Syntax of Change in the Mid-twentieth Century American House

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Abstract
How strongly is the spatial organization of a building related to its and its physical aspects and its stylistic attributes? The question is of particular relevance to space syntax theory since historically much of the analytical work on the morphology of buildings has been weighed in favor of spatial analysis partially resulting from the assumption that genotypical attributes are essentially lodged within the spatial syntax of a building and that the corporeal, or stylistic elements, carry much of the phenotypical information. Relatively scattered studies, by Hillier, Hanson, Peponis, Steadman, Amorim and Bafna over the years, as well as well empirical work by Henry Glassie on Virignian folk-housing and Mark Girourad on English country houses, have challenged this assumption, but a coherent reformulation is still not available.

We offer additional insights into this issue through a study of parallel change in the formal, stylistic, and spatial attributes of the genotypical American house. Our data are drawn from the catalogues of the Aladdin Company, which was a major supplier of mail-order houses during the first half of the twentieth century. Our material is drawn from 35 catalogues (produced between 1908 and 1954), giving us access to detailed plans of 2687 houses, of which 760 were new models. We systematically chart changes in these new models, noting the proportional relationship between width and depth, footprint and floor-areas, number of floors, and the articulation of the front-façade, including the shape of the roof-line, and the presence of culturally significant elements such as porches. We also chart corresponding change in the spatial structure of the house, noting the shift in overall integration values, the location of integration core, and the distribution of connectivity values. Innovations in our methodology include (over and above the general approach of recording of systematic change in morphology over 50 years), a marking of genotypical change through the change in depth between the most integrated and the most connected rooms of the house.

We show that the changes in the spatial form of the house systematically correspond to changes in the physical attributes, such that at times the spatial form lags as it accommodates to changes in the physical form, and that these changes correspond with well documented general social change in American domestic life. The findings additionally give us material to challenge a dominant assumption within anthropological thinking (particularly in the work of Susan Kent and Amos Rapoport) that architecture only reflects the life and does not actually have any formative influence on it. A final implication of this study is that it allows us to make a case for systematic analysis of the spatial structure of the house as critical factor in deciding the suitability of mid-twentieth century houses for cultural preservation.

1. Introduction

Does the architecture of the house have a constitutive influence on social organization, or does it only follows cultural changes without any impact on the shaping of everyday life at either the domestic or communal level? One useful way to cast light on this issue is to document change in architecture in the context of social change. A secondary issue that arises here is the relationship between the two components of built form—spatial organization and physical form in the context of such a change. Intermittent writings in space syntax over the years (Hillier 1998; Hanson 2003; Steadman 2003; Amorim 2001 and Bafna 2003, 2005), as well as well empirical work by Henry Glassie on Virignian folk-housing (1975) and Mark Girourad on English and French country houses (1978), have addressed this issue, within it but a coherent reformulation is still not available.

Our study then attempts to document the reciprocal change in architecture and society through the study of the American single family house. Our primary source for the houses consists of single-family house designs produced and published in the catalogues of the Aladdin Company between 1908 and 1954. They are of interest for two major reasons: they are designed for generic sites and for typical customer profile. The Aladdin catalogues also present a large database of single-family layouts. In the 2687 models published in 35 catalogues, only 760 were identified as new. This extensive set of house plans offers a very suitable opportunity to understand the process of formal change in a type and its relationship with broader cultural changes in associated periods. These models were designed by architects belonging to a single company, which brings coherence in the sample. The conditions of design subsume personal knowledge and competence of the individual 'architect' within overall specifications issued by the company; in the case of the Aladdin Company, a group known as the "Board of Seven" was responsible for the production of such specifications. Given this, and the market-driven conditions for design, it seems fair to assume that the requirements are a fair summary of a "standard" or "modal" set of expectations related to a generic American single family house of the period. Another way of saying this is that in the design of these houses, neither the demands of an individual architect's design philosophy, nor the requirements of a particular client, would be dominant influences on the design. Consequently, the overall formal organization, and any change in it, could plausibly be interpreted as a direct reflection of changes in American domestic lifestyle.

Below we document significant patterns of change in selected aspects of the form. In the first section, we chart changes in overall massing (including the shape of the house foot-print, and its orientation with respect to the street), paying particular attention to the shape of the front of the house, describing changes in the articulation of its façade and the emergence of the largely ornamental front lawn. We follow this up with a description of the syntactic order of the interior in relation to the outside, with specific attention to how the interface between domestic and communal realms is negotiated across that boundary. For each aspect of the house, appropriate sub-samples were selected. Reasons for selection of sub-samples are described in the relevant sections.

2. The physical form: the emergence of the visually deep façade

We begin with an examination of the physical/formal attributes of the building with regards to two main elements: the overall volume of the house defined by the size of its footprint and its height, and the shape of the front façade defined by its 'contour', the location of the main entrance, the roofline and the porch. Our analysis demonstrates a strong correlation between the features of the house's volume and the shape of the front façade. As the house becomes wider, the front façade grows deeper. General features describing the shape of the house in terms of quantitative parameters are first compared in all the 760 new designs. This comparison indicates different trends in the evolution of the volume of the house, which are then related to the shape of the front façade.

2.1 Changes in volumetric characteristics

A first set of data concerns the volumetric characteristics of the house. Three volumetric parameters are first recorded individually for the 760 new designs: the number of floors, the width of the plan (the projected length on the front axis facing the street) and its depth (the projected

length on side axis perpendicular to the street). Both width and depth includes in their dimension all the external features such as porches, terraces, garages, but not those of steps or plinths.

FIGURE 1 presents the mean of the three measures for each available year.

