48-747 Shape Grammars

QUEEN ANNE HOUSES

Follows in the picturesque traditions of the 19th century

"one of the most complex habitations ever devised for commoners. It rejected the traditional concept of the unity of design, deliberately contrasting shapes, textures, and colors – solid and void, in and out, square and round, light and dark, rough and smooth. …

… Paradoxically, this busy allover pattern created a unity of its own, very much like a patchwork quilt that makes a strong design out of many different fabrics."

Queen Anne houses

have history

have features

have texture

have structure

have aesthetics

have style

and … are describable by **shape grammars**

among the worlds I study

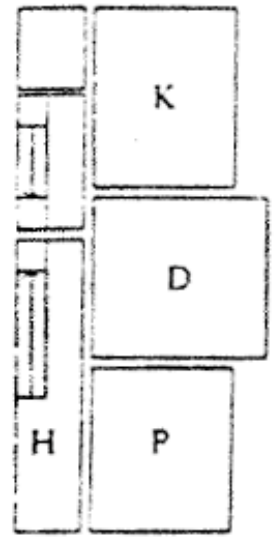
recall that analytic shape grammars are intended for a **particular style**

clarify ***commonality of structure*** and appearance manifest in buildings in a corpus;

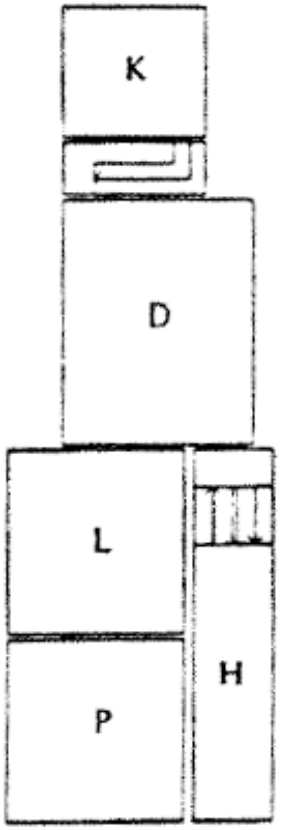
supply ***conventions and criteria*** to determine whether any other building outwith the original corpus is an instance of the style; and

provide a ***compositional*** *machinery* to describe other buildings in the style

language → style ← shape grammar



Plan A1



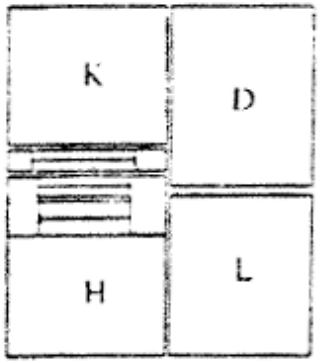
Plan A2

Key
B Billiard room
CE Carriage entry
D Dining room
De Den
H Hall
K Kitchen
L Library
P Parlor
Pt Pantry
S Study
SP Sun porch
SR Smoking room

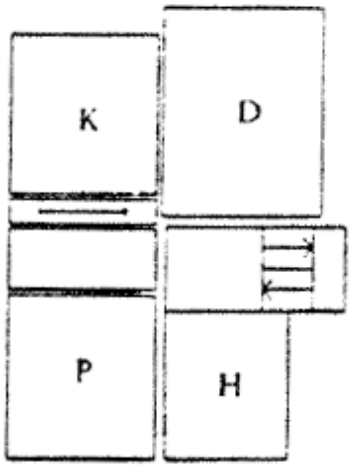
0 10 30 ft

a small sample of measured drawings of Queen Anne Houses in Shadyside, Pittsburgh, PA

