

More than the sum of parts: the grammar of Queen Anne houses

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Abstract. Shape grammars are specified that generate houses in the Queen Anne style which dominated domestic architecture in the United States of America in the 1880s: examples are used which are typical for Pittsburgh's historic Shadyside district. Separate grammars are given for the generation of plans and for the articulation of plans in three dimensions. Both grammars emphasize aspects of geometry and overall design and explain how individual parts and features are related to each other.

1 Introduction

1.1 *Queen Anne houses*

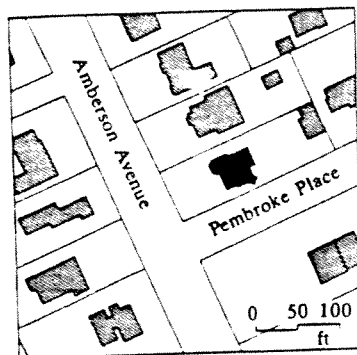
In the Queen Anne house of late 19th century America, thirty years of building in the picturesque tradition came to their conclusion and produced

"one of the most complex habitations ever devised for commoners. It rejected the traditional concept of unity in design, deliberately contrasting shapes, textures, and colors—solid and void, in and out, square and round, light and dark, rough and smooth. The ground plan is irregular, each facade has a different elevation, and the roof, with its intersecting ridges and turrets, is a problem in solid geometry. Each story is usually finished in a different material. The ground floor may be stone trimmed with brick, or brick trimmed with stone; the second story is faced with clapboards or shingles; the third story often features half-timbered gables, topped by a roof of varicolored slate. There are porches, overhangs, bay windows, oriels, balconies, leaded glass, stained glass, plaster relief panels, dormers, turrets, towers, and clustered brick chimneys. Paradoxically, this busy all-over pattern created a unity of its own, very much like a patchwork quilt that makes a strong design out of many different fabrics" (Maas, 1972, pages 140-141).

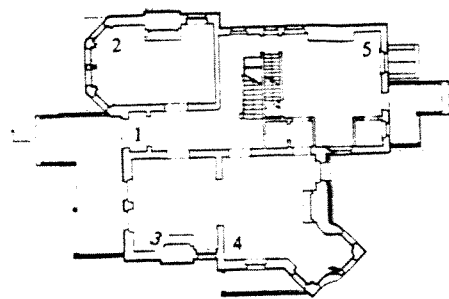
The features listed in this quote are nicely demonstrated by the Queen Anne house shown in figures 1 and 2, one of the best examples of the style to survive in Pittsburgh's historic Shadyside district, which will provide the focus for this paper.

The house was built in 1887 by Charles Spencer whose daughter Ethel described life in the house at the turn of the century in a memoir which is very informative for anyone interested in how these houses were originally used (Spencer, 1983). Only minor alterations have happened to the physical structure of the house since that time. The plans shown are based on actual measurements done in the spring of 1985, but depict the original state as it can be deduced from the architect's drawings still in possession of the present owner.

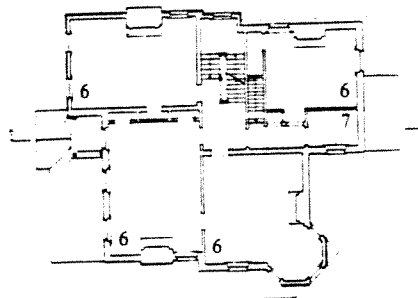
The house has a center entrance, followed by an entrance hall and main stairs located at right angles to each other. A parlor or reception room occupies the northwest corner of the house. A second public room, called 'library', occupies the other corner at the front across the hall from the parlor. It was used for a multitude of functions: occasional naps taken by the father, board games played by the children, and informal family gatherings. This space is followed by the dining room in the southeast corner, which is thus oriented towards the back and side. The remaining corner contains the kitchen.



(a)



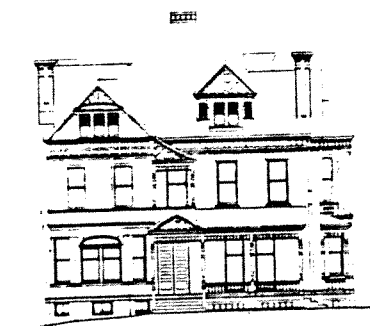
(b)



(c)



(d)



(e)



(f)



(g)



(h)

- | | |
|---------------|------------|
| 1 Entry | 5 Kitchen |
| 2 Parlor | 6 Chamber |
| 3 Library | 7 Bathroom |
| 4 Dining room | |

Figure 1. 719 Amberson Avenue (a) context (1985), (b) first floor, (c) second floor, (d) section, (e) southwest (front) elevation, (f) northwest elevation, (g) northeast elevation, (h) southeast elevation. (All drawings show the original state, except for the attic floor in the section, which cannot be reconstructed in its original form.)

The entrance hall disappears on the second floor, and the space above it becomes part of one of the front rooms. Aside from that, the second floor reflects closely the first floor in the arrangement of major rooms. The rooms are used as bedrooms for the family and guests, with the room on top of the kitchen serving as day nursery. A bathroom is added at the back. It is made accessible from the stair hall by a secondary corridor, which gives access also to the service stairs and a row of built-in closets. The Spencers employed several full-time servants who had their bedrooms in the attic.

The exterior shows features typical for the style: an irregular mass and a mix of materials and textures that become particularly dense at gables and chimneys, elements that are treated with particular care. The gables show a great variety of stickwork patterns that contrast with the plain brick surfaces of the walls, and the chimneys are richly decorated with corbels, ribs, and inlaid patterns.

The characterization of the Queen Anne style given in the opening quote is certainly correct if compared with the present example. But it is not very precise. The 'problem in solid geometry' posed by the Queen Anne roof is identified, but not solved. Aspects of geometry are neglected in general, and this is true both for the overall arrangement of volumes and rooms and for the shape of individual elements. Features are described in isolation and no attempt is made to identify if and how they relate to each other.

Nor is this untypical for attempts to characterize housing styles. If anything, the opening quote is more detailed than the descriptions found in guidebooks (for example, see Foley, 1980; McAlester, 1984). In the present paper, I try to demonstrate how the shape grammar formalism (Stiny, 1980) can be used to characterize corpora of similar designs and artifacts in a precise, explicit, and comprehensive way, especially when it comes to aspects of geometry. I have used American Queen Anne houses as examples because their geometry is particularly intricate; an approach that succeeds with them should certainly have general appeal. I also hope that the demonstration will contribute to a deeper understanding of this style.



(a)



(b)

Figure 2. 719 Amberson Avenue (1985): views, (a) front, (b) back.

1.2 Background

The work reported here is part of a larger study that concentrated on the historical housing stock in Shadyside and posed the question how new construction can be fitted into the fabric of the district so that its visual coherence and identity are not destroyed, but strengthened and, possibly, reestablished. A full account can be found elsewhere (Flemming et al, 1985).

The following sections present results from the analytical part of the study⁽¹⁾. Before I go into detail, it might be useful to briefly outline the historical context in which the houses under consideration were built. Shadyside developed in the second half of the 19th century into a prime residential suburb for the middle and upper-middle class, with certain sections that were decidedly affluent. Decisive factors in triggering this development were a favorable topography (an essentially flat terrain in a region crisscrossed by rivers and deep ravines) and the opening of the Pittsburgh-Philadelphia railroad line. Shadyside station became the first stop on that line in 1860, making the district attractive to residents who worked and had their business in downtown Pittsburgh.

The housing stock that gives Shadyside its character was built between 1860 and 1910. It contains examples of all the major styles that dominated residential construction during that period in the United States; among these, Queen Anne and Colonial Revival houses are particularly well represented [a detailed account of the economic and architectural history of the district is given by Jucha (1980)].

2 Spatial organization

2.1 Plan types

In our treatment, we decided to separate aspects of spatial organization from those of exterior articulation, because our survey of houses from the period under consideration clearly suggests a certain independence between these aspects. Starting with Downing's influential *Cottage Residences* (1842; republished 1981), it became an almost stereotyped device for pattern books to show houses that have the same plan in different styles. It was not surprising, then, when we found the same plan type underlying houses of different styles in our sample. Conversely, we also found different plan types within the same style.

We are not sure, at the present time, if the independence between spatial organization and articulation style is complete; that is, if every plan type has been articulated in every style. Our sample is simply too small to support such a general conclusion. But we have not found any clear dependencies and proceed therefore from the assumption of complete independence.

Methodologically, this has certain advantages. It means especially that questions of spatial organization can be treated independently of style. We are consequently able to divide the design of a house into two phases; the first phase determines its basic layout, as given by the plan of its first floor, and the second phase articulates the resulting organizational pattern in a particular style. The conventions underlying the two phases are expressed in distinct grammars. The first of these contains the rules that can be used to generate basic layouts; they are described in the present section.

The grammar is based on a sample of plans obtained from various sources: on-site measurements done by my assistants and me; drawings by the original architects; remodeling plans; and plans published in journals during the period, especially in *The Builder*, a local trade magazine that proved a rich source. According to our

⁽¹⁾ I shall use the first person plural when I describe material prepared by the entire project team.

premise that plans are independent of style, our sample covers the entire period of study. Instances from the later years are more frequent simply because more houses survive from that time and plan information about them was more readily available. This might cause some bias, a fact we have to accept given the difficulty we had in obtaining accurate plan information. A selection of plans from our sample is shown in figure 3 (for easy comparison, all plans are shown at the same scale and in the same orientation, with the front at the bottom).

As a measure of convenience, the plans have been grouped into four types in this figure. Two of the types, the side hall and center hall plan, are well established. They give a principle of classification (the position of the entrance hall) which we extended to include two additional types.

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134
133
The *side hall* plan is $1\frac{1}{2}$ bays wide. It contains a long and narrow corridor in the half bay, flanked by two public rooms and, possibly, backed by additional rooms stacked behind each other at the rear. Two instances are shown in figure 3(a). Plan A1 is common throughout the district on narrow, deep lots; it contains three major rooms, parlor, dining room, and kitchen, which follow each other in that order along the side hall. Plan A2 shows an enlarged version with a third public room on the first floor.

The *corner hall* house is two bays wide. The entrance hall occupies the front of one bay and contains the main stairs as an integral part. But this hall is used for more than circulation: its size and the care with which it is ornamented turn it into major public room; a clear indication is that it almost always contains a large fireplace. Plan B1 is the most frequent instance of the type. The two bays extend from front to back and each one contains two major spaces (if the entrance hall is included). Thus, each room occupies one of the four corners of the house, and it is consequently sometimes called the *four-corner house*. The other plans show variations of the type including instances with five major rooms (plans B3 to B5).
The *center hall* house is $2\frac{1}{2}$ bays wide. The half bay is located in the center and contains the entrance hall followed by the main stairs. The plan normally carries the three bays through to the back as demonstrated by the variations shown in figure 3(c).