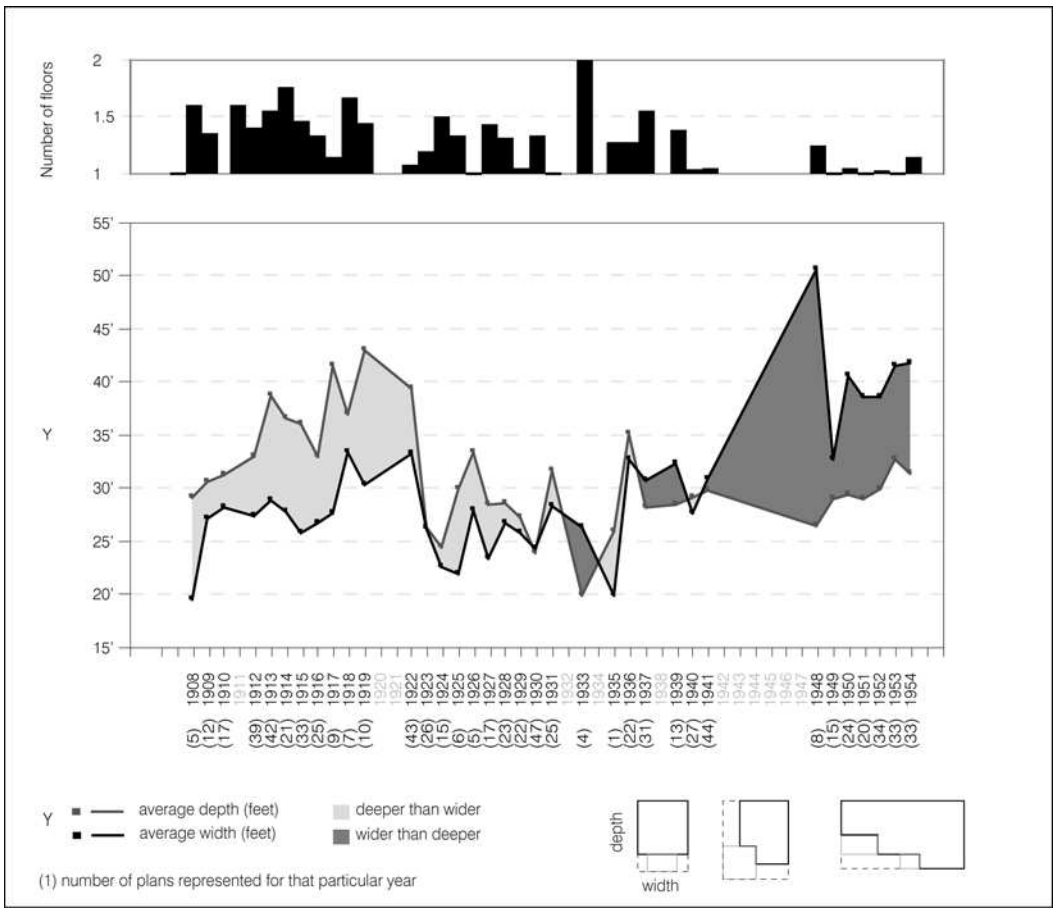


Figure 1

Footprint growth: from deeper to wider

: based on the 758 plans produced between 1908 and 1954. Within each, the width and the depth of the extended footprint of each new plan is averaged and plotted.

A first observation shows that the data fall into three periods of distinctive difference in the shape of the house. Between 1908 and 1922, the three parameters grow in parallel. Both depth and width increase proportionally in size but the design favors depth over length (light gray); the plan could be defined as 'narrow'. The trend is reversed in designs produced after World War II. Although the increase of both dimensions remains proportional, the houses become wider than deeper (dark grey). Plans are increasingly oriented along the axis of the street. This growth allows a wider frontage for this type of houses, an 'elongated' plan. The period between the two trends (1923-1941) does not carry such strong bias. Light and dark greys are both present, not showing any preference for narrow or elongated plans. If compared to the earlier and later periods, there is an overall decrease of both dimensions, that is, the foot-print is much smaller.

The number of floors indicates another type of transformation that correlates with the change of dimension of the plan in the last period. Until the forties, there is a distribution of both one-story and two-story houses. No strong correlation exists between the shape of the massing and its height. The plan allows flexibility of volume. After 1940, designs strongly favor a one story house. There is concomitance of two shifts: houses tend to be lower and layouts give more and more importance to the street façade over the development in depth towards the back.

2.2 Shape of the front façade

A second quantitative analysis refines the relationship between the transformations of the volumetric characteristics of the house and their impact on the front façade. As houses become wider, the front façade gains in depth. The growth of the front façade distinguishes a front and back zone thickening in reference to the main entrance door. The entrance door represents the physical link between interior and exterior, between private and public realm. It is the main point of access in the boundary. FIGURE 2 shows how this trend plays out in a sample of 50 designs selected randomly from the 760 new designs.

