Future of architectural hybridity: exploring the Bauhaus culture in Hajjar's hybrid architecture

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ABSTRACT: The aim of this study is to explore the notion of stylistic hybridity in architecture by using shape grammar as a computational design methodology. The mid-twentieth-century architecture produced by William Hajjar is used as a case study for this exploration. Hajjar was a member of the architecture faculty at the Pennsylvania State University (Penn State), a practitioner in State College where the University Park campus is located, and an influential figure in the history of architecture in the area. The residential architecture he designed for and built in the area incorporates many of the shapes, rules, and features of both modern European architecture and traditional American architecture. Using computational methodology, this study offers an investigation into this hybridity phenomenon and explores the possibility of producing hybrid architectural designs for future uses. In the present study, shape grammars are used specifically to verify and describe the influence of Bauhaus/European modernism on Hajjar's domestic architecture: rules from the grammar developed for his single-family houses in the State College area will be compared with rules from the grammar developed for the Gropius–Breuer partnership in the United States. The potential of shape grammar will be discussed as an effective complementary tool for architectural historians to use in a mathematically rigorous way to verify the formal and functional similarities between styles. In short, it is proposed that shape grammars be used broadly in detective work to verify or disprove hypotheses.

KEYWORDS: Modern architecture, Single-family house, William Hajjar, Walter Gropius, Shape Grammar

INTRODUCTION
In *A Field Guide to American Houses,* Virginia and Lee McAlester describe "modern" as a post–World War II architecture that abandoned historical precedents in favor of new variations in architectural composition (1984). The modern U.S. houses featured in their book include minimal traditional, ranch, split-level, contemporary, and shed-roofed styles. However, earlier in the twentieth century, Henry-Russell Hitchcock and Philip Johnson defined modern architecture in general in a different way: Their focus was the "International Style" in reference to three identifying features: volume instead of mass, a lack of ornamentation, and elements characterized by regularity and standardization (Hitchcock & Johnson 1966). They offered definitions related to the five points used by Le Corbusier as a basis for defining a new architecture. Rooted in Europe and transferred to and further developed in the United States, modern architecture later in the twentieth century was defined by scholars such as Kenneth Frampton, David Handlin, and William Curtis by principles close to those proposed by Hitchcock and Johnson (Wright 2008). A tendency to use simple rectangular volume (instead of mass) articulated by crisply cut openings, regularity, avoidance of architectural decoration, flat roofs, an open floor plan, and a free façade are the main characteristics.

In documenting examples of mid-twentieth-century architecture in U.S. college towns, the authors discovered that many of these houses, including those designed by William Hajjar in State College, PA, do not seem to fully fit in the existing mainstream categories of the period inasmuch as his houses are not built according to popular mid-century ranch, split-level, shed, or minimal traditional styles. Nor do they feature the characteristics or shapes of modern

architecture such as flat roofs, ribbon windows, or free facades, as first identified by Hitchcock and Johnson (1932) and later by other scholars such as Frampton and Curtis. Furthermore, these houses do not conform to traditional American styles such as colonial, revival, or Victorian styles. Instead, many simultaneously reflect traditional American styles together with forms associated with modernist ideologies, showing forms/shapes and rules associated with both. For example, some houses boast sloped roofs, partially open plans, large windows, and traditional balloon frames with local stone, wood, or brick cladding, and horizontal organizations in split-level arrangements.

To verify and describe the influences of modernism/Bauhaus internationalism on the work of Hajjar in State College, PA, this study offers an investigation of the faculty-practitioner's hybrid architecture by comparing and contrasting it with Gropius's architecture, with a focus on single-family houses produced by the Gropius-Breuer partnership in the United States. Via computational design methodology, this comparison will provide information to serve as a basis for determining the nature of Hajjar's single-family architectural language including by verifying and describing the influence of Gropius-Breuer's architectural language.