An example of a *corner room* house was introduced in section 1 (see plan D1); additional instances of the same type are indicated by plans D2 to D5 shown in figure 3(d). This type normally has a center entrance like the center hall house, but the entrance and stair halls form an angle and enclose a room in the resulting corner. This room is distinguished by its isolated location and was used to give the type a name. A variation with a side entrance that can be found occasionally in the district is shown by plan D6.

We found this classification useful in our initial survey. But we are not sure that it always captures significant differences in our sample. It is true that for each type, we found instances that fully realize the possibilities inherent in the type and express them in a memorable way. For example, the asymmetry inherent in the corner room scheme is emphasized in Queen Anne houses, where it is used to produce the desired picturesque effects. But the scheme is also common in Colonial Revival houses where it is pressed into a more regular outline and, if viewed from the front, becomes indistinguishable from a center hall scheme. We were also impressed by examples like plan D5, a corner room house, which can be converted into a plan similar to C1, a center hall scheme, simply by changing the position of the stairs. Types, like species, should be more stable at their boundaries and less easy to convert into each other.

As a result, we treated the plans in our sample as variations within the same type, and we used that part of the grammar that deals with spatial organization to discover and express the principles common to all plans.

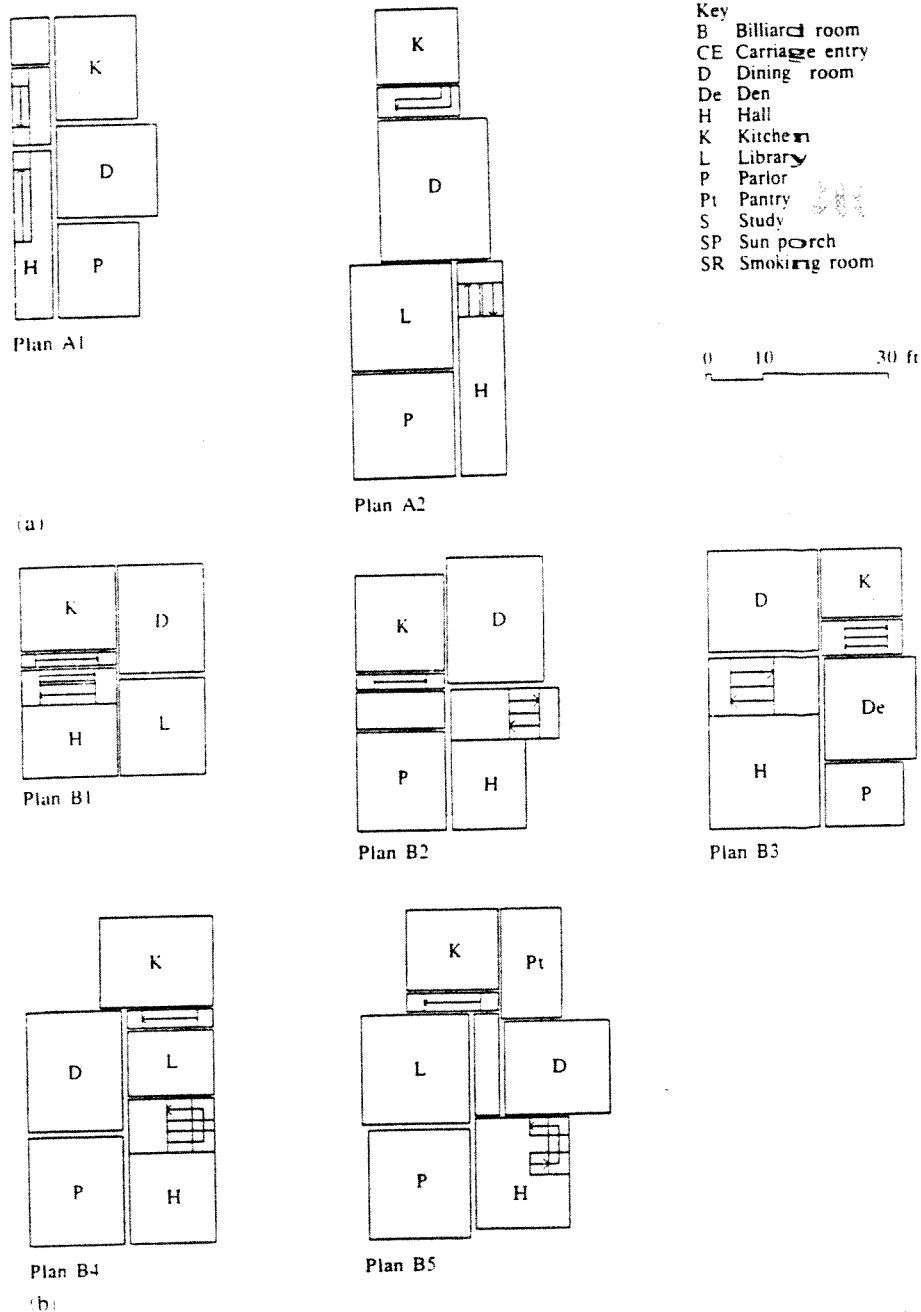


Figure 3. Sample of plans of Queen Anne houses: (a) side hall plans. (b) corner hall plans. (c) center hall plans. (d) corner room plans.

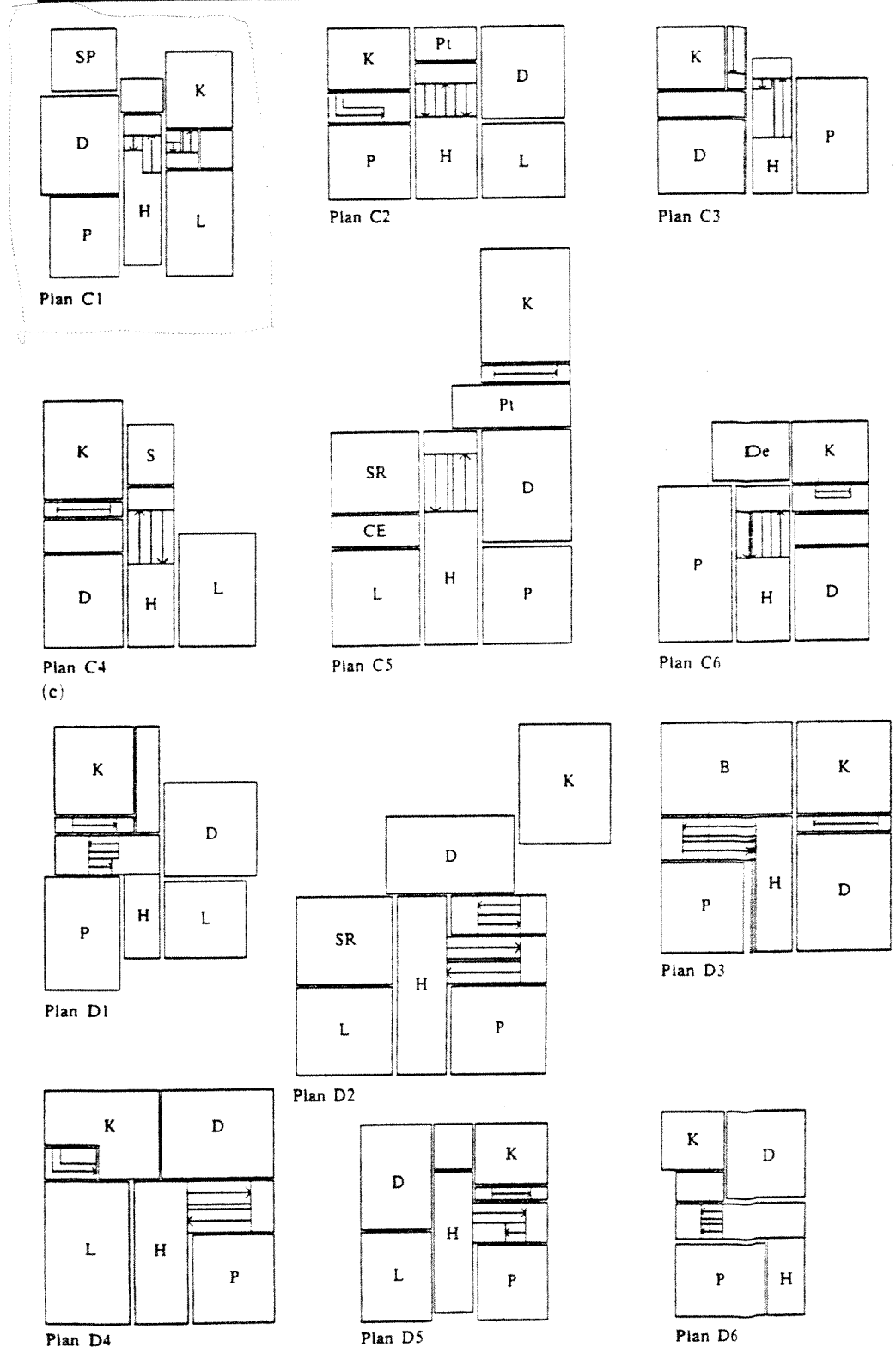


Figure 3 (continued)

2.2 Allocation of rooms around a hall

The placement of the stair hall relative to the entrance hall apparently has little impact on the placement of the other rooms on the first floor. The main organizer on that floor is the entrance hall: it gives access to all other public spaces and thus forms the hub of the plan. Scully has called this kind of space planning "peripherally additive, controlled by the center" (1971, page 14). The present grammar was designed to reflect this principle and to explore its implications: it consequently starts by allocating rooms around the entrance hall and adds the main stairs in a later step.

Rooms can be arranged in various permutations around the hall. The parlor always faces the front, and the kitchen is always close to the dining room (if not directly adjacent to each other, these rooms are connected by a 'butler's pantry'). Aside from these very strong constraints, we could not infer any additional restriction on the placement of rooms around the hall. For example, the dining room can be adjacent to the parlor (as in plans A1 or C1), but does not have to be in this position (see plans B2 or B5). A possible explanation is that every space is in easy reach from every other space through the entrance hall, which serves as both a separator (when the doors are closed) and a connector (when the doors are thrown open: large sliding doors are frequently used between rooms). In response to this observation, we do not distinguish at the outset rooms according to their special function. The allocated rooms are uniformly labelled R, leaving a more precise identification to a later step.

Peripherally additive planning around a hall leads to relatively compact plans. In addition, the geometry of the plans reflects a strong tendency towards zoned arrangements, that is, alignments of adjacent spaces along at least one side. This feature results most likely from the fact that the predominant structural and space-enclosing elements are walls (masonry or frame), which meet at right angles, both to stiffen the structure and to enclose rooms completely. In most cases, walls meet in a T-junction, which leads to zoned arrangements.