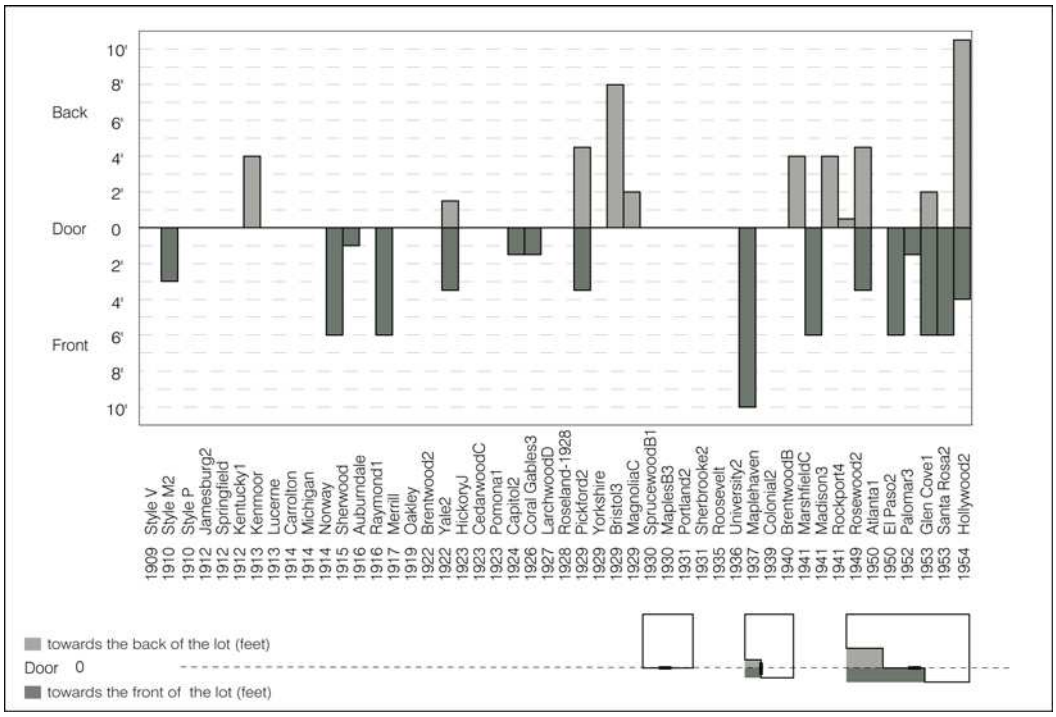


Figure 2

Front facade depth in regards to the location of the main entrance door
: based on the 50 plans produced between 1908 and 1954, selected randomly from the 758 plans produced. The chart shows the location of the main door (at level 0). If the door is located on a wall perpendicular to the street, the dimensions are measured from the center of the door. It records how deep in the back or the front of the lot, the line of the front façade is located. It excludes the porch and the terrace – only including the front contour of recessed or projected walls – for there is an ambiguity whether they belong to the interior or the exterior.

Until the forties, 70% of the selected designs have a straight façade and 30% only increase in depth (7 expands towards the front, 4 towards the back and 2 in both directions). After 1940, 90% of the 10 selected models have a recessed or projected wall (4 expands towards the front, 2 towards the back and 3 in both directions). Only one model has a straight front façade. Overall, the thickening of the front façade ranges from 0' to 15' deep on both directions – a maximum of 10' deep towards the front and 11' towards the back.

The physical development of the front line in depth results from two distinct procedures (FIGURE 3). Privacy is first achieved by attaching small elements onto the façade, such as a vestibule, an entry, or a chimney, or by subtracting a small space creating a recess within the façade. Although both are opposed strategies, the same effect is achieved. The second procedure results from a very different attitude. The façade is built by the shifting of entire rooms forwards or backwards from the front line. Such a procedure creates a series of intermediary outdoor spaces defined visually by the depth of each corner. The front façade is now composed by layering of front spaces that increases the depth of the front façades.

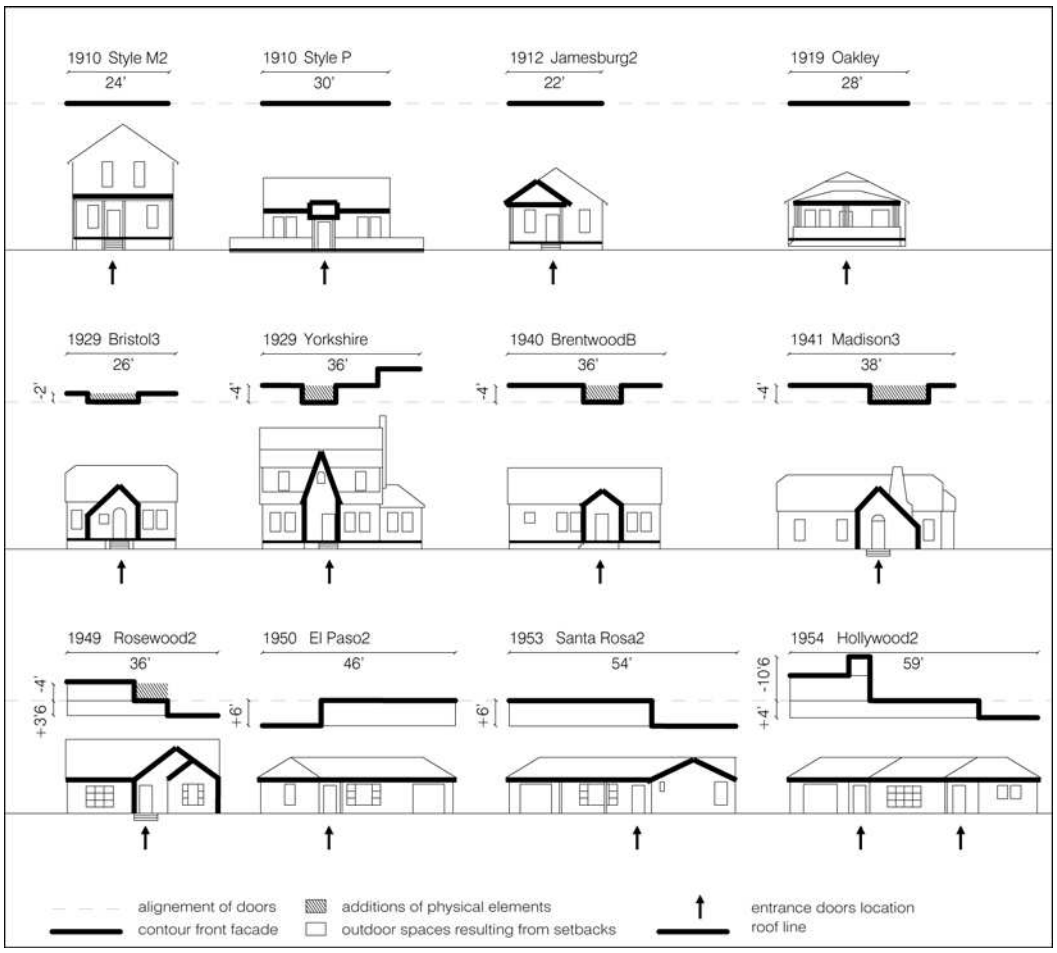


Figure 3
Increasing depth in front facade and simplification of roof line
: based on 12 plans produced between 1908 and 1954, selected from the 50 previous plans. The doors of each model are aligned at level 0.

Associated with the change in façade is the gradual transformation of the porch. There is a considerable literature on the role of the porch in the early twentieth century and its sudden disappearance in the postwar years (Jackson 1985; Wilson-Doenges 2001; Donlon 2001). Our analysis suggests that rather than disappear, it actually transformed and was integrated into the form of the house, both physically and spatially. The transformation of the porch came with other changes in the front of the house. By the postwar years, the complexity of the front edge of the house was suppressed by straight, overhanging, roof line, whose strong shadow unified the entire house under a single roof. The façade, while becoming more articulated, had ceased to address the street. Instead the strong roof oriented the house inward, increasing the perceived distance between it and the street.