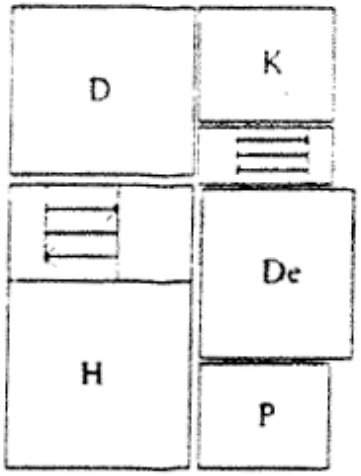
the sources **side hall plans**



Plan B1



Plan B2



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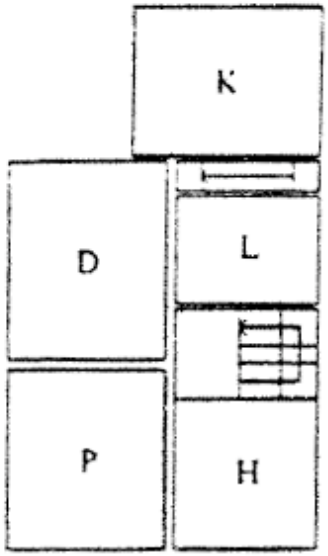

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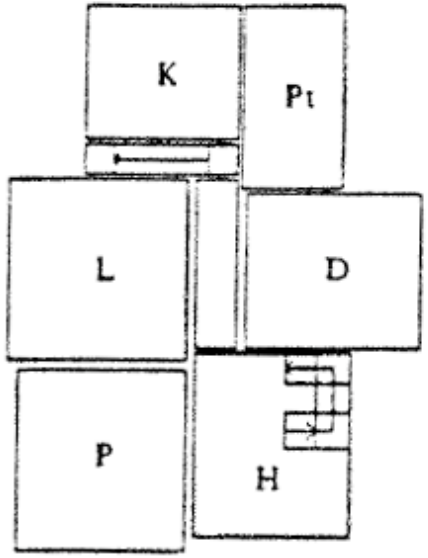
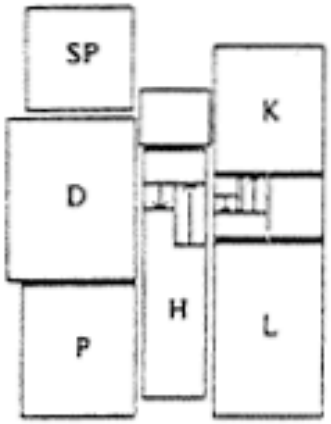


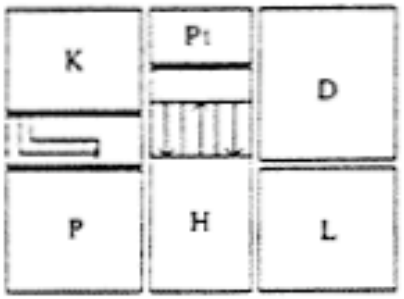
Plan B5

the source

corner hall plans



Plan C1



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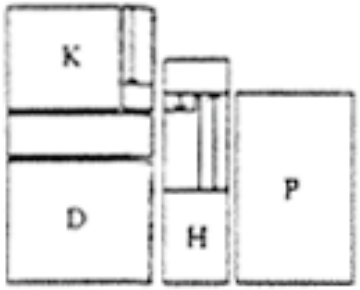

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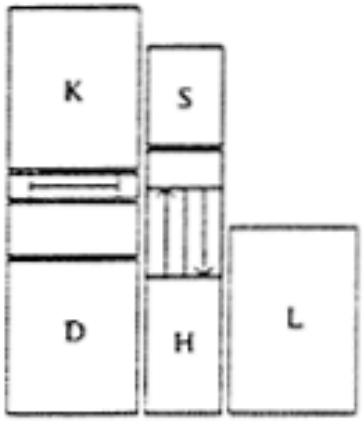