1.0 NOTION OF HYBRIDITY

The notion of hybridity between modern architecture and traditional architecture, or the duality between modern and traditional, international and local, and designed and vernacular in architectural practice has already been addressed in the literature. Frampton (1983) drew on Alexander Tzonis's "critical regionalism" in this context. Whereas the postmodern era's modernism/International Style was criticized for its placelessness, critical regionalism was an approach to architecture that offered the possibility of both countering that placelessness and rejecting the whimsical ornamentation of postmodern architecture. With this duality in mind and in search of a definition of popular architecture—specifically in modern architecture— Devlin and Nasar (1989) conducted extensive research to compare "high style" versus "popular" architecture produced in the second half of the twentieth century. Later, Fernando Lara (2008) explored how modern architecture became popular in Brazil by borrowing local elements. The idea of "vernacular modernism" was also explored by scholars such as Maiken Umbach and Bernd Huppauf (2005), and more recently by Anthony King (2016). If critical regionalism calls for architects to use elements from local and vernacular architecture, vernacular modernism calls for elements of high modern architecture to be incorporated into local-vernacular architecture. However, Hajjar's hybrid architecture, constitutes a mixture of both of these, thereby constituting one way to bridge modernist and popular architecture. In this paper two important questions centering on this duality/hybridity are explored: Can computational design methods verify this hybridity? Is shape grammar as a computational design methodology an accurate and adequate method for analyzing the ways in which architecture might reflect elements from multiple traditions?

2.0 METHODOLOGY

This paper is part of a larger research project that includes five steps: (1) tracing Hajjar's life and practice to identify likely influences on his work; (2) developing a shape grammar for the houses he designed in State College; (3) identifying or developing grammars for some of his likely influences; (4) comparing Hajjar's grammar to the grammars of such influences to determine the nature and extent of their impact on his work; and (5) identifying aspects of the social and technological context that may explain such influences—i.e., trends in regard to lifestyle and availability of materials and technologies. Whereas a previous paper (Hadighi & Duarte 2018) described Hajjar's single-family architecture by developing a grammar of his work, the focus of the current paper is on highlighting hybridity in his architecture and on exploring the use of shape grammar as a computational methodology to analyze and design hybrid architecture. Future papers will focus on further methodological steps related to the notion of hybridity.

2.1. Shape Grammar

The history of shape grammars goes back to the early 1970s when Stiny and Gips (1972) published their first paper illustrating shape grammars for the original language of paintings.

Shape grammars in computation are defined as a class of production systems based on an initial shape (or a set of finite shapes) and transformational rules that can be applied to the original shape recursively (Stiny & Gips 1971). Based on the numbers and sequence of rules that can be applied to an initial shape, the grammar can produce an unlimited number of solutions. Since the 1970s, as a design computation method, the concept of shape grammar has been used in architectural analysis when a pattern in design characteristics or a stylistic repetition of shapes in architecture is evident. This method has been used to analyze examples of historical architecture, such as the Palladian Villas by Stiny & Mitchell (1978), Frank Lloyd Wright's Prairie houses by Koning and Elizenberg (1981), Bungalow houses by Downing & Flemming (1981), Queen Anne houses by Flemming (1987), and Alvaro Siza's houses at Malagueira by Duarte (2005). More recently, shape grammar has been used in the production of a variety of designs especially within the idea of mass customization. An example is the generation of mass customized housing units in Malagueira, Portugal, based on Siza's housing style (Duarte 2005). Given that Hajjar's work, the present study's focus, shows some evidence of shapes and transformation rules shared with multiple architectural traditions, the shape grammar methodology is appropriate for testing the hypothesis. For example, many of the houses designed by William Hajjar can be considered in reference to shapes and rules as follows: a wing (i.e., a garage), connected through a breezeway (the connector, usually the main entrance) to the main volume. This main volume in his early work is a simple shoe box, which regardless of size (short or long) and orientation (parallel with or perpendicular to the main road), usually has a low-pitched roof. The main volume sometimes comprises two stories: the bottom story is usually the main living area (living room, dining room, and kitchen), and the top story is usually the sleeping area. Depending on the orientation and slope of the site, the bottom story may be a garage whereas the main living spaces may be located in the wing, the latter of which consists of one or two stories.

3.0 A. WILLIAM HAJJAR

Abraham William Hajjar (1917-2000) was born on February 11, 1917, in Lawrence, MA, the youngest of a large immigrant Lebanese family. He initially pursued a career with the family business of grocery store. However, in 1936, he left the business to enroll at the Carnegie Institute of Technology (now Carnegie Mellon), graduating in1940 with a professional architecture degree. For his graduate studies, he attended MIT, graduating with a master's degree in 1941 (Hadighi et al. 2016). After graduation, he moved to Washington State to join the Department of Architecture at the State College of Washington in 1941. Five years later, he joined the Department of Architecture at the Pennsylvania State University (the Pennsylvania State College at the time) in State College, PA. While Hajjar was at Carnegie, the school's pedagogical philosophy of design was dominated by the Beaux-Arts, similar to most of the architecture programs in the country. Yet, at Carnegie Tech in the late 1930s, some young faculty members assigned to teach freshman and sophomore studios leaned toward a modernist philosophy of design. Walter Gropius, founder of the Bauhaus School and one of the pioneering masters of modern architecture, was invited to deliver a lecture on March 11, 1938, when Hajjar was a sophomore. This was probably, the first interaction between Hajjar and Gropius.