3. The spatial structure: across the boundary, the role of the interface

The previous sections considered the physical shape of the boundary that separates the domestic realm of the house from the broader communal realm. It concludes that the presentation of the house to the outside becomes less legible as the physical demarcation of the boundary between the domestic and community domains gains in depth and complexity. This section is concerned with the change in the structuring of internal boundaries in the house and the structuring of the various interfaces that comprise domestic space—the interfaces between inhabitants and visitors, and those amongst various classes of inhabitants, between parents and children, between guests and family, and sometimes between family and servants. In the period under discussion here, the

basic definitions of such interfaces, captured by the programmatic list of spaces for the house, did not change much. What did change, however, was the structural relationship between the interfaces and it is that change that we will be concerned with in this section.

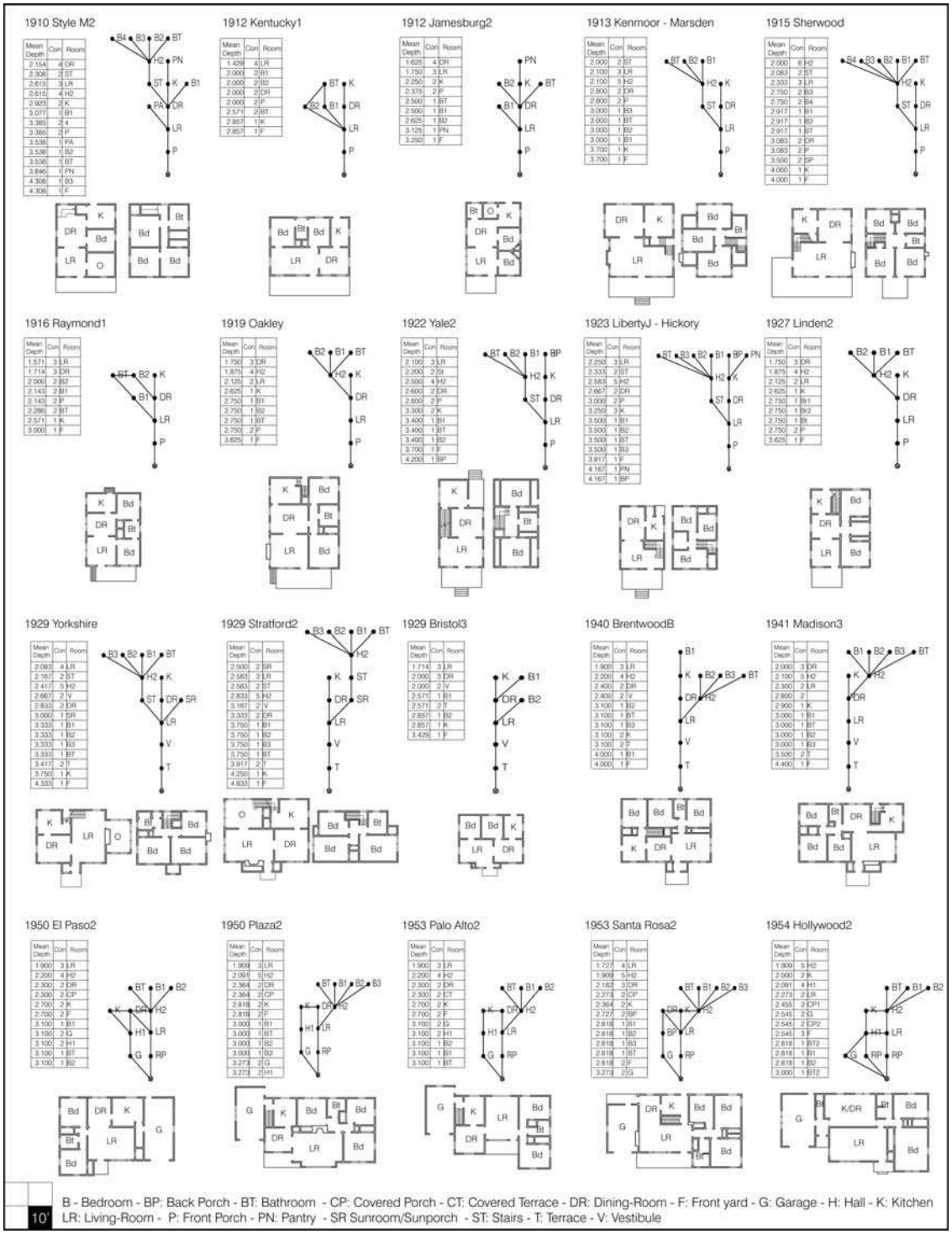


Figure 4
Plans of 20 models from 1910 to 1954
with their connectivity and mean depth values, and their justified graphs

The syntactical analyses were run on a sample of 20 plans categorized according to their front façade and volumetric features. Figures 5 and 7 indicate in the top part of the graph the massing features: single or double-story house and narrow or elongated plan. Boundary partition analysis, rather than the more conventional convex space partitioning, (Hillier et al. 1984, Bafna 2001; Bafna

2003), was used to study how the spaces created by internal partitions relate to each other, and connectivity and mean depth values of each space in the house are computed. The main reason for using boundary partitions here is that our interest is in the relationship between labeled spaces, which is most directly and least ambiguously captured by the boundary partition. Porches, terraces and stairs are considered as labeled spaces. Each door or opening through wall is considered as connection to other rooms. Because the plans are taken from catalogues, the space located between the built-structure and the street remains undefined. Usually a front yard, it is labeled here as the 'front' and considered as a single space that defines the exterior space for the justified graphs.

