “staggered,” and the second housing type, “Z-formation,” basically share the same spatial organization, systematic elements and mass proportion, but their arrangement are somehow different, and so achieve different results. For example, for “staggered,” the arc guide wall at the entrance and the clearance on the second floor are in linear relation (symmetric axis) with the bearing of the house. Even though the units are combined with reverse terrace, the visual penetration is not very significant. In contrast, under the same conditions, the arc guide wall at the entrance and the clearance of “Z-formation” are offset axes and the units are connected to show a Z-shape, so it offers great visual penetration. When we compare the variation of the spatial organization of these two housing types on Table 1, it is clear that the architect handled the arc guide walls of the two housing types differently (one is symmetrical and the other dislocated), but all the others are quite the same.

2. Rational Arrangement of Spatial Functions and Rules

Table 1 shows the correlation between the spatial mass and the functions. The basic rule is to increase the scale of the outdoor space and the entrance space to a certain degree. Then various rules of spatial variation, such as clearance, inversion, elevation and disposition are used, which shows the architect’s desire to emphasize the importance of outdoor living space for occupants in the workers’ housing. Even though the living space has not been elevated, as proposed in Maison Citrohan, the complete unit mass and the long, horizontal windows provide rational space. The staircase that connects the stories is 5 meters wide, so as to avoid the common feature of most traditional housing, i.e., too many cleardstories and to make the five housing types different of traditional houses. The functions of the plane surface are reflected on the rational and practical dimension. For instance, the size of the sleeping space is the same as the living room while the kitchen and the hall is half the size of the living room. When all the spatial functions are combined, their widths are controlled properly to proportional to the house and avoid leaving any unused space. Even though Le Corbusier did not use the car space standards for these housing types as he did in “The Radiant City” (Frampton, 1980: 179), all dimensions are carefully calculated. Once established, this rational, standardized arrangement of spatial mass could be used in future projects.

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<th>Housing type</th>
<th>Features of housing type</th>
<th>Variation principles of space organization</th>
<th>Comparison of the interior and corresponding functions</th>
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Table 1. Spatial Organization in Quartier Fruges.
These housing types offer different functions for different activities, adding to the variation of the base. Generally speaking, each housing type has its own garden; at the same time, open gardens of various sizes are formed in between all the housing types. The spatial arrangement is basically similar to the Charterhouse of Éma in Italy, but Le Corbusier’s arrangement of the housing in Pessac is somehow different. Among the five housing types, the first three have complete arrangement with open space at the entrance and living room on the ground level. The occupants’ daily activities are closely related to the outside environment; hence, the architect places more emphasis on the entrance. The remaining two housing types are located in a less-favorable location in the base, so the ground floor is designed to be working space and the living space is elevated to the second floor. Such spatial arrangement distances the occupants from the outside world, so the design of roof garden is emphasized as compensation.

3. Window Openings Can Be Adjusted According to the Internal Function

According to the basic principles of modernistic architecture, standardized window openings can be combined in multiples on the vertical plane of the different housing types to reflect the interior spatial functions on the vertical surface. We can see from Table 1 that the largest window opening is 1 fenêtre, and the corresponding unit mass is also the biggest (5 x 5 m). The internal space is used for living space that needs a lot of lighting, so the visual bearings of the windows are adjusted according to the surrounding environment and the housing types. In the fourth housing type, “skyscraper,” for example, two more window openings are added to create a special atmosphere in the internal space: for the stair light, a bar window that is narrow in the outside and wide in the inside is used to guide the vertical activity; for the bath space, a louver is used for functional needs.

Conclusion

In this paper, the authors discussed the features of Le Corbusier’s housing design from a typological point of view:

1. Le Corbusier’s method of design, with its ability to create a sense of hierarchy, reveals his vision for modern housing. First, the concept of standardization is used to establish the basic specification of the prototype and object types, and then the five housing types are generated in assembly-line-style combination procedures. By analyzing the production of the objects, we can see the logical progress of each design phase. Furthermore, it is clear that Le Corbusier, by using the production rules, can develop different combinations of space within the same production system or under the same conditions as the base, creating various housing forms.

2. The operation process and rules of formality provide us with another way to conceive of housing design. In contrast with most housing typology that focuses on the common features of the interior form, Le Corbusier dealt with the exterior appearance using production logic. He also tried to respond to the problem of interior spatial function by adopting numerical and proportional relationships. Hence, by using certain basic rules, we can develop infinite formal possibilities for housing design. Moreover, the diagram of object organization can help us to infer what the sixth housing type, and so on, might look like.

3. Le Corbusier is dramatically different from all the other modern architects because he not only used the mechanical method and aesthetics of the mechanical era to design various housing types, he also kept the classical idea of internal consistency. Take this project as an example. Here, Le Corbusier used the Golden Proportion to arrange the five housing types in their base in such a way as to fit with the surrounding environment. Even though such relationship is internal, the aesthetical significance is more persuasive then abstract segmentation of the base.

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Figure Credits

Figures 2, 3 and Table 1 are prepared by the authors.
Figure 5: Originated from Adolf Max Vogt, Le Corbusier, the Noble Savage: toward an archaeology of modernism. London: The MIT Press. 1996.