When Hajjar attended MIT for his graduate studies in architecture, he became more familiar with modernism through proponents of modernism, such as his advisor, Lawrence Anderson. Anderson not only designed the first modernist building on an American campus (MIT Alumni Pool-1939), but he also tried to bring a modern outlook to MIT's program in the late 1930s. Also, he advocated for Alvaro Aalto's appointment as a research professor in architecture at the school in 1940. It is worth noting, too, that Aalto's work, in addition to Jorn Utzon's, was an example of the critical regionalism approach discussed by Frampton (1983). More importantly, it is likely that Hajjar was influenced by modernist ideas propagated by the German émigrés: He was at MIT when Gropius and Breuer were at Harvard, a time when students from the two schools attended lectures together and when Anderson would often invite Gropius, Breuer, and other outside critics to MIT to review the students' work (Anderson 1992).
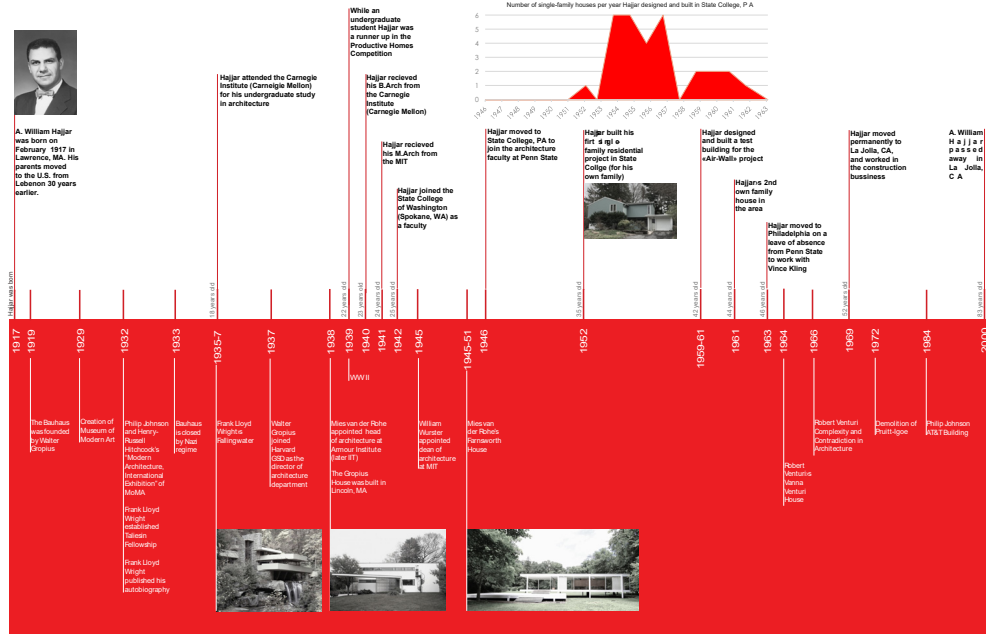
Figure 1: Abraham Hajjar timeline, showing a brief history of his personal, academic, and professional life