3.1 The shape of the Integration core

Studies of inequality genotypes and other standard techniques proved inconclusive, so we decided to adopt some new measures and descriptive techniques. A very useful exercise was to look at the shape and location of the integration core of the houses, taking the core to consist of the three most integrated spaces in the house. (FIGURE 5) The location of the integration core of the house in depth or in shallow space gives the degree of formality of each three spaces. Several properties are shared by all the models. The living-room is always part of the integration core (except for the last model). This fact places that room as a key component of the house. The fact that the front door is most of the time associated with it, except when there is a vestibule, gives the living room strong properties of control, with regard to the interface between domestic and communal realms for the house. Second, in most of the designs, the most connected space, the hub, is present in the three most integrated spaces; we'll discuss the significance of this observation in the following section. A third observation is that the three spaces are connected with each other either as an elongated linear sequence or in the form of a compressed tree.

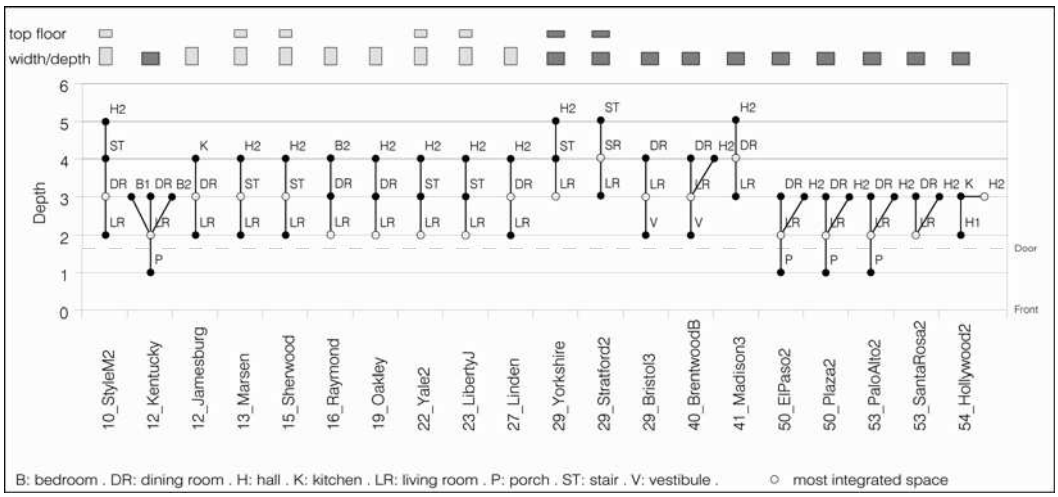


Figure 5

Integration core and depth for 20 selected models produced between 1908 and 1954.

One can discern a rough pattern of chronological change even with a relatively discrete sample of 20 houses. There appear to be three distinct periods. In the first period, ending around the time of the 1929 model, most of the houses, corresponding to the bungalow type, have simple linear cores. In the houses with two floors, a staircase is the most central area, and apart from the inevitable living room, the third space is typically a hallway. In single storied houses, the core includes the bedrooms. This period, actually, may be further broken into two sub-period, marked by the shift around 1916 to houses centered on the living room from those centered on staircases. The ranch houses of the postwar years (models from the 50s, onwards in the figure) all have distinctive tree-like cores, centered on living room, which his also the most integrated space. Interestingly, the front porch is now a part of the core, and the entire core is much more closer to the entrance. Only one model, the Kentucky (introduced in 1912), of the prewar houses corresponds to this type of arrangement. The middle period, consisting of the models of the late twenties, thirties, and the forties, is the most

unsettled one; the constitution of the integration cores varies from model to model, and the integration cores are much more deep with respect to the front of the house.

From the point of view of social functioning, clearly, there is a possible genotypical shift through the years. The original houses were centered on circulation spaces and had integration cores deeper from the entrance, corresponding with a domestic life that featured a fair mount of discretization of the internal activities of the house and a clear separation of the domestic life of the house from its interface with the community. Already, by the twenties, we can see a shift towards houses centered on living spaces and cores much more close to the exterior, thus featuring a society where the domestic-communal interface is much closer to the most central areas of the house. But this transition was not smooth, with some changes reversed, during the middle period, before returning the original trend.

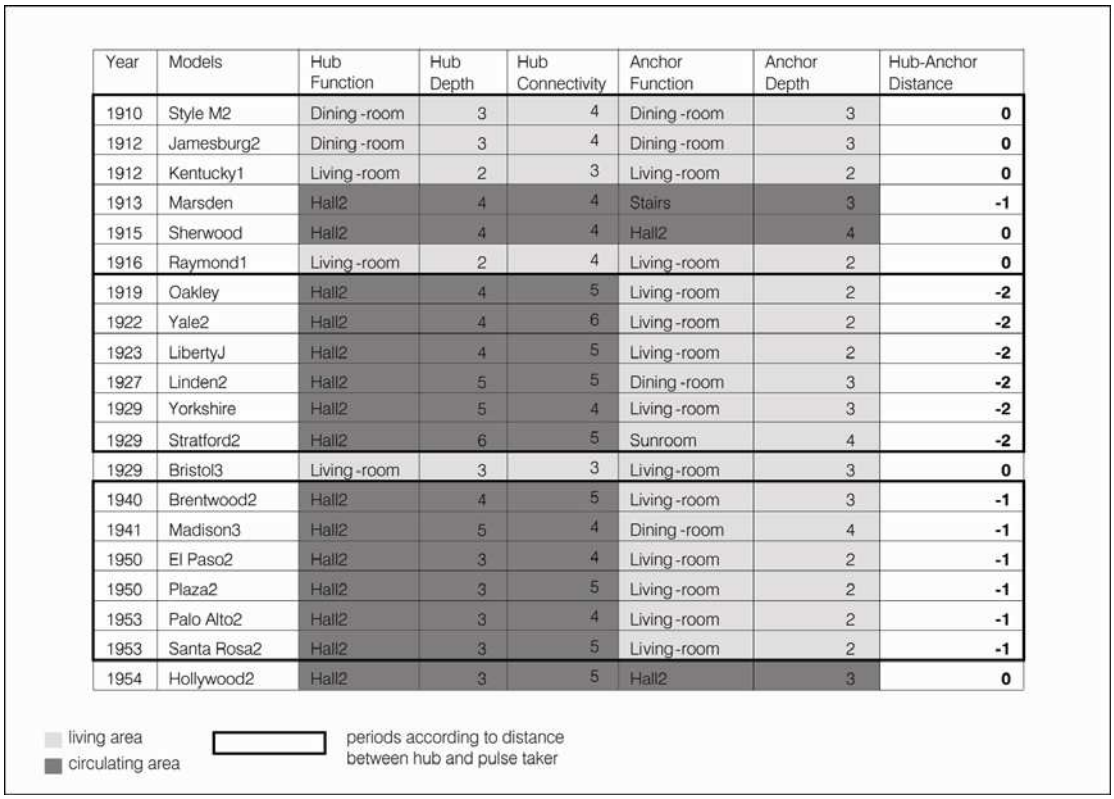
3.2 Hubs and anchors as descriptors of syntactic genotype