The rules specified in the present section allocate rooms according to these principles. Rule 0 is the starting rule that must be used in the generation of every plan (see figure 4). Its left-hand side is the initial shape, which consists of a single labelled point, H, at the origin and is meant to represent the empty page. Rule 0 replaces this shape by an entrance hall, labelled H, which creates the core of a plan. The labels F and B are used to identify the front and back of the plan with respect to the street (independent of compass orientation).

By means of an appropriate transformation on the right-hand side, the hall allocated by rule 0 can be placed in any orientation and thus respond to any site in the proper way. By replacing the label H at the origin by the label R, rule 0 cannot be applied again. Labels attached to the origin will be used throughout to this end: to prevent the grammar from 'overdrawing' and to proceed through a succession of phases in a controlled manner.

Rules 1-3 locate rooms around the hall while maintaining the basic compactness of the plan. Rule 1 does this in the most straightforward way: it adds a room by extending a plan towards the side or back. This rule applies only to shapes in which the hall reaches the back or side (otherwise the newly added space could not be adjacent to the hall), and the back or side cannot be more than two rooms wide (otherwise, the newly allocated space would become too large). The hall and all other spaces that have been allocated previously remain unchanged. This rule can be applied to a layout consisting of a hall alone. If it is used to place a first room at the back of the hall, it can be used again to add rooms at the side, generating layouts 1 and 2 shown in figure 5. If the rule is first used to place a

relatively
unimportant

space at the side of the hall, it can be used again to generate layouts 3-5 by first extending the plan at the back and then at the side.

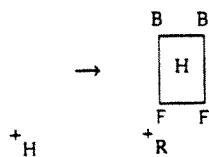
If the back or side are wide enough, rule 2 can be used in a similar way to allocate two rooms simultaneously. In combination with rule 1, it generates layouts 6-10.

Rules 1 and 2 leave the depth of the hall unchanged. But for larger plans, this depth must increase, and rule 3 can be used to this end. It adds a room to a layout containing a room at the side of a hall and makes this hall deep enough to accommodate two rooms at its side, thus generating layout 11. Subsequent applications of rules 1 or 2 will generate layouts 12-17.

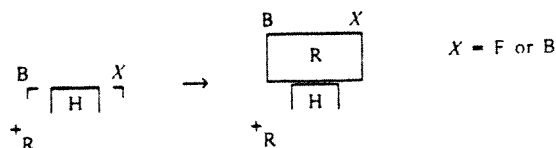
Initial shape:

$+H$

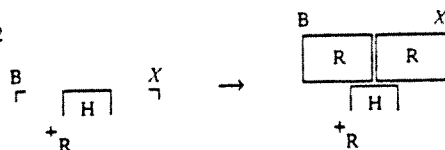
Rule 0



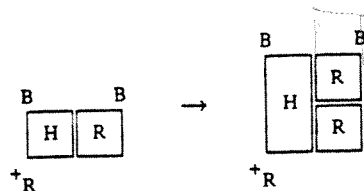
Rule 1



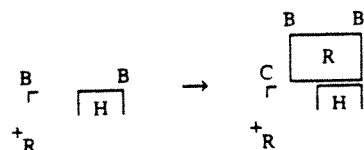
Rule 2



Rule 3



Rule 4



Rule 5

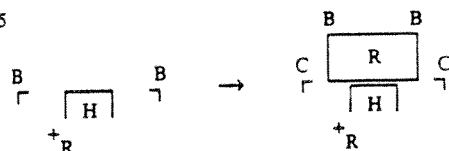


Figure 4. Initial shape and rules to allocate spaces around hall.

To the compact plans generated by these rules, rooms can be attached from the back (for example, see plans C5 or D2). The two basic possibilities are indicated by rules 4 and 5; the first of these attaches a room at a corner, and the second centers a room, leaving both back corners intact. Layouts 18 and 21 in figure 6 are generated by applying rule 4 to shapes generated by applications of rules 1 or 3; layouts 19, 20, and 22 show how these shapes can be further developed by application of rules 1 or 2.

Rule 5 centers a space at the back. It can be applied to shapes more than one room wide, provided the hall extends to the back. Layouts 23-25 show possible layouts with a center hall generated by application of rule 5 to layouts 5, 14, and 16, respectively.

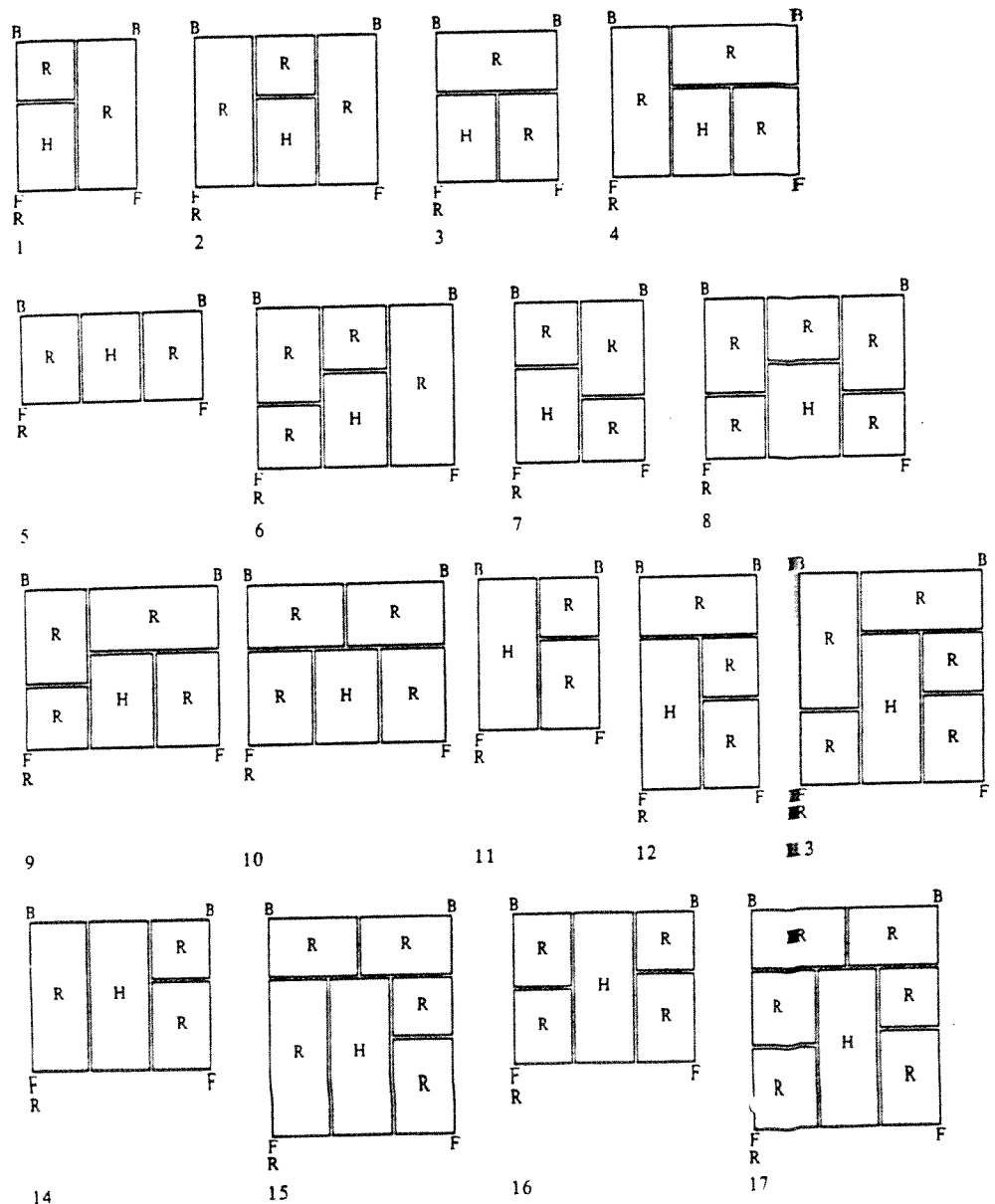


Figure 5. Layouts generated by application of rules 0-3 (see figure 4).

It should be noted that to generate realistic layouts, information about the context, especially the shape and size of the lot, would have to be taken into account. For example, it must be assured that the layout under development actually fits within the given boundaries and, possibly, keeps desired setbacks. In addition, the dimensions of the spaces allocated would have to be considered in an explicit way; in figures 5 and 6, for example, the hall has always the same width as the rooms, whereas in reality, the hall is narrower in most cases. Such aspects could be incorporated easily into the grammar but are omitted here because they are rather trivial and would only distract from more basic issues, in this case, from a concentration on basic *spatial relations* between spaces. Minor irregularities in the boundary of a plan depend very much on the style of articulation and will be treated in section 3.

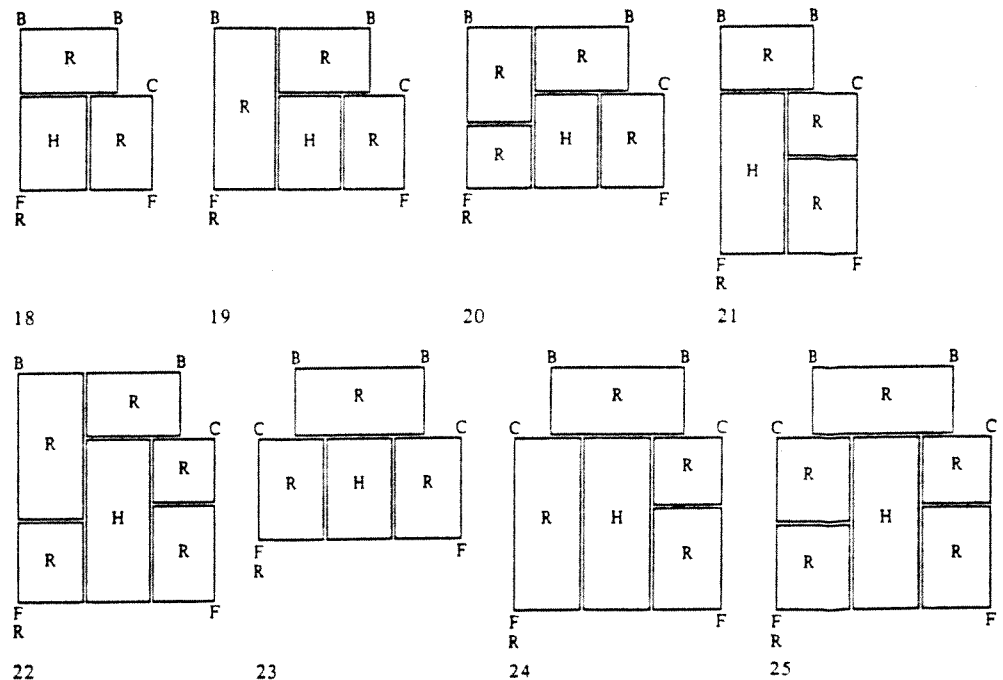


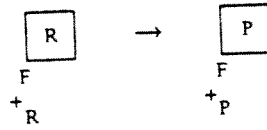
Figure 6. Layouts generated by application of rules 4 or 5 (see figure 4).