When Hajjar moved to State College with his family, he bought a house in an area close to the campus. The house was a simple traditional two-story building in the Georgian revival style with a four- square plan (Figure 2). To be different, and to make it easier for his family to recognize the house from other similar houses of the area, as he mentioned to his son, he painted the street face of the house in white—a design element that expresses his philosophy of improving traditional American architecture with integrating it with modern ideas/elements. In 1951–1952, after he had been at Penn State for a few years, he designed and built a house for his family, his first house in the area. At the time, most single-family residences in the area were in the Georgian revival, Colonial revival, Tudor, and Cape Cod styles, although ranch and split-level houses were also starting to appear. Hajjar's first family house represents his main idea of volumetric design and interior planning: the house consists of a simple shoe box and a garage connected to the main house via a breezeway. From the exterior, Hajjar's house is similar to other houses that had already been built in the area, especially given its cement blocks for the base, the wood cladding for the top part, and the sloped roof. However, there is no front porch and no entrance in the front façade. In fact, the front façade seems to be a side façade when compared to those of other houses in the area. Additionally, whereas most of the local Colonial revival houses in the area had a garage at the back of the building, the organization of the house is rotated in Hajjar's design such that the garage appears at the front and the main entrance to the house is hidden in the breezeway. Many of these features appear in Hajjar's later designs in the area.
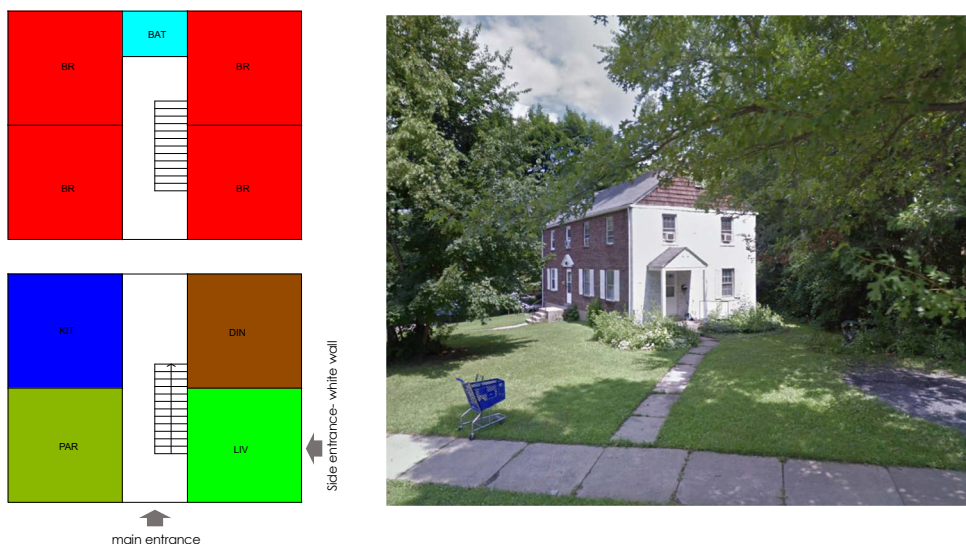
Figure 2: Hajjar's first house in the area and its schematic layout.

Hajjar designed and built thirty-two single-family houses in State College, mostly in two neighborhoods close to the Penn State campus. Many of his houses blend into the traditional houses in the neighborhood in terms of exterior building materials, volume, and roof shape. However, Hajjar's houses have an internal organizational structure that is both modern for the time and unique to his work. In the new College Heights neighborhood, located at the northwest side of the campus, most of the houses Hajjar designed are located on sloped sites. Taking advantage of the slope, he situated the entryway between the two main levels of the houses—a feature that can be read as an adaptation of the mid-century split-level effect. As explained in a previous paper by the authors (2018), there are similarities between Hajjar's architecture and mid-century split-level houses, especially in terms of the section and façade. However, there are definitive differences in regard to the interior planning, the organization of the fenestration, and the slope of the roof. Hajjar's interior planning leans toward the modernist open plan concept, especially in the public part of the house (living room, dining room, kitchen). There is also a clear division between the public part of the house where day-time activities take place, and the private part of the house where night-time and personal activities take place (bedrooms, bathrooms, and private living area). Typical mid-century split-level houses were organized so that the living room faced the street, whereas Hajjar's designs are open with the kitchen facing the street and the living room at the back of the house.

In the plans, the entryway to Hajjar's houses is on the main floor through the breezeway and generally in the middle open space, which could include a hall and a family/sitting room on the private floor. Hajjar's typical plan can be read as a modern plan with an open space in the center, rooms organized on both sides, and service spaces, including the bathroom, staircase, and hallway, in the middle. However, it can also be read as a very traditional plan as used in the Georgian period and the Georgian Revival, i.e., a developed hall-parlor organization, or as a developed four-square design, similar to the plan of the first house Hajjar bought in the area.