Our understanding of this shift can be further sharpened by introducing a specific metric or index—the hub-anchor distance. The metric, as its name suggests, comes from identifying two types of spaces in the house—the hub and the anchor. The hub refers to the space with greatest degree of connectivity. In houses, the distribution of connectivity values follows a specific pattern; there are several spaces with connectivity of 1 or with connectivity of 2, and very few spaces with high degrees of connectivity. It is useful to describe those with connectivity degrees 4 or more as the public areas of the house, the term public used here to mean those areas of a house which are not given to specific activities and where one may not generally expect privacy or seclusion. The hub is, by this definition, the most public space in the house. The anchor is defined as the most integrated space, the space from which the spatial organization of the rest of house is best understood cognitively. Anchors are central and core spaces of the house. It is possible, but not necessary, for the two spaces to match in a given house. We propose that the distance, in terms of depth, of the two spaces in a house is of interest, since it gives a good sense of how far the public core of the house is from the center of the house; a house where such a difference is greater, is arguably one that invests more in privacy amongst its inhabitants and in separation of activities; (it is a house that uses the internal spatial organization to create genotypical patterns). We believe that houses with large hub-anchor distances will be those where the hub is a dedicated circulation space, a corridor, or a lobby. Looking at our sample of houses, we were interested in examining whether the hub was a dedicated circulation space or not, and then to see how far it was located from the core of the house.

Comparing the hub and the anchor determines three periods in which both behave in a similar way (FIGURE 6). For the first period, 1910-1916, hub and anchor are undifferentiated, they share a single space. If the layout does not have a hallway in its design, it is located in a living area. When the design presents an upper floor, it becomes a circulation area and it is physically disconnected from the ground floor. Between1919 and 1929, hub and anchor are differentiated and located 2 steps away. The hub is a circulation area and the anchor a living space. In the last period, 1940-1953, both follows the pattern of the previous periods in terms of differentiation and function but they are only located one step away.

In the first period, the hub and anchor are the same, implying a house with a gregarious domestic culture where the center of activity is also the most public area of the house. But by the twenties, the hubs begin to be dedicated circulation spaces, stairs and hallways, creating an interior in which the most public areas are undedicated spaces, and where spaces given to dedicated activities are therefore mutually private. This mutual privacy is heightened in the second period, since not only is the hub a dedicated circulation space, its separation from the anchor increases to two steps. The two step depth difference corresponds with the observation, from the previous section, that the more central area is removed from the center of circulation of the house. In the third period, the hub and the anchor are often connected directly, with a step-depth value of 0 between them. There is slightly reversal compared to the previous period suggesting a return to the gregarious household of the early teens and twenties, but while they are in closer proximity, the public areas of the house (circulation) are still separated from those of individual activities, and the hub and anchor remain distinct from each other.

It is clear that there is not a distinct match between the trends captured by the hub-anchor distance and those captured by the shape and location of the integration core, although there is some undeniable and encouraging correspondence. Before we look into that further, we will discuss another aspect of spatial organization which we found to be telling in terms of shifting trends.



Year	Models	Hub Function	Hub Depth	Hub Connectivity	Anchor Function	Anchor Depth	Hub-Anchor Distance
1910	Style M2	Dining -room	3	4	Dining -room	3	0
1912	Jamesburg2	Dining -room	3	4	Dining -room	3	0
1912	Kentucky1	Living -room	2	3	Living -room	2	0
1913	Marsden	Hall2	4	4	Stairs	3	-1
1915	Sherwood	Hall2	4	4	Hall2	4	0
1916	Raymond1	Living -room	2	4	Living -room	2	0
1919	Oakley	Hall2	4	5	Living -room	2	-2
1922	Yale2	Hall2	4	6	Living -room	2	-2
1923	LibertyJ	Hall2	4	5	Living -room	2	-2
1927	Linden2	Hall2	5	5	Dining -room	3	-2
1929	Yorkshire	Hall2	5	4	Living -room	3	-2
1929	Stratford2	Hall2	6	5	Sunroom	4	-2
1929	Bristol3	Living -room	3	3	Living -room	3	0
1940	Brentwood2	Hall2	4	5	Living -room	3	-1
1941	Madison3	Hall2	5	4	Dining -room	4	-1
1950	El Paso2	Hall2	3	4	Living -room	2	-1
1950	Plaza2	Hall2	3	5	Living -room	2	-1
1953	Palo Alto2	Hall2	3	4	Living -room	2	-1
1953	Santa Rosa2	Hall2	3	5	Living -room	2	-1
1954	Hollywood2	Hall2	3	5	Hall2	3	0

Figure 6
Hub and Anchor
: based on 20 models produced between 1908 and 1954, and the value of connectivity and depth.

3.3 Integration front and porch

For each 20 models, FIGURE 7 reports the changes in the mean depth value of the different rooms of the house, and highlights the pattern of change for those of the front yard (labeled "front") and the porch (used as a generic term for all the front features: roof covered and terrace).

Note that the presence of a top floor or a vestibule implies a deeper internal layout that increases the segregation of the front and the porch. Another design characteristic that can influence depth values is the ratio of the depth of the house to its width. As the houses become wider rather than deeper, the porch and the front are more integrated, but the presence of a vestibule may counteract that trend.