2.3 Allocation of kitchen

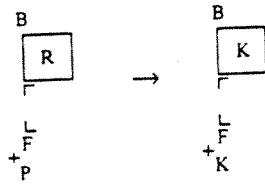
The kitchen and surrounding ancillary rooms form an area that is distinct from the public realm. It never reaches the front and always borders the back, normally via a back porch from which deliveries are made and outside work areas can be reached. The kitchen itself can be incorporated into the plan like a public space, but if it is, it is hidden from public view. It has a strong connection only to the dining room, and this can be realized also if the kitchen is more detached from the core of the plan. The present section presents a set of rules that generate the resulting possibilities.

It is convenient to start the placement of a kitchen by designating a front room as parlor; this is done by rule 6 (see figure 7). An application of this rule signals that no additional rooms will be placed next to the hall. Rule 7 then selects a room at the back as kitchen, and rule 8 selects an adjacent room as dining room. The special case in which this room is located across the hall and connected to the kitchen by a pantry is generated by rule 9. These rules generate all cases in which the kitchen is connected to the hall.

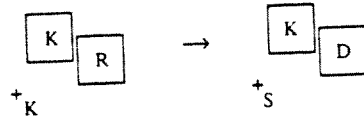
Rule 6



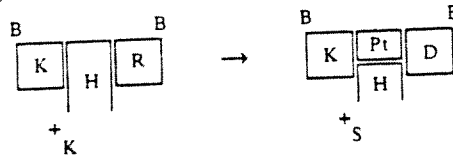
Rule 7



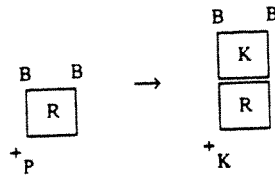
Rule 8



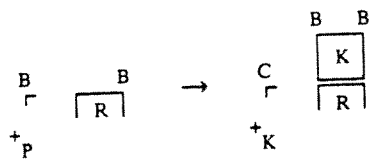
Rule 9



Rule 10



Rule 11



Rule 12

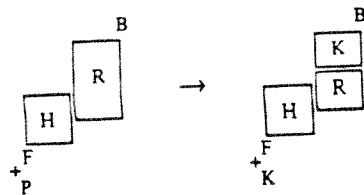


Figure 7. Rules to allocate kitchen.

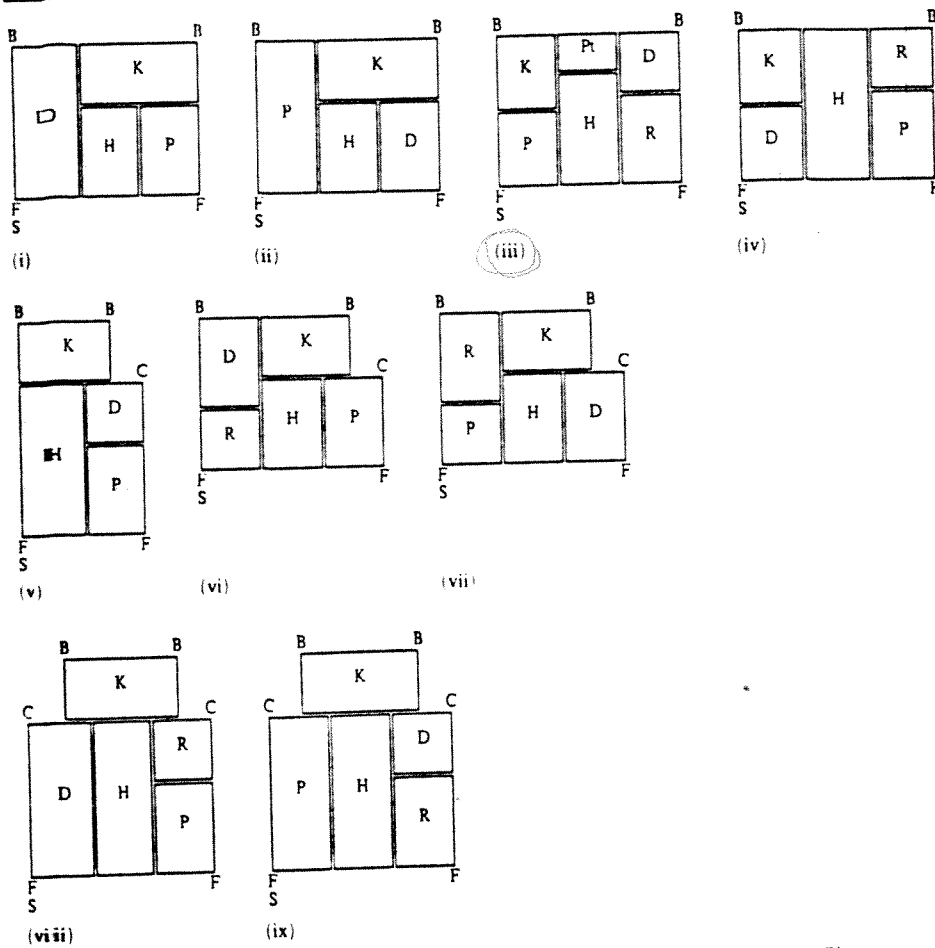


Figure 8. Layouts generated by application of kitchen rules 6-9 (see figure 7).

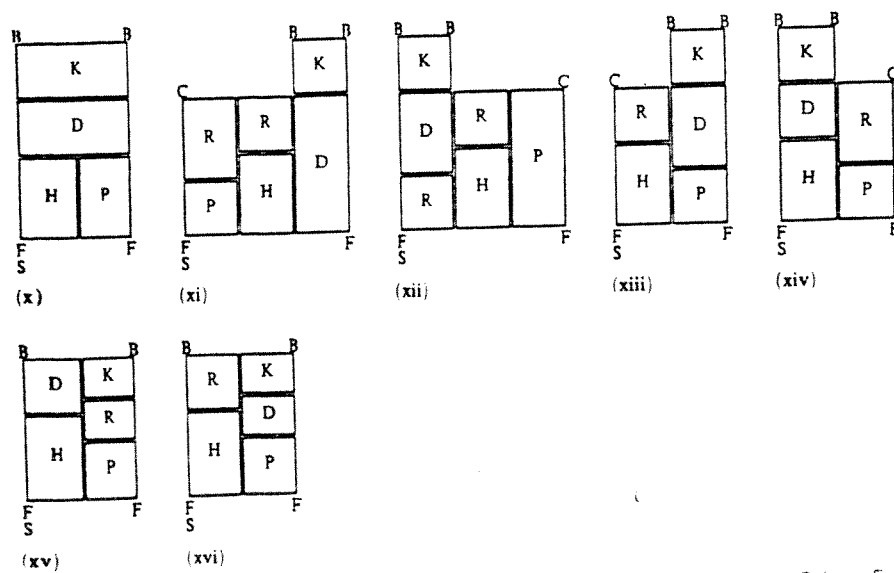


Figure 9. Layouts generated by application of kitchen rules 6, 8, 11, and 12 (see figure 7).

Some examples are shown in figure 8. Layouts (i) and (ii) are generated from layout 4 using rules 6-8. Layouts (iii) and (iv) are produced from layout 16; the first of these requires an application of rule 9. The remaining layouts in figure 8 demonstrate that these rules also work for more irregular back configurations; they are generated from layouts 21, 20, and 24.

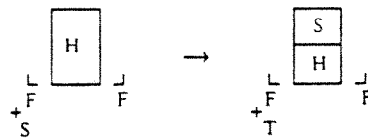
Kitchens that are not connected to the hall must first be allocated. The principal possibilities are generated by rules 10 to 12. Rule 10 attaches a kitchen at the back of a single space in the rear. This rule, in connection with rules 6 and 8, generates layout (x) shown in figure 9 from layout 3 (in fact, it must be used to turn this layout into a complete plan). Variations of this rule could be used to generate more accurately the configurations at the back of plans A2 and D2. Rule 11 attaches a kitchen at the back of a rear corner room (as exemplified by plan C5). It generates layouts (xi)-(xiv) in figure 9 from layouts 6 and 7. Rule 12 must be used to generate layouts similar to plans B3 and D6, where the kitchen is incorporated into the main mass of the house without being connected to the hall. The first of these cases and a variation are generated again from layout 7 and shown as layouts (xv) and (xvi) in figure 9.

2.4 Addition of stair hall

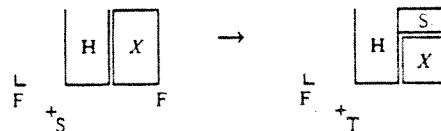
The rules presented in the previous sections fall into two categories: those that incorporate a room into the main mass of the house and those that attach rooms from the back to that mass. An analogous distinction can be made for the placement of the main stairs which can be incorporated into the entrance hall or set apart from it so that they disrupt, to a certain degree, the sequence of spaces around the hall, creating what we have called corner room plans.

Three rules are needed to produce the principal cases (see figure 10). Rule 13 generates a main stair as an integral part of the hall. At this point, we do not distinguish between stairs in side, corner, or center halls; what is important is the relation of the stairs to the hall, which is the same in all of these cases. The remaining two rules generate corner room plans. Both rules reduce the depth of a

Rule 13



Rule 14



Rule 15

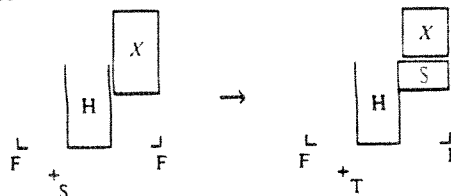


Figure 10. Rules to allocate main stair (X can be any room label).

room next to the hall to locate the stairs. Rule 14 uses a room at the front and rule 15 a room behind a front room. Application of these rules is straightforward. Figure 11 illustrates this by two possibilities generated from the same layout.

In addition to main stairs, all houses in our sample contain service stairs, which can be allocated in various ways, provided that some basic requirements are met, especially easy access from the service rooms on the first floor and to the main circulation areas on the second floor. It would not be too difficult to formulate rules that satisfy these requirements. But if done properly, plans would have to be considered, both on the first and second floors, at a detail greater than is required for our purpose.