Another typical mid-century plan that appears to have exerted an influence on Hajjar's work, or at least on some of his designs, is the U-shape plan used in ranch-style houses (Figure 3). Hajjar kept the U-shape geometry with a garage, or a covered porch in some cases, attached to one wing. Although the geometry is the same, Hajjar's spatial organization is more modern in comparison to the traditional plans: one wing for private activities/bedroom section, and the other wing for public/daytime activities, such as the living room and dining room, with service spaces in the center (Figure 4).
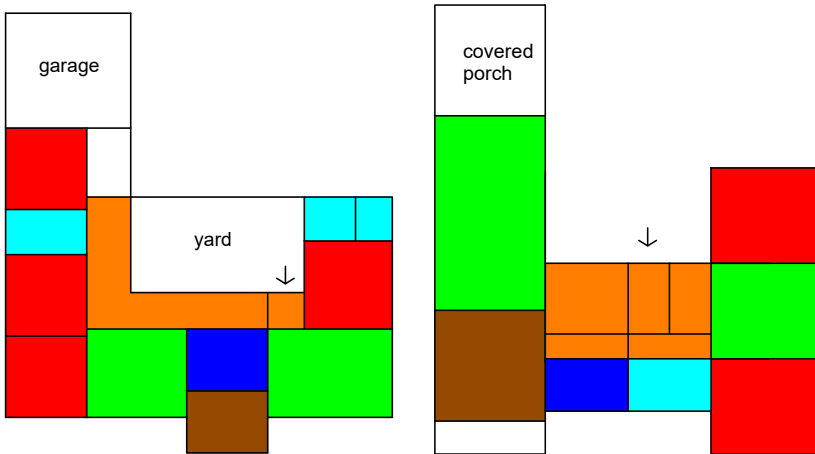
Figures 2 (left) and 3 (right): A typical mid-century U-shape plan used in ranch-style houses (left), and Hajjar's plan for the Condee Residence (1955). Color representation: green represents the living room, red represents bedrooms, brown represents dining room, dark blue represents kitchen, light blue represents bathroom/laundry, and orange represents entry/corridors and transitional spaces.

In general, given the spatial relationships in Hajjar's houses, it is possible to identify five subtypes of floorplans (Figure 4): (1) tri-partite organization, where a breezeway connects the garage to the inhabitable space, the lower floor hosts the living areas, and the upper floor the sleeping area; (2) split-level organization, where the sleeping area is a half floor above the living area; (3) butterfly, where a cross-shape or U-shape organization prevails; (4) compact organization, where a square-shaped plan reflects Hajjar's idea of a core area; and (5) linear organization, where two square-shaped plans forms a rectangular/linear plan.
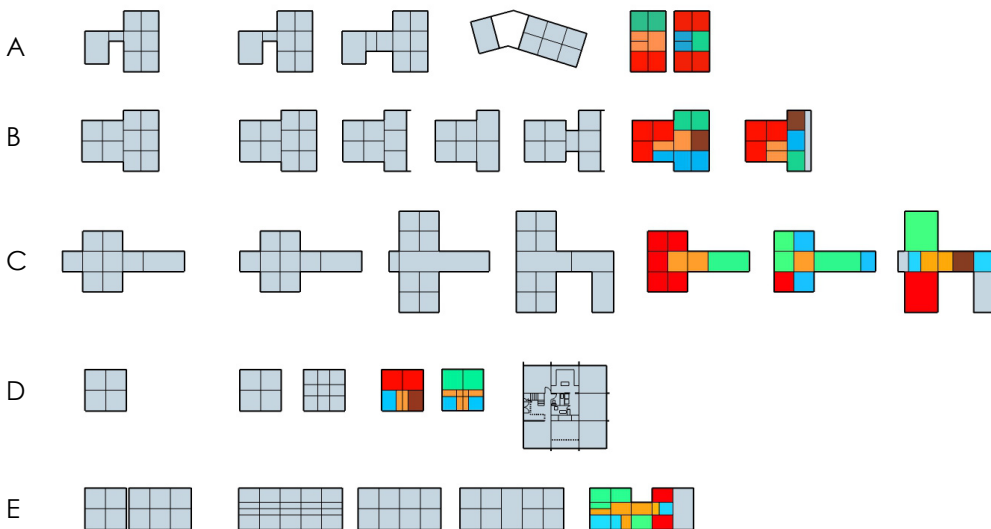

Figure 5: Subtypes of Hajjar's single-family houses in State College, PA.

3.1. Hajjar's Hybrid Grammar
A detailed account of the development of a grammar for Hajjar's single-family houses can be found in a previous paper by the authors (2018). However, in brief, the grammar was

developed based on the five subtypes described above. Figure 6 shows selected rules of the grammar. The grammar encompasses four phases or groups of rules:

1) Rules that capture the way in which Hajjar situated his houses on the lots (Rules 1 and 2);
2) Rules that describe the formal relationships between mass volumes (Rules 3–5);
3) Rules that describe the way in which the interior space is divided into smaller rooms or spaces (Rules 6–29); and
4) Rules that generate details such as the placement of closets and wall thickness.