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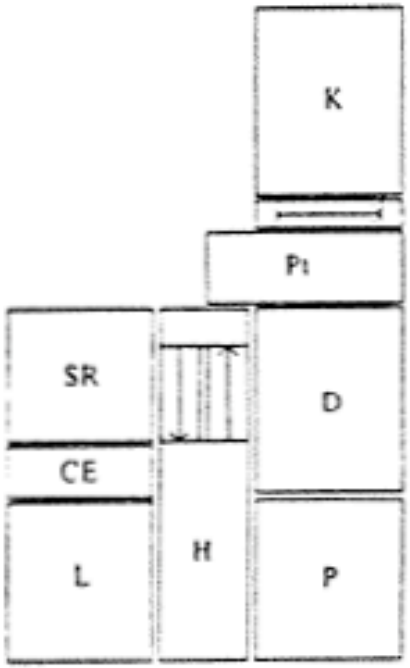

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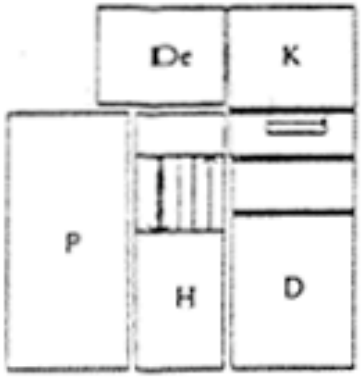
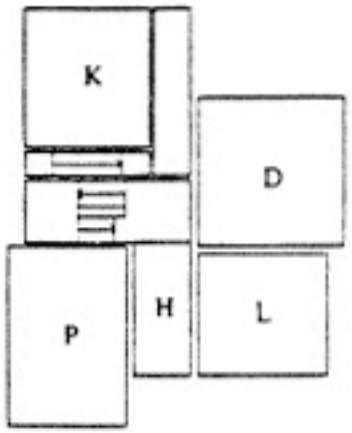


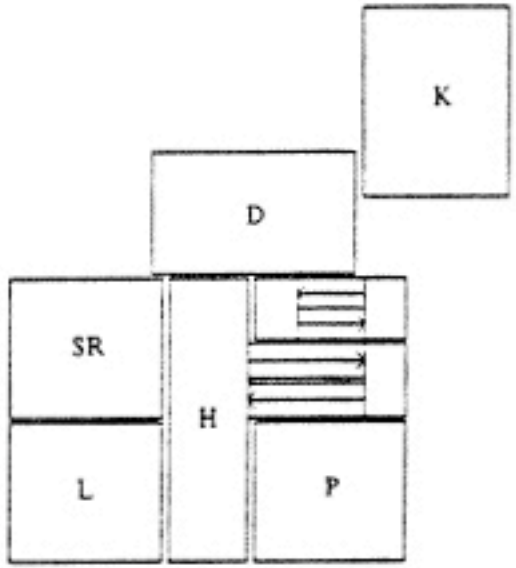
Plan C6

the source

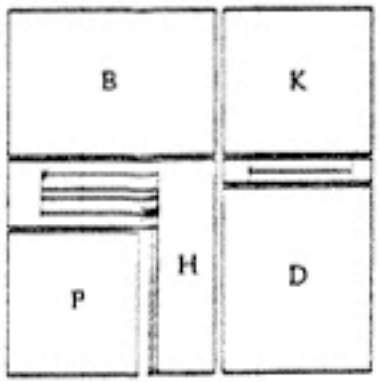
center hall plans



Plan D1



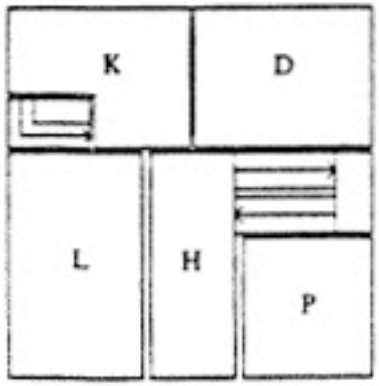
Plan D2



Plan D3

the source

corner room plans



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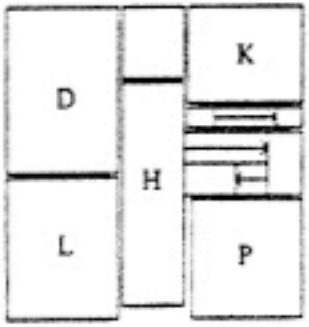