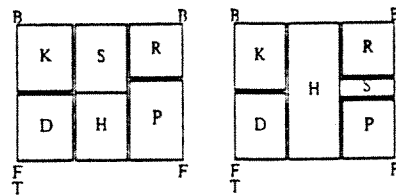


Figure 11. Layouts generated by application of stair rules.

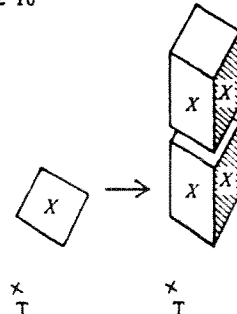
2.5 Extrusion in three dimensions

A main characteristic of the houses in our sample is that their second floors are essentially copies of their first floors. Specifically, the major spaces on the second floors are placed on top of the major spaces below and have similar sizes and shapes; modifications occur only through the addition of built-in closets or auxiliary halls and through the disappearance of the entrance hall. This property allows us to determine the spatial organization of a house from the layout of its first floor, that is, from a two-dimensional diagram, which simplifies considerably the way in which the basic organization of a house is derived. The grammar presented in this section takes advantage of this fact: it generates first-floor layouts and then copies this floor as a second floor.

Layouts that contain label T at the origin are complete enough to be developed in three dimensions. A grammar able to do this will be described in the next section. As a preparation, we conclude the present grammar with two rules that take a room in a layout and extrude it in three dimensions.

Rule 16 does this by creating two rooms on top of each other, whereas rule 17 applies only to stair halls, which are extruded in one piece (see figure 12). The resulting configuration of spaces is the basic shape to be developed in the following section. Figure 13 illustrates how these rules can be applied repeatedly to a layout and make it grow, step by step, into a three-dimensional configuration.

Rule 16



Rule 17

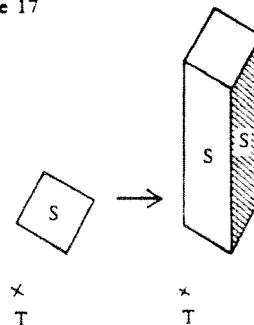


Figure 12. Extrusion rules (X can be any room label).

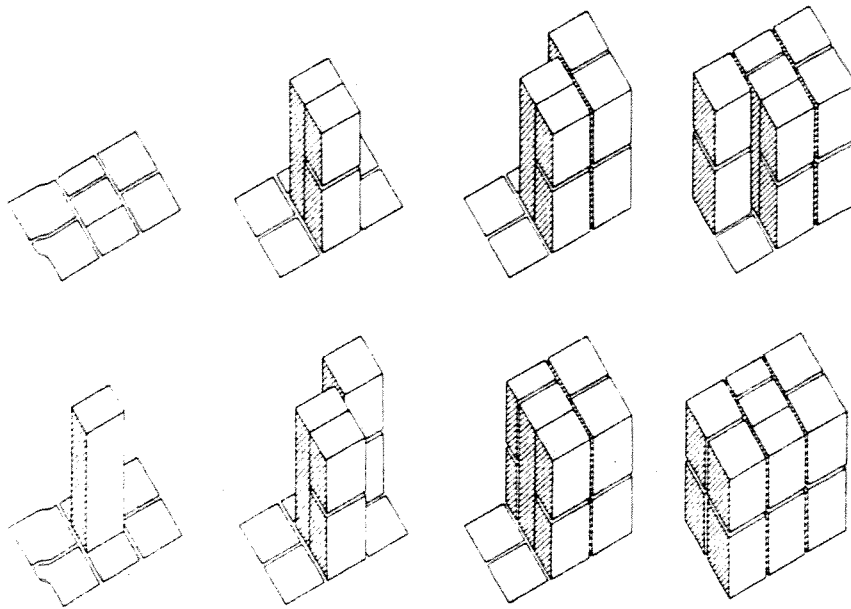


Figure 13. Three-dimensional configuration of spaces generated by the recursive application of rules 16 and 17 (see figure 12). Labels are omitted in this and subsequent figures.

2.6 Comments

Peripherally additive planning around a hall leads to plans that are certainly not 'open'. Each room is clearly defined by walls or partitions and has a simple, regular geometric outline. Furthermore, each public room is directly connected to the overall circulation system; no room is 'trapped', that is, can only be accessed through another room.

The spaces are, as a result, well defined, but not rigidly confined; they are separate, but can be connected and sometimes combined. We are not sure that these characteristics point to inherent 'ambiguities' in the concept of the Victorian house, as Handlin has claimed (Handlin, 1979, pages 344ff). Rather, we have come to appreciate these houses as remarkably successful attempts to accommodate the life of the middle-class or upper-middle class Victorian family in all of its manifestations, a goal that by necessity calls for multifunctional rooms and an adaptable environment, characteristics that are still appreciated today when these houses must be adapted to changed demands.

For the same reasons, we believe that these houses represent more than a transitional stage in the development of the open plan. They represent a developed type that was successful enough to retain its essential characteristics for half a century. Our grammar demonstrates not only how the underlying principles can be geometrically realized, but also that this realization follows very simple rules, which can be understood by builders without architectural training. This probably contributed to the success of the type.

In this connection, it is illuminating to compare the present type with other types from the period of study. Among these, at least two come to mind. There are, on the one hand, plans organized by axes. Alexander Jackson Davis, Downing's friend and collaborator, used this type in his larger houses (see the examples in Pierson, 1978). He frequently employed two axes which serve as major circulation elements and arranged the rooms along them. Stairs are located

not where the axes intersect, but at their end; this introduces a directional pull into a plan not found in the more centered schemes from our sample. There are, on the other hand, large, rambling houses that spread out in one direction and present as much surface as possible to the approaching visitor or towards a preferred view, notably the sea shore (a good collection can be found in Lewis, 1982). They are more loosely organized than the sample plans (although they may contain parts that follow the same principles).

These examples are based on contrasting sets of rules (which could again be made explicit through shape grammars), and it is through a comparison with these rules that the plans in our sample reveal basic similarities.

3 Exterior articulation

3.1 *The tradition of the picturesque*

In the present section, I will specify a grammar whose rules can be applied to three-dimensional configurations as generated by the extrusion rules; they will turn an abstract configuration of rooms into a house, in this case, a house in the Queen Anne style that dominated construction in Shadyside in the 1880s.

Major principles underlying this style were introduced into the domestic architecture of the United States by Downing, who adapted mainly English sources to the American context [see, Pierson (1978) for a full account of Downing's work and influence]. Downing required that a house should be designed for convenience and comfort and clearly express its purpose:

"[the] prominent features conveying expression of purpose ... are the chimneys, the windows, and the porch, veranda, or piazza; and for this reason, whenever it is desired to raise the character of a cottage or villa above mediocrity, attention should first be bestowed on those portions of the building" (1981, page 12).

Downing did not advocate a particular style. But he stated that a house

"must nestle in, or grow out of, the soil. It must not look all new and sunny, but show secluded shadowy corners. There must be nooks about it, where one would love to linger; windows, where one can enjoy the quiet landscape leisurely; cozy rooms, where all domestic fireside joys are invited to dwell".

Given these preferences, the classical or 'Grecian' style is not suitable for dwellings. It is, first of all, associated with temples and therefore unable to express purpose for other types of buildings. It furthermore results in very regular compositions that place limitations on the possible spatial arrangements and isolate the building from the surrounding landscape. Downing preferred irregular, 'capricious' houses, with high roofs, steep gables, even a tower or campanile—"any and every feature that indicates originality, boldness, energy, and variety of character" on the part of the owner (quoted by Pierson, 1978, page 354).

With statements such as these, Downing placed himself firmly in the tradition of the Picturesque. Simplified versions of his precepts became stock ingredients of pattern books. For example, Amos J Bicknell and William T Comstock, who were busy compiling and publishing various pattern books and handbooks at the time when the Queen Anne style was at its peak, find

"that convenience and utility, as well as appearance, are promoted by a departure from bare rectangular form ... By abandoning the old 'dry goods box' style, the arrangement of the rooms and their individual comfort and convenience is [sic] greatly increased, while to the appearance of the whole there is given such character and picturesqueness as will add greatly to the value and attractiveness of the property" (Bicknell and Comstock, 1880, page 14).

The following sections will show how these principles were realized in a particular way in the Queen Anne houses surveyed.

3.2 Generation of a basic house

We are not entirely sure that flexible space planning demands an irregular plan, at least not for small to medium-sized houses: we have simply encountered too many houses of the 'old dry goods box style' that are well planned. But the massing resulting from an irregular plan undoubtedly creates picturesque views. In fact, it allows for an 'expression of purpose' that goes beyond Downing's recommendations, which focus very much on the articulation of windows, chimneys, and porches, a 'naive' approach in the sense that it deals with isolated features without attempting to arrive at an overall integration. The houses in our sample go beyond this (see the example shown in section 1 and figure 14). Their massing is not irregular in a vague picturesque sense; it is irregular because *every major space is usually expressed at the outside* and distinguished from neighboring spaces through breaks in the exterior walls; these breaks are created by pulling one space farther out; and it is this principle which accounts for much of the irregularities observed in plan and massing.

Our development of a Queen Anne house consequently starts by defining the exterior walls according to this principle. It proved convenient to divide the rules that can be used to this end into two groups: those that generate exterior walls at the front and back; and those that generate exterior walls at the sides. The first are shown in figure 15 and the second in figure 16.

The corners of a configuration are always occupied by a primary space. In some configurations, one of these spaces may already be pulled out; in this case, rule 1 applies and simply wraps an exterior wall around the spaces. In cases where the spaces are aligned at the front or back, rule 2 applies; it pulls one of the corner spaces out and thus creates the desired break in the wall surface.

Rules 1 and 2 are generally used to generate the front and back walls. Sometimes however, especially on restricted sites, these pullouts are difficult to achieve.