The grammar can produce plans of all the houses designed by Hajjar in the State College area, and also new house plans based on Hajjar's design philosophy, what we call Hajjar-inspired houses. Figure 7 shows solutions produced by the grammar, including plans of houses designed by Hajjar and a Hajjar-inspired plan.
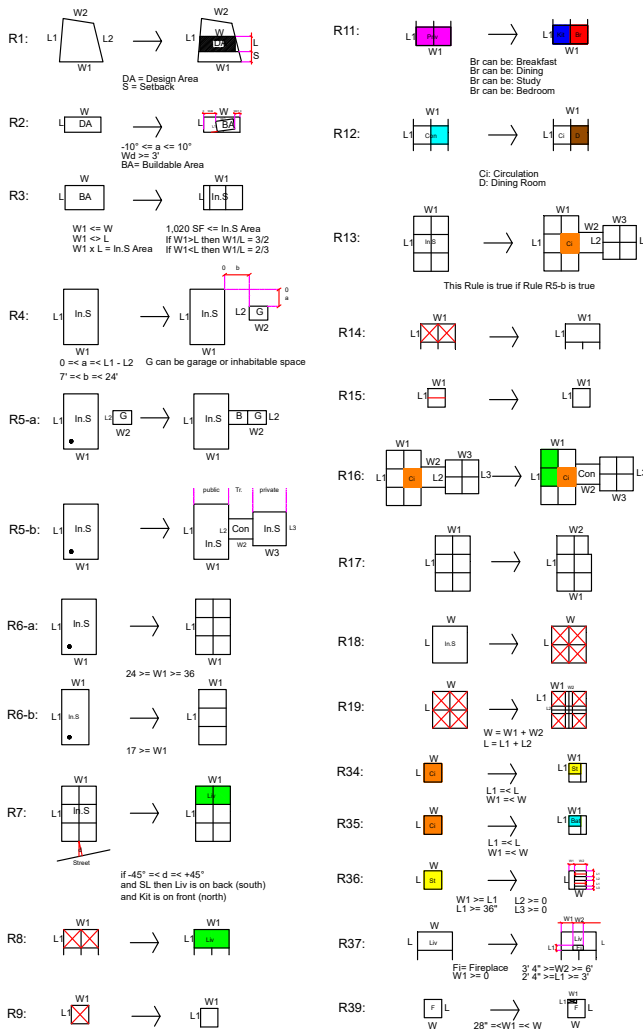

Figure 6: Selected rules of Hajjar's grammar.

Figure 7: From left to right: Euwema House, Ferrell House, Christ-Janer House, as well as a Hajjar-inspired house, all generated by the grammar.
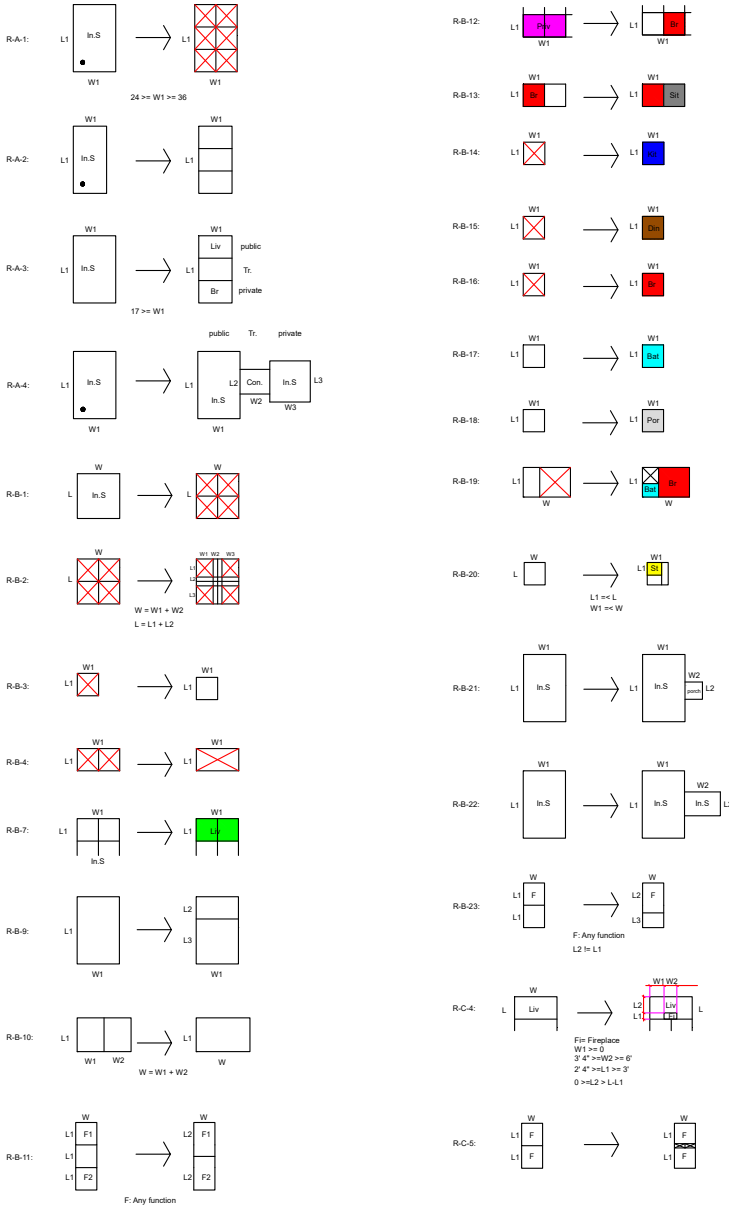