In each model, the porch is more integrated than the front. Up to the forties, the front tends to have the most segregated space of the whole system. The porch and the front behave as two distinct entities: the front is deep and isolated while the porch is more integrated; their relative values however, remain stable. In the postwar models, the difference between integration values of porch and front drops to around 0.4, as compared to 0.9 in prewar models. At the same time, both these spaces also become much more integrated within the overall structure; in fact, as we can recall from our discussion of the integration core above, the porch actually becomes a part of the integration core of the house, with the clear implication that the exterior is made much more a part of the domestic space. It appears then that with the advent of the ranch houses, the boundary between the domestic and communal realms was much weaker than in the previous cases. This is

not entirely correct way to interpret the data, however. A combined look at the trends from all three syntactical observations will give us a much more coherent picture (FIGURE 8), which we discuss in the next section.

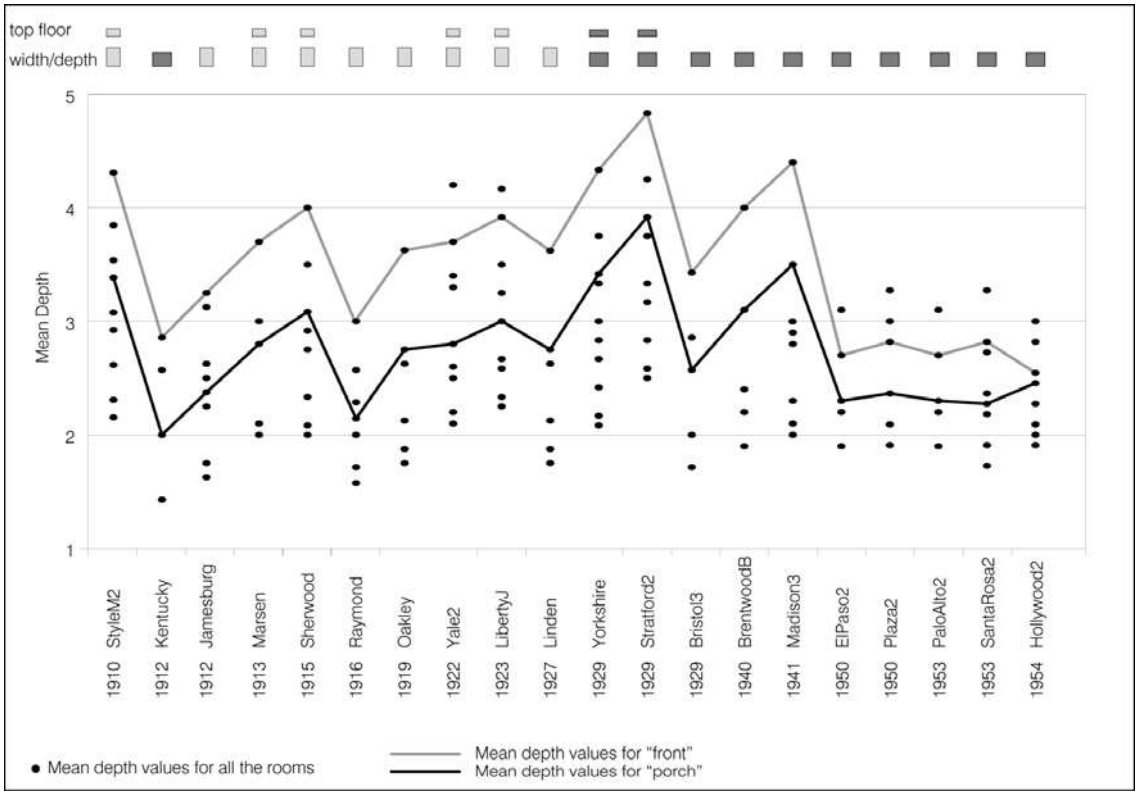


Figure 7
Mean depth porch and front
: based on 20 models produced between 1908 and 1954. The front represents the outdoor space in front of the house, the porch stands for different types of outdoor elements such as terraces, stoods, covered roof porch, etc. Some point can represent one or several rooms sharing the same mean depth value.

4. From spatial to trans-spatial communal realm

The changes in the spatial structures of the houses that we have observed give indication of a deeper change at social level. In the early houses, the comparatively deeper integration cores and the increasing tendency of the public areas of the houses to be dedicated circulation spaces are characteristic of a relatively formal domestic life in which clear separation is maintained between individual activities. Such a society may be called spatial, since there is an active utilization of spatial configuration to maintain appropriate privacy between activities. This is seen not just in the organization of domestic space, but in the interface of the domestic and communal realms as well. What is interesting is that the changes in physical elements of the house—its corporeal form, to use terms borrowed from Paul Frankl—reflect such a life as well.

At the physical level, the earliest houses are deeper than wide. Their front facade is aligned with the street, narrow and has a compact front porch. The surroundings and the built structure are two distinct entities. The interior does not differentiate interfaces for different actors. The front yard does not play any role in control. In the various depictions of the house that accompanied the catalogues, its boundary remains undefined as it does not affect the functioning of the house. The most important element that acts as an interface is the porch. It is here that the interface between the visitors and inhabitants can be controlled in a fine-tuned way, permitting selective penetration according to degrees of familiarity and of status. It is comparatively segregated from the internal core of the house, and remains a distinct space, neither belonging entirely to the exterior nor to the interior.

In the later years, particularly in the postwar period, the increased shallowness of the core, the centrality of the living room, combined with the closeness of the distinct hub and anchors, all speak of a society which at the domestic scale is much more informal, but in a way that still preserves a degree of privacy between certain spaces, such as the bedrooms. There is increased hierarchical structure within the house, indicated partly by the more complex integration core. The increased informality along with a complex hierarchy are typical of a society that is trans-spatial at the communal scale, since it gives each household enough structure to produce a solidarity based on similarity. However, the overall heightened integration and large core centered on the living areas helps maintain overall informality. As before, the changes in the physical features of the house match this shift towards communal trans-spatiality combined with domestic informality. In the final period, the front façade shares a long frontage with the street. Its more complex massing breaks the alignment with the street and creates outdoor spaces, occasionally occupied by a roof covered porch. In this period, the distinction between the domestic and communal domains becomes uncertain for a visitor. The houses have a shallow layout. The front and the porch, while becoming more integrated in the layout, reinforce the unclear demarcation of spaces. The primary interface between domestic and communal realms is now very much inside the house and very close to the center; but this weakening of interface is compensated by the trans-spatial society in which there is very little reliance of chance visits by neighbors to maintain a larger solidarity.