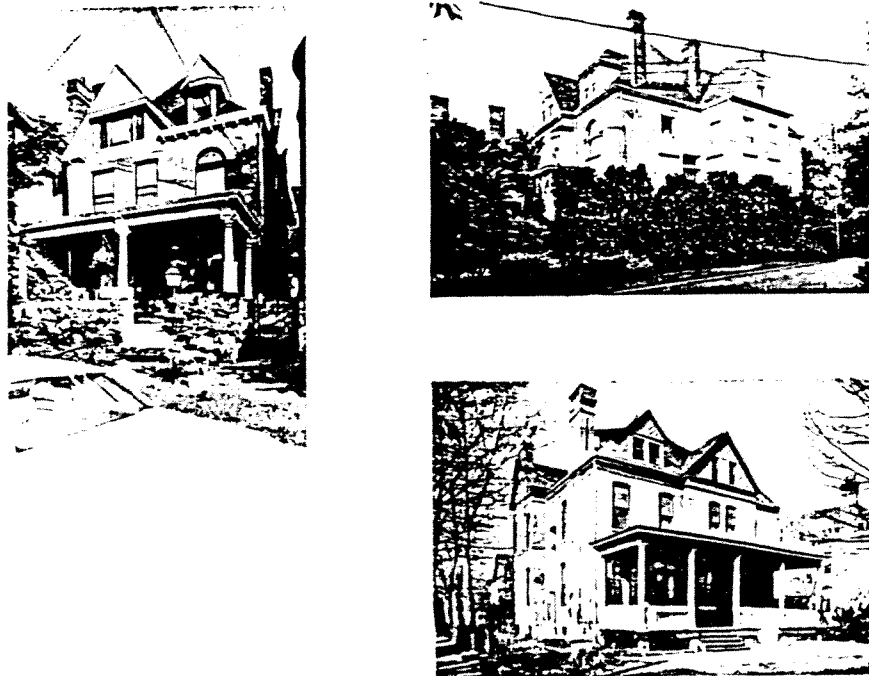


Figure 14. Queen Anne houses in Shadyside.

In these cases, rule 3 can be used to create a flat surface; but it is to be understood that this rule can only be applied under exceptional circumstances. Rule 4 finally creates a back wall when a space (most likely the kitchen) has been attached and centered at the back.

In all cases, labels B, C, and F are removed from the corners of a configuration, and new labels are attached to the center of the wall surfaces, to be removed when further elaborations have taken place. Points at a level above the second floor ceiling are labelled R; they mark the corners of a rectangle that contains the core of the configuration, to be used later in the placement of the main roof.

Rules 5-8 act similarly to close the sides of a configuration and to create a continuous exterior wall surface. Again, rules 5-7 indicate the desired breaks, and rule 8 applies in special cases similar to rule 3. Figure 17 shows typical configurations generated by these rules.

Based on this approach, the 'problems in solid geometry' posed by the roofs of Queen Anne houses largely disappear, at least for the houses under consideration. The rules that create exterior walls also mark a rectangle on top of the configuration which covers the bulk of the house. This area will be covered by a main roof

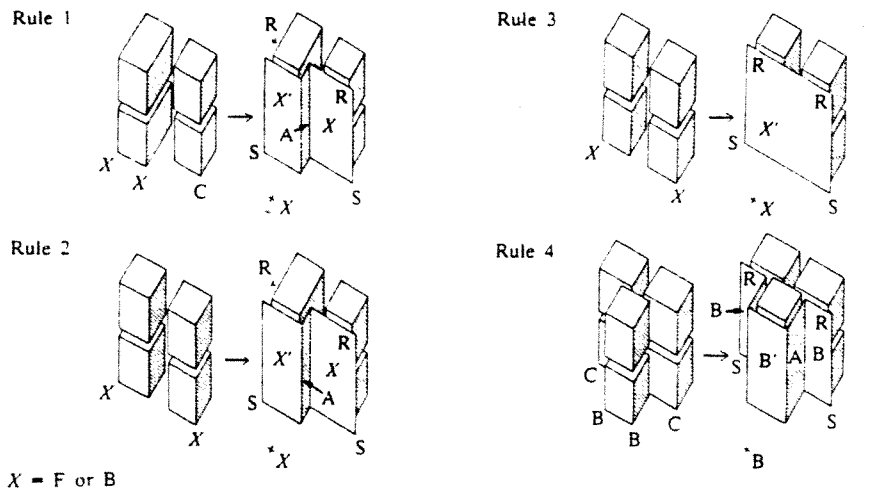


Figure 15. Rules to generate front and back walls.

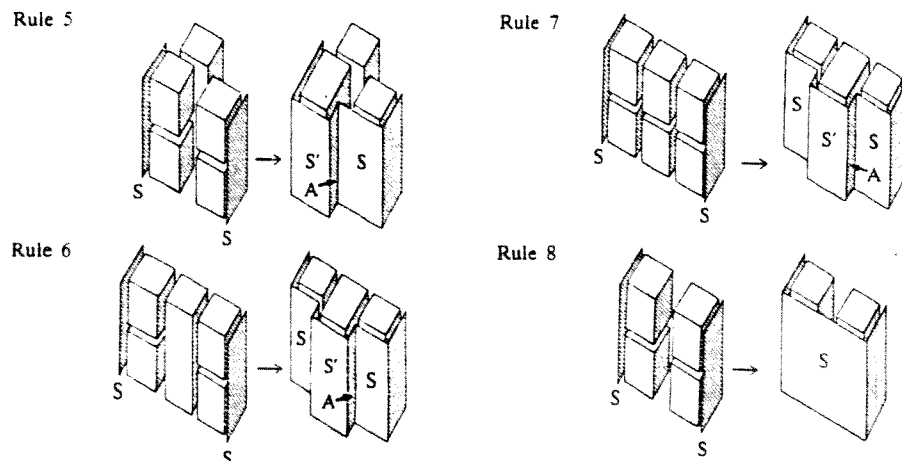


Figure 16. Rules to generate side walls.

to which secondary roofs must be attached in order to catch all of the irregularities that have been generated before.

Rule 9 creates a main roof which is hipped. This is the predominant form for the houses in our sample. Its ridge runs parallel to the longer dimension of the base rectangle, independent of the position of the street. A variation is introduced by rule 10, which can be used to change a front hip into a gable. The application of rule 10 is optional and restricted to houses with narrow fronts.

An application of rule 9 normally creates a configuration with a roof that is incomplete because it does not cover every part of the plan. The uncovered parts can readily be found because their end walls have labels with a prime. The rules shown in figure 18 can be used to place secondary roofs on top of the uncovered parts. Rules 11-14 specify the normal ways in which this can be done. In each instance, the secondary roofs intersect cleanly with the main roof or become continuous with it; they end in a gable at the front or sides and in a hip at the back. Note that rule 11 applies also when the main roof ends in a gable, in which case it generates a front with two stacked gables, a motive that is not uncommon in Shadyside. Rule 15 is an addition to the basic set of roof rules. It creates a gable placed off-center on top of a flat front in order to produce a picturesque effect without the normal wall breaks.

Rules 9-15, in combination, are able to generate quite intricate roof geometries which might be difficult to build, but are certainly not difficult to understand. To us, these rules embody the basic logic of the Queen Anne roof and go a long way towards explaining the puzzle posed by it.

However, rules 9-15 are not able to handle every case successfully (technically, they are not able to remove all of the primes, which is an indication that some unresolved problems remain). An example is given by the Spencer house, where a corner space is pulled out simultaneously towards the front and side (rules 1-8 were deliberately designed to allow for this complication); in such a case, parts of the simple secondary roofs created by rules 11-15 would miss the main roof and

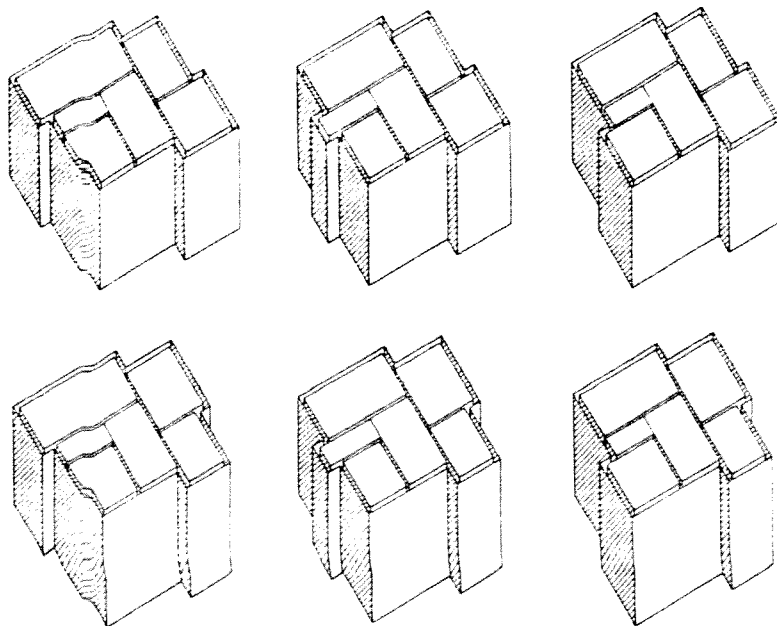


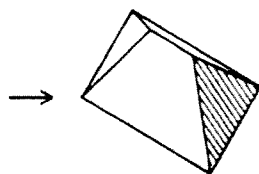
Figure 17. Shapes generated by application of rules 1-8 (see figures 15 and 16).

Rule 9

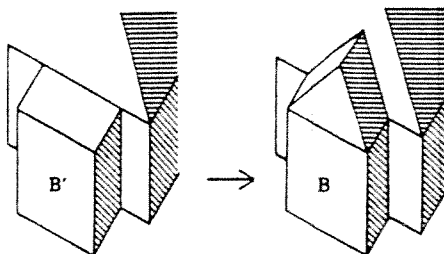
R
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R
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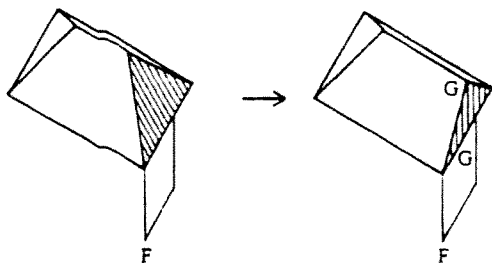
*R