Figure 8: Selected rules of Gropius-Breuer grammar.

As noted earlier, through his academic training at MIT, Hajjar learned about European modernist/Bauhaus principles from his advisor, Lawrence Anderson, and more importantly through the influence of Gropius and Breuer—all of which are evident in the houses he designed in the State College area. Using shape grammar, the authors compare Hajjar's architecture in the State College area with single-family houses designed by the Gropius–Breuer partnership in the United States. In order to describe these influences through shape grammars, a grammar of Hajjar's work should be compared with one of Gropius and Breuer's work. A detailed account of the development of a grammar for single-family houses designed by the Gropius-Breuer partnership in the United States will be explored in a separate paper. Figure 8, however, shows selected rules of the Gropius-Breuer grammar. In brief, the grammar was developed with the same strategy as that used for the grammar of Hajjar's work. In general, to compare grammars, they should be developed in the same way at the same level of detail. When this is the case, it is easiest to compare the grammars by determining which rules are adapted, deleted, changed, or added.

A comparison of the two grammars shows the rules that Hajjar borrowed or adapted from the grammar of Gropius–Breuer. There are two ways to test similarities between the rules of the two grammars: (1) compare step by step the derivation of a house designed by the Gropius–Breuer partnership and the derivation of a house by Hajjar, and (2) produce a Gropius–Breuer house through the grammar of Hajjar's work and compare it with the original design.

Figure 10 shows a comparison of a step-by-step derivation of the James Ford House designed by the Gropius–Breuer partnership in 1939 and the Higdon Residence designed by Hajjar in 1955 (Figure 9). Higdon house is one of the few houses designed by Hajjar with a linear organization and a division between daytime and nighttime activities such that each is assigned to its own floor. It is also possible to produce the James Ford House using the Hajjar grammar. However, the part projected out that expands the dining area is unique to Gropius–Breuer design.
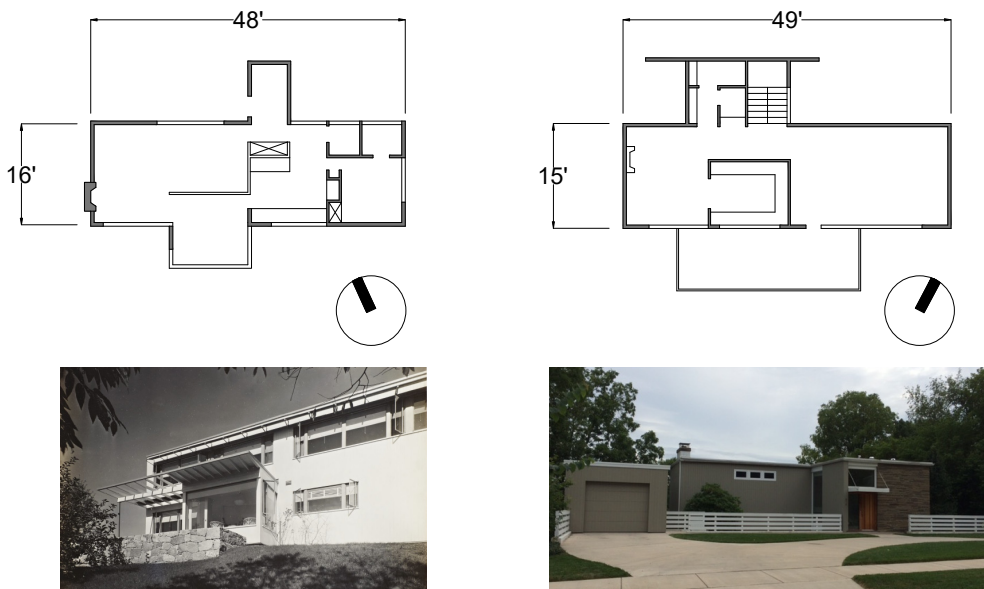