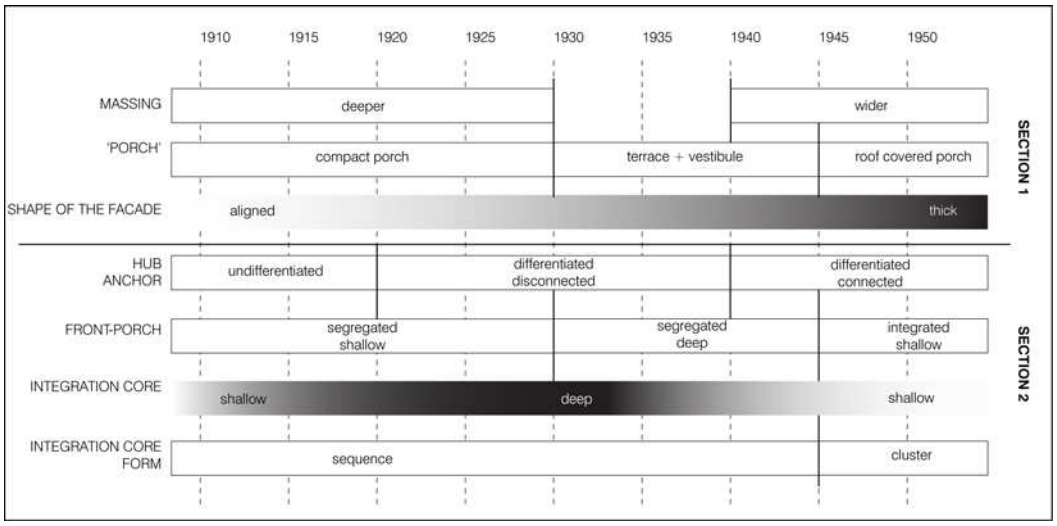


Figure 8
Synchrony of changes

But what remains to be explained is the odd, unsettled aspect of the middle years, particularly those of the thirties and forties. There does not seem to be a clear sense of direction in those houses, and there is a hyper-progressive trend in some features of the spatial organization, captured in the increased hub-anchor distance in the models between 1919 and 1929 before it is adjusted back in the latter houses. Clearly, the structural organization of space during these years is influenced by changes in the physical form, rather than being a simple reflection of social changes. There is a sharp drop in the interwar period—between the late twenties and late forties—in the footprint size of the house. This happens, even though their overall size increases marginally, by each house being two storied, rather than single storied. The increased hub-anchor distance is directly a result of this shift. But as the house increases in overall area, there is a tendency for its integration core to become deeper with respect to the front and the overall segregation values to increase. The heightened form of this trend is seen in the new models introduced in 1929.

However, this increased segregation and larger hub-anchor distance is at odds with the general cultural trend in domestic life is towards increased informality and a somewhat greater gregariousness within the household. The result is that in the postwar years, all the activities of the

house are now brought down to a single story, thus freeing the building of specific structural or dimensional concerns at the physical level, and increasing the overall integration at the level of spatial configuration. Initially, the arrangement in the single story houses of the forties is similar to previous years, essentially consisting of cellular rectangular rooms. But the larger footprint and restriction to a single ground floor offers a far more flexible framework for arranging the rooms and allows more free-form rooms for several activities where actual privacy is less critical. By the fifties then, we see the classic ranch house types, characterized not just by single floors and greater width, but also by large non-convex living rooms which are syntactically the anchors of the house.

5. Discussion

Our description of the historical change in model designs has two broad theoretical implications over and above what it tells us about historical change in American domestic culture. First, there are some clues about the mechanism of genotypical change, particularly about the issue of the relationship between physical and spatial form. The description of change confirms a point that has increasingly been made in some recent work (Bafna 2005; Steadman 2005; Bafna 2003; Hillier 1998) that physical form of a building is not a mere dressing up or fine-tuning of a socially driven spatial structure, but rather plays a reciprocal role in determining the social functioning of the house. In the interesting shift from the bungalow type of house to the ranch house type, it is difficult to say whether it was the spatial organization or the physical form of the houses which led the change. Clearly, if there can be a generic model for the evolution of a genotype, it would be one in which acknowledges the interia carried by physical elements in the face of social change. As a result of this, any change in the social life associated with a type would be first met with moves that effect minor formal changes (re-orienting of doors or access, for instance, or changing sizes). This means that change in spatial organization is not free, and not even limited, but rather guided by aspects of the physical form of the house. The spatial organization, therefore, does not change completely in line with what social organization might demand and might deviate considerably from such demands. In such conditions, the response is to make larger structural changes to the physical form of the house. Stable genotypes come to exist when physical elements and spatial form are both aligned with social requirements. It follows that a definition of genotype must necessarily include some physical dimension in addition to the much discussed spatial one.

This way of thinking about genotypes also has consequences for an issue raised mostly by anthropologists but of significance to space syntax. It has been argued by Susan Kent (Kent 1991; Kent 1993) that the role of the built environment in social organization is passive and reflective of social conditions rather then instrumental in creating or maintaining them. "Architecture is an active force only in the sense that is a visual expression and a reminder, and in that way of perpetuator of culture, not a creator or modifier of culture." (Kent 1991,pp 468). What this study shows is that Kent's question may not have been framed appropriately; it implies a causal relationship (from society to space to physical form) that is difficult to prove. In addition, framed in this way, Kent's proposition leaves the relationship between architectural form and social organization arbitrary—any kind of form could, with appropriate conventional agreements, express any aspect of social organization. The shift in design of the models that we have described shows that the complexity of reciprocal changes in spatial and physical form, particularly the many instances of lag and misfit between different aspects of organization speaks of an instrumental rather than symbolic relationships.

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