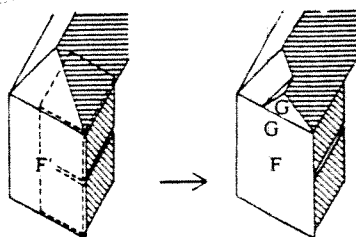
Rule 14



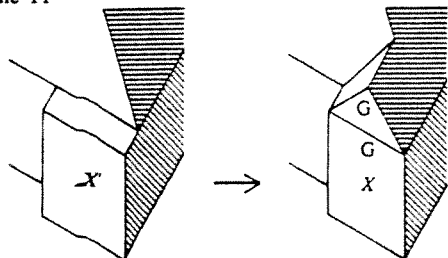
Rule 10



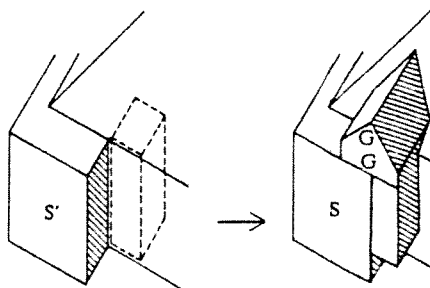
Rule 15



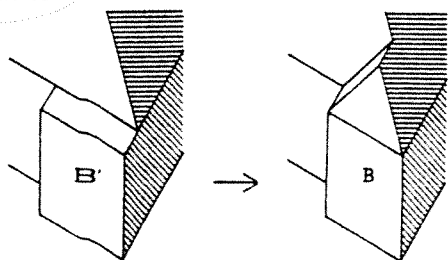
Rule 11



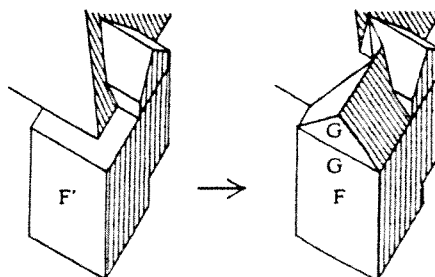
Rule 16



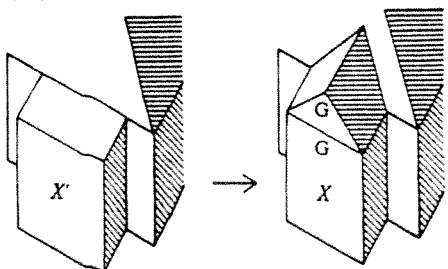
Rule 12



Rule 17



Rule 13



X = F or S

Figure 18. Rules to generate roofs.

therefore cannot be used to cover the protrusion. The solution adopted at the Spencer house is reproduced by rules 16 and 17, which must be applied in sequence. Rule 16 generates a gable and secondary roofs that intersect with the main roof and cover one end of the corner space (following the example set by the Spencer house, it also pulls out the staircase). Rule 17 can then be applied to cover the remaining portion of the corner space by a second gable perpendicular to the first one. Six roof planes are involved in this basic solution: two from the main roof and two from each of the secondary roofs. They cannot intersect at a point and therefore form unwanted valleys or water traps. Rule 17 covers the trouble spot by two additional roofs (using again the Spencer house as a precedent).

This is a very special solution for a very special problem. There are other instances where auxiliary roofs must be used to solve all problems imposed on the design of a roof by the geometry of a plan. We tried to demonstrate with rules 16 and 17 how these cases can be handled as exceptions within the approach presented here. It would certainly be interesting to arrive at a more general solution for the problem; but this goal is beyond the scope of the present study.

When all primes have been removed from exterior walls, the entire configuration of spaces is covered. This concludes the first stage in the design of a Queen Anne house and results in a basic shape that can then be elaborated in later stages. Examples of such basic shapes are shown in figure 19.

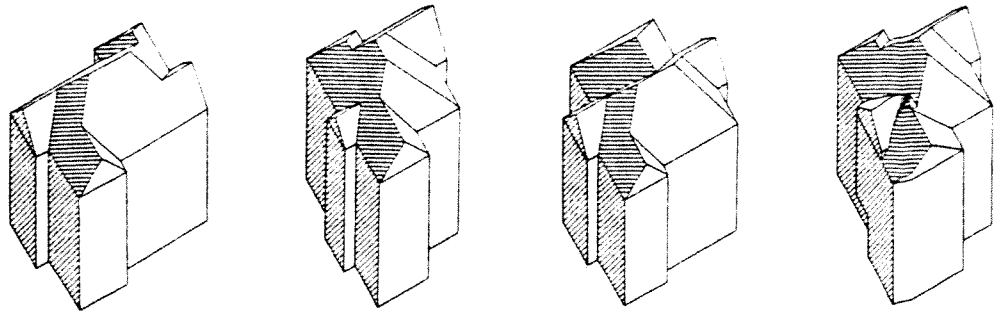


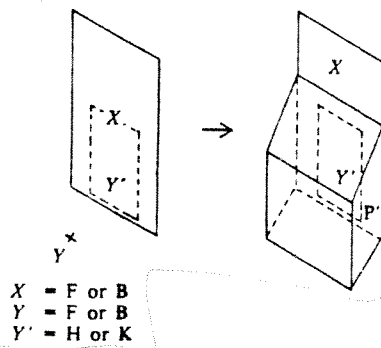
Figure 19. Basic Queen Anne houses.

3.3 Volumetric refinements and additions

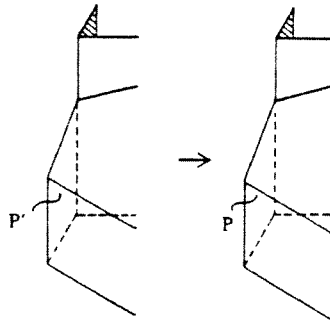
The basic shapes produced in the first stage can be enriched by various volumetric refinements and additions. Dormers are always added to the roof and can be joined by towers or turrets, which can combine with highly articulated chimney ends to create elaborate roofscapes. Bays can be attached to the exterior walls, sometimes at an angle (for example at the Spencer house). Protrusions may end in polygons or curves and change their shape from floor to floor. Chimneys occupy prominent spots, for example, at the center of a polygonal bay; and balconies are sometimes added at the second or third floor. Some of these possibilities are treated in our full study; in the present paper, I can only demonstrate through a selected element how a grammar can handle these cases. I selected the front porch for this purpose, an indispensable feature of a Queen Anne house with particular expressive potential according to Downing.

The front porch of a Queen Anne house can be small, covering only the entry portion of the front; it can extend over the entire front; or it can turn a corner and wrap around a good portion of the first floor. We unify these possibilities by the concept of a *growing porch* which, starting from a minimal porch, can extend over the front, turn around corners, and fill in all of the angles, nooks and

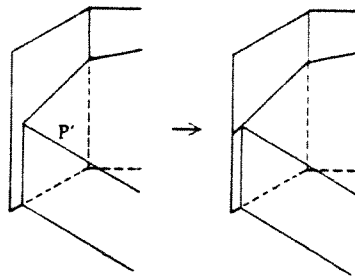
Rule 18



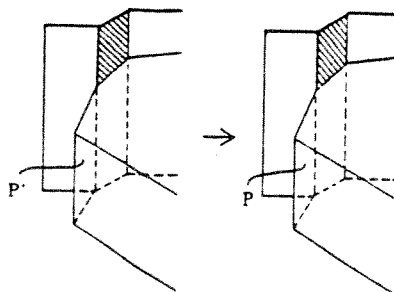
Rule 19



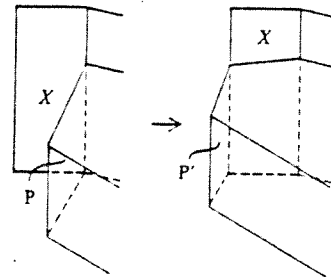
Rule 20



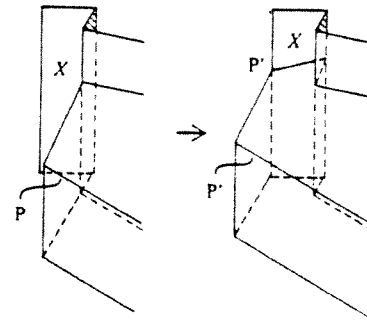
Rule 21



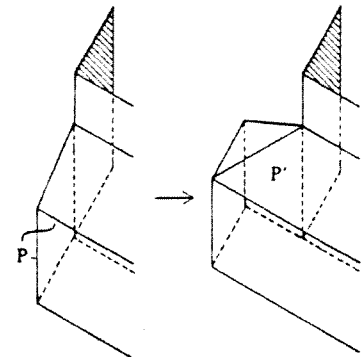
Rule 22



Rule 23



Rule 24



Rule 25

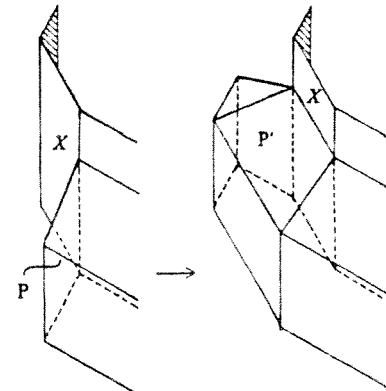


Figure 20. Rules for addition of porches.

crannies encountered along the way. The rules shown in figure 20 generate this type of porch.

Rule 18 allocates the initial, minimal porch in front of the entrance hall. This hall is always flush with at least one corner of the front (rules 1-3 guarantee this); and if a porch is placed in front of the hall, one of its sides must always stand free. The other side may run partially or fully into a wall formed by a break in the front. Rules 19-21 recognize these cases; they mark the open side of a porch and remove labels from the side that is closed off by a wall.

Rules 22 and 23 can now be used to extend the porch to the right or left. Rule 22 extends the porch along an adjacent wall that is angled relative to the wall at the back of the porch (for example, where a polygonal bay meets a wall). Rule 23 extends the porch along a wall that is stepped back. In each case, the outer face of the porch and its roof are extended in the same plane. To turn a corner, rules 24 or 25 must be used; the corner is right-angled in the first case and polygonal in the second case.

Rules 19-25 can be used to make a porch grow around an irregular mass. The porch will maintain a regular open front or side, while the back is able to adapt to all of the breaks that might have been produced by protruding spaces, towers, bays, and chimneys. Examples of porches that grow around a house, forming the well-known wraparound porches of Victorian houses, are shown in figure 21.

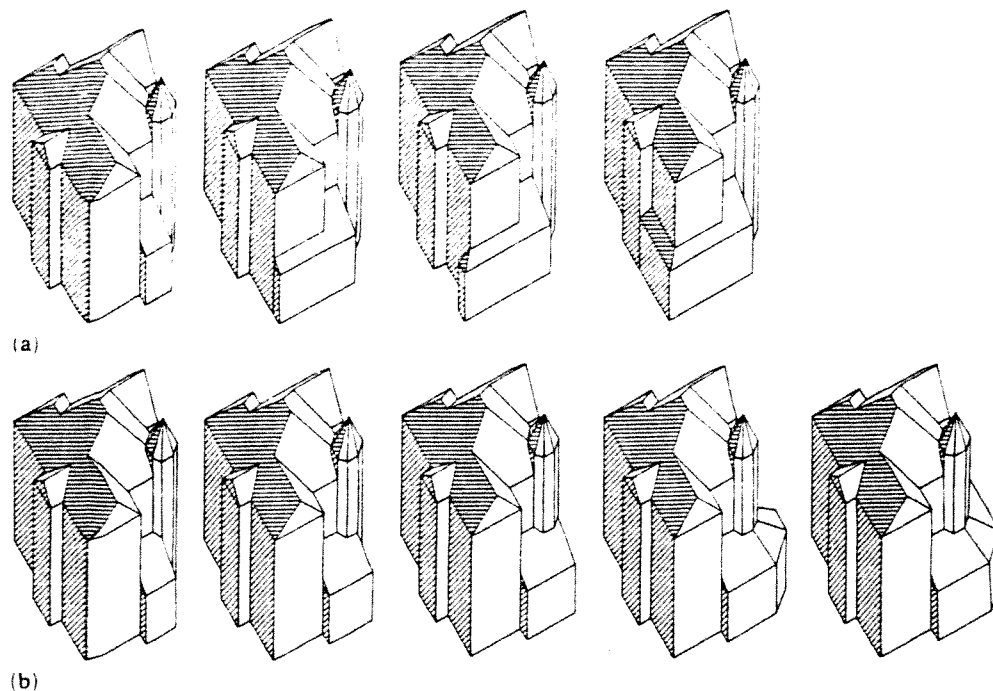


Figure 21. Examples of growing porches. (a) Around left-hand corner, (b) around right-hand corner.