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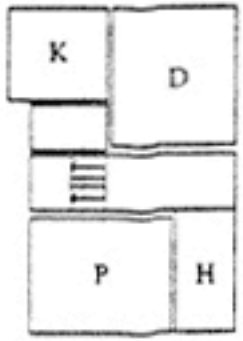


Plan D6

Spatial Organization

Allocating rooms around a hall

Allocating the kitchen

Adding a stair hall

Extruding into the third dimension

Exterior Articulation

Generating a basic house

Generate roofs

Volumetric refinements and additions

Articulation of elements

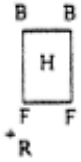
termination

stages in the shape grammar

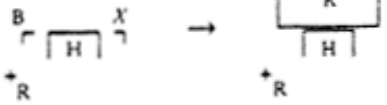
spatial organization

Initial shape:

Rule 0

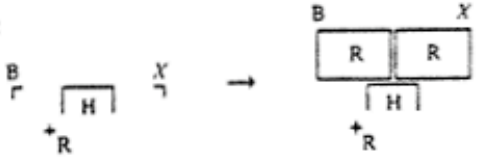


Rule 1

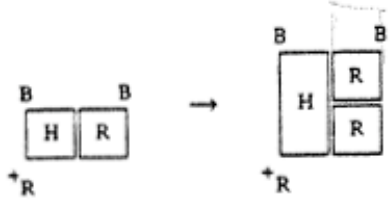


X = F or B

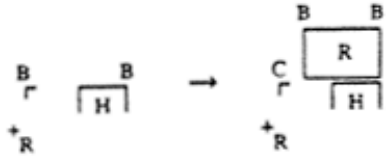
Rule 2



Rule 3



Rule 4



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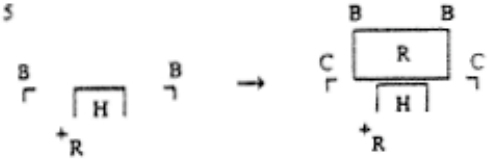
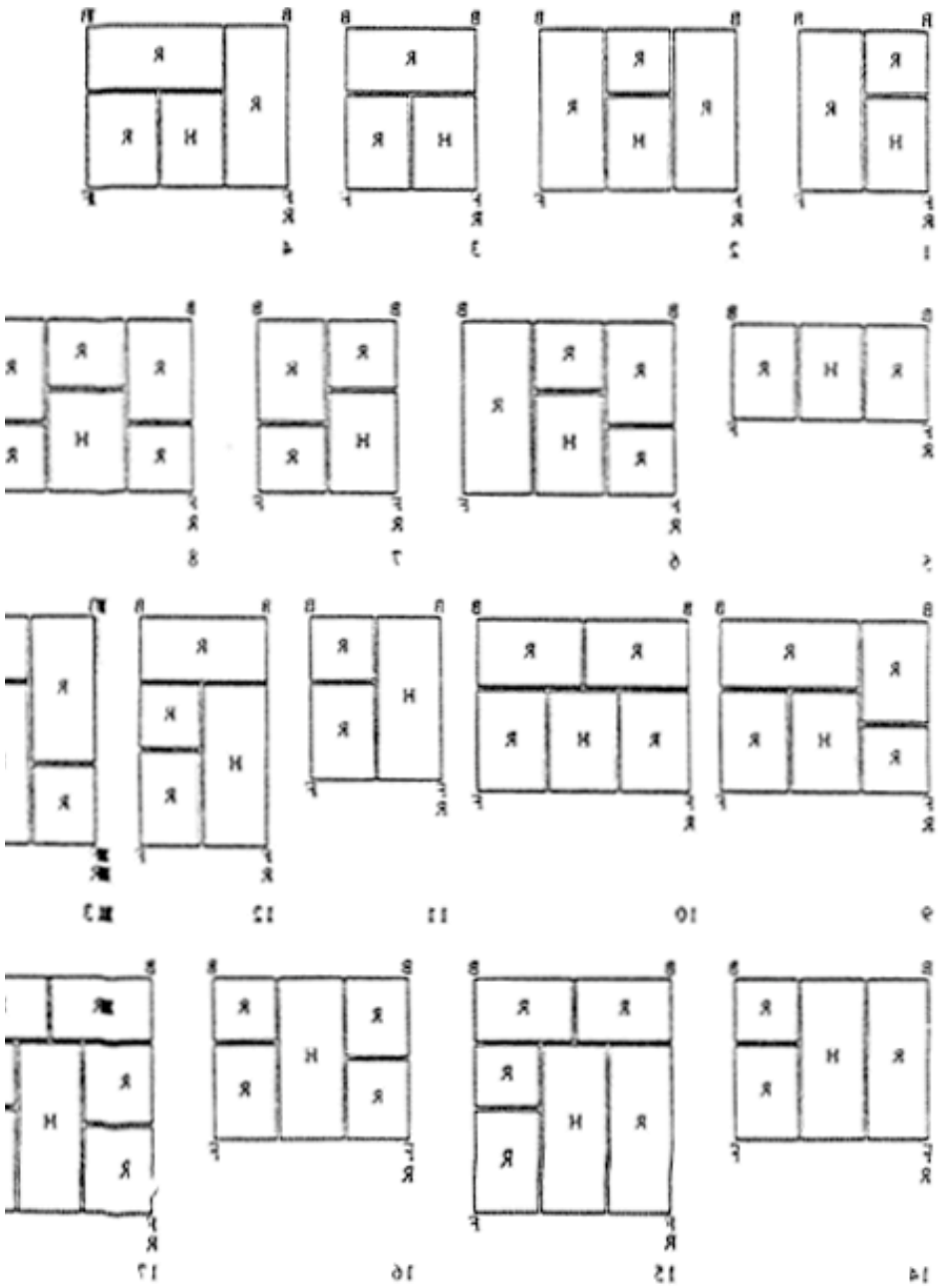
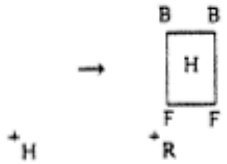


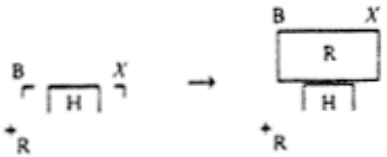


Initial shape:

Rule 0

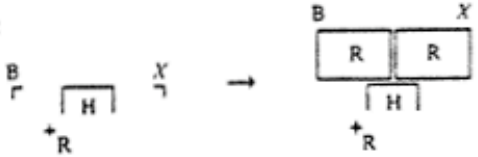


Rule 1



X = F or B

Rule 2



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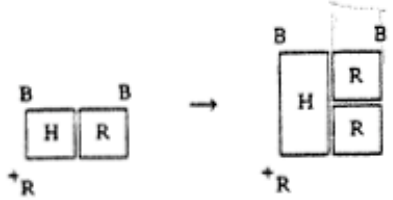
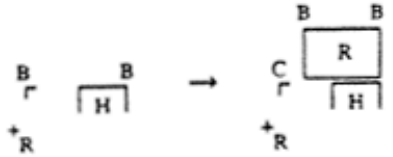
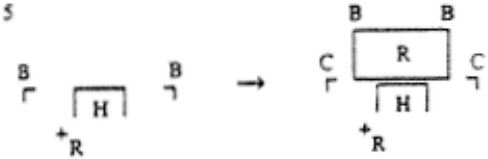