Figure 9: James Ford House designed by Gropius-Breuer in 1939 (left) and the Higdon Residence designed by Hajjar in 1955 (right).
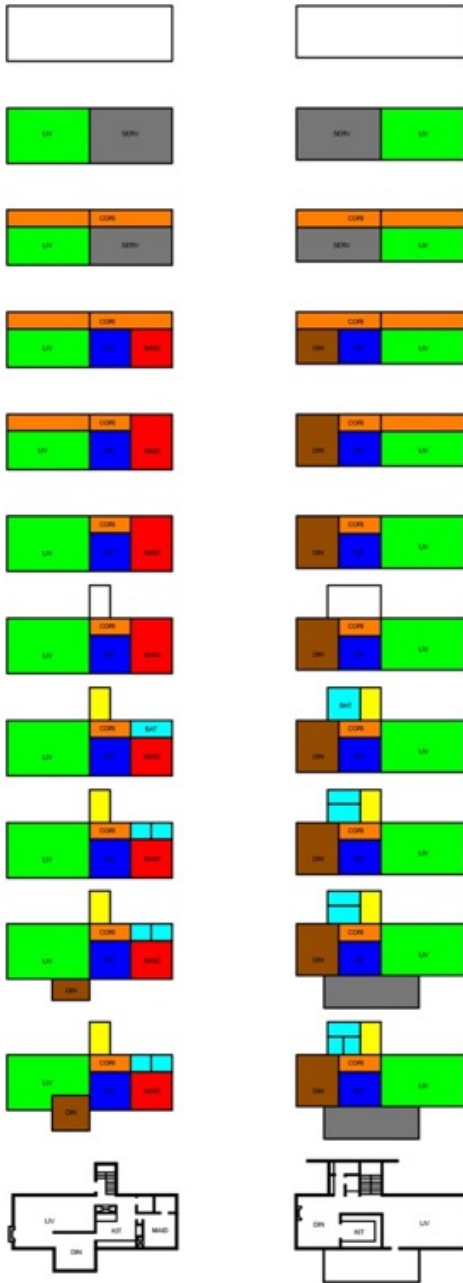
Figure 10: Comparison of a step-by-step derivation of the James Ford House designed by Gropius-Breuer (left) and the Higdon Residence designed by Hajjar (right).

4.0 DISCUSSION: FUTURE OF ARCHITECTURAL HYBRIDITY

As noted earlier, this paper is part of a larger study undertaken with the purpose of analyzing Hajjar's hybrid single-family architecture by developing a grammar of his work and comparing and contrasting its shape rules with those of works of modernist and traditional American architecture. The proposed study will concentrate on using shape grammar to verify and describe the notion of hybridity in architecture by using Hajjar's single-family houses in the

Penn State area as a case study. Comparing the grammar of Hajjar's work with the grammar of the Gropius—Breuer partnership's work in the United States verifies that shape grammar as a computational design methodology can be a useful and effective method for verifying and describing such influences and, therefore, for identifying hybridity in architectural design. In fact, the authors with other scholars are collaborating on using this same method to analyze hybridity in mid-twentieth century architecture in another part of the world.

Since the postmodern era, many scholars have advocated for architectural hybridity, or as Frampton described it, critical regionalism, to promote a local adaptation of European modernism as an approach to counter the placelessness of European modernism. Being keeping with those who are looking for such a response, a grammar that can produce hybrid architecture would be an effective instrument for professionals in the building industry in an era in which the industry is seeking greater efficiency in producing higher-quality housing.

As part of the larger study, a computer program has been developed to produce Hajjar-inspired houses based on the grammar developed for his work in the State College area. The aim of developing the computer program was to facilitate the generation of designs and to eliminate human input while applying rules to generate houses. However, the program can be used to produce new hybrid designs based on Hajjar's design philosophy. An appropriate future use of this computer program would be to further develop the program to mass-customize hybrid and efficient single-family houses. The authors of this paper, collaborating with other scholars, are in fact in the process of further developing Hajjar's grammar and the associated computer program to help the building industry in the state of Pennsylvania to produce energy-efficient, low-cost, high-quality, customized single-family houses.

5.0 CONTRIBUTION

The proposed study will make a contribution to the field of architecture not only by presenting shape grammar as a tool for verifying and describing hybridity between modern and traditional architecture, but also by describing the work of Hajjar, a local architect who contributed to the stability and popularity of modern architecture in the United States. Further, it is our hope that the study will show the potential of shape grammar as a complementary tool that architectural historians can use to verify formal and functional similarities between styles in a rigorous way.

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