3.4 Articulation of elements

Downing identified three types of elements as having particular expressive power for houses: windows, chimneys, and porches (see section 3.1). Next to these, gables receive particular attention in Queen Anne houses. All of these elements can be further developed by the appropriate rules. For the present paper, I again have to concentrate on a single element to demonstrate how this can be done. I selected chimneys, Downing's second element with good expressive potential.

In Queen Anne houses, chimney breasts are decorated in three parts: the bottom, the center shaft, and the top, each of which is treated using a particular vocabulary of decorative forms. We concentrated on the principles underlying the articulation of bottoms; the other parts could be treated in a similar way. Typical bottom articulations are shown in figure 22.

The bottom of a chimney breast is cut into a profile made up of alternating horizontal and vertical edges, where each horizontal edge rests on a corbel. The simplest case is shown in figure 22(a). Perhaps the most common one is shown in figure 22(b), where the horizontal edges descend progressively towards the center, and the corbels form a characteristic shape resembling a bunch of grapes. Horizontal and vertical edges alternate in a more intricate fashion in figure 22(c), where the vertical parts are stretched out in various lengths, generating a quite sophisticated design. The remaining examples show further variations in the sequence of horizontal and vertical edges and indicate that the center depression can end in an arch instead of a corbel.

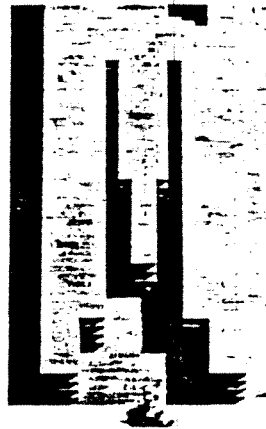
complex and



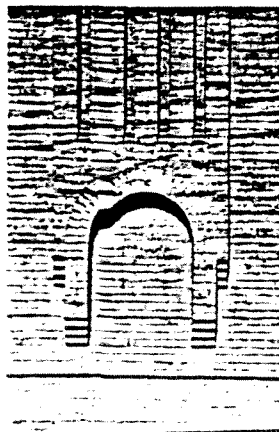
(a)



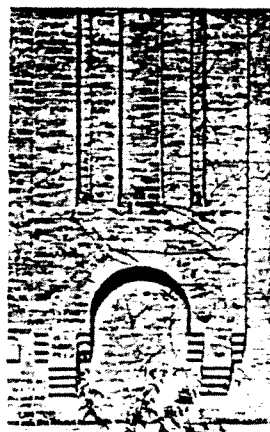
(b)



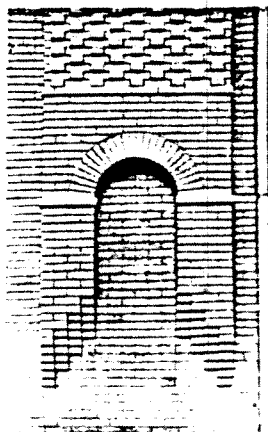
(c)



(d)



(e)



(f)

Figure 22. Bottom ends of chimney breasts.

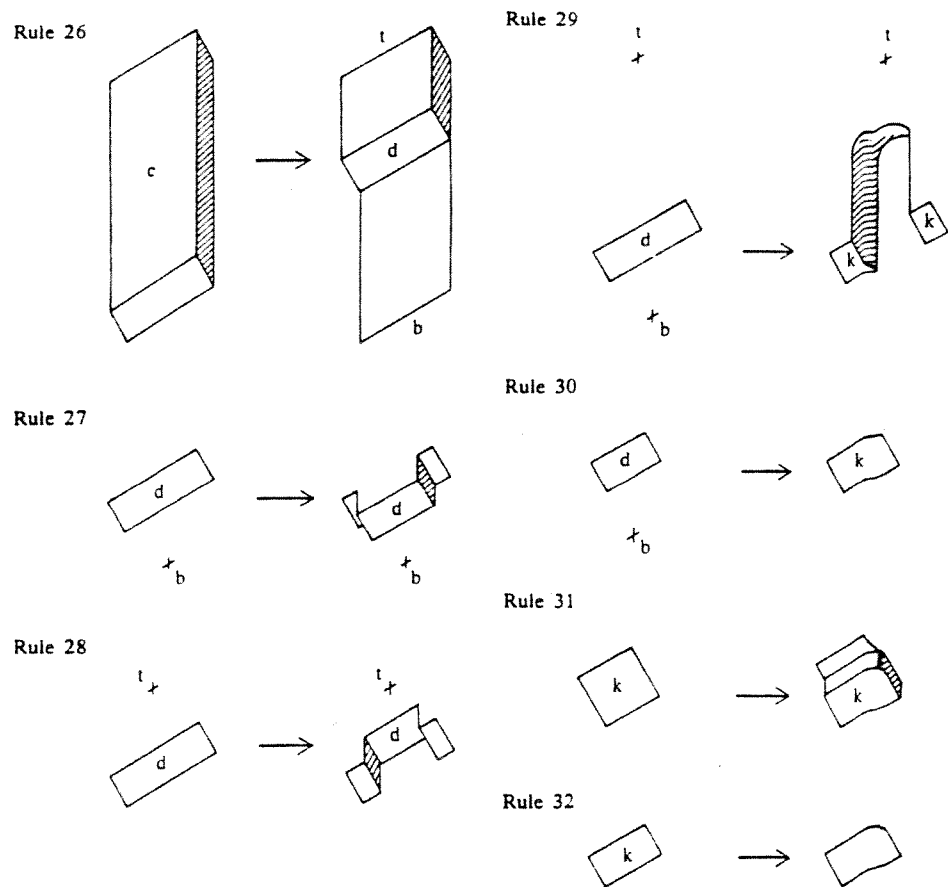


Figure 23. Rules to generate bottom ends of chimney breasts.

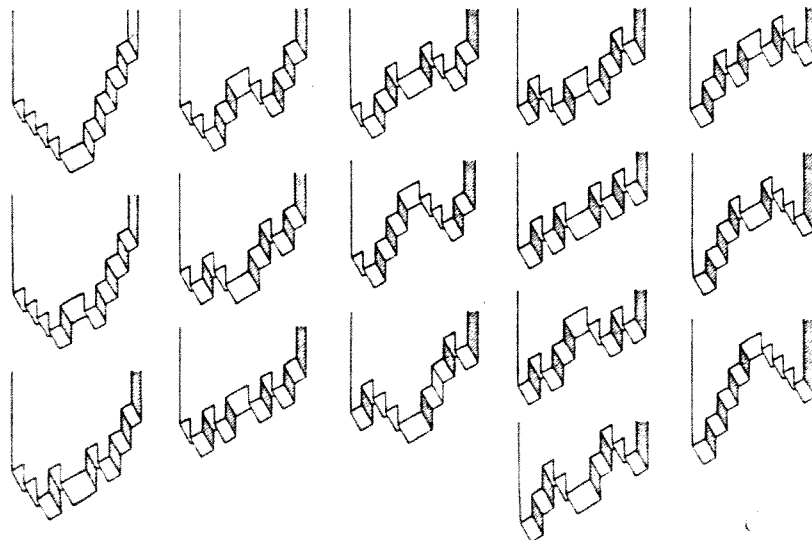


Figure 24. Examples of bottom ends of chimney breasts generated by application of rules 26-28 (see figure 23).

Rules that generate a bottom profile are shown in figure 23. Rule 26 prepares a chimney breast for elaboration by cutting off its bottom part, thus generating a bottom edge that can be further articulated. The edge is cut into a profile by repeated applications of rules 27 and 28 (in an arbitrary sequence). Rule 27 cuts a piece out of the bottom edge, and rule 28 pulls a portion of the bottom edge down. The dimensions involved are governed by the size of the standard brick used to build the chimney. Figure 24 shows all of the profiles that can be generated by all possible sequences of rule applications for a chimney ten bricks wide.

Rules 29 and 30 terminate the process of creating a bottom profile, and rules 31 and 32 generate the corbels underneath the horizontal edges.

3.5 Comments

Sections 2 and 3 specify the rules of grammars that can be used to generate Queen Anne houses from scratch. In the process of developing the grammars we were forced to look at examples with a degree of closeness that is hardly necessary if the analysis proceeds in the traditional, intuitive way. In particular, we were forced to deal with overall aspects of plan organization, massing, and articulation that are usually neglected in style descriptions or are described in less precise terms. As a result, we were able to demonstrate how the various parts and features of a house relate to each other and to explain its overall geometry, given the premises of the Picturesque aesthetic.

It should be noted that once a basic house has been created, individual parts can be developed to an arbitrary level of detail. This is needed to reproduce the richness of contrasts and patterns for which Queen Anne houses are known. But it is also conceptually easy within the framework developed here.

However, some technical difficulties have to be overcome if this kind of work is to succeed. In our experience, it is usually easy to design a shape grammar which does what it is supposed to do: it is much more difficult to prevent, at the same time, the grammar from doing what it is *not* supposed to do. There is, at the present time, no body of theory available that would allow us to predict the properties of shapes generated by a grammar solely from an inspection of its rules. In order to assure that a grammar is properly constructed, we often have to enumerate a substantial number, if not all of the shapes it generates. This process is tedious and error-prone if done manually and could clearly gain from automation.

To test the grammars presented in the preceding sections, we used a simple interpreter that proved perfectly adequate for the occasion: it will be described in greater detail elsewhere (Flemming, forthcoming).

Acknowledgement. The work reported here was supported in equal parts by a grant from the National Endowment for the Arts and by the Department of Architecture. We are indebted to Mr and Mrs Francis E Fairman, the present owners of 719 Amberson Avenue, for letting us measure their house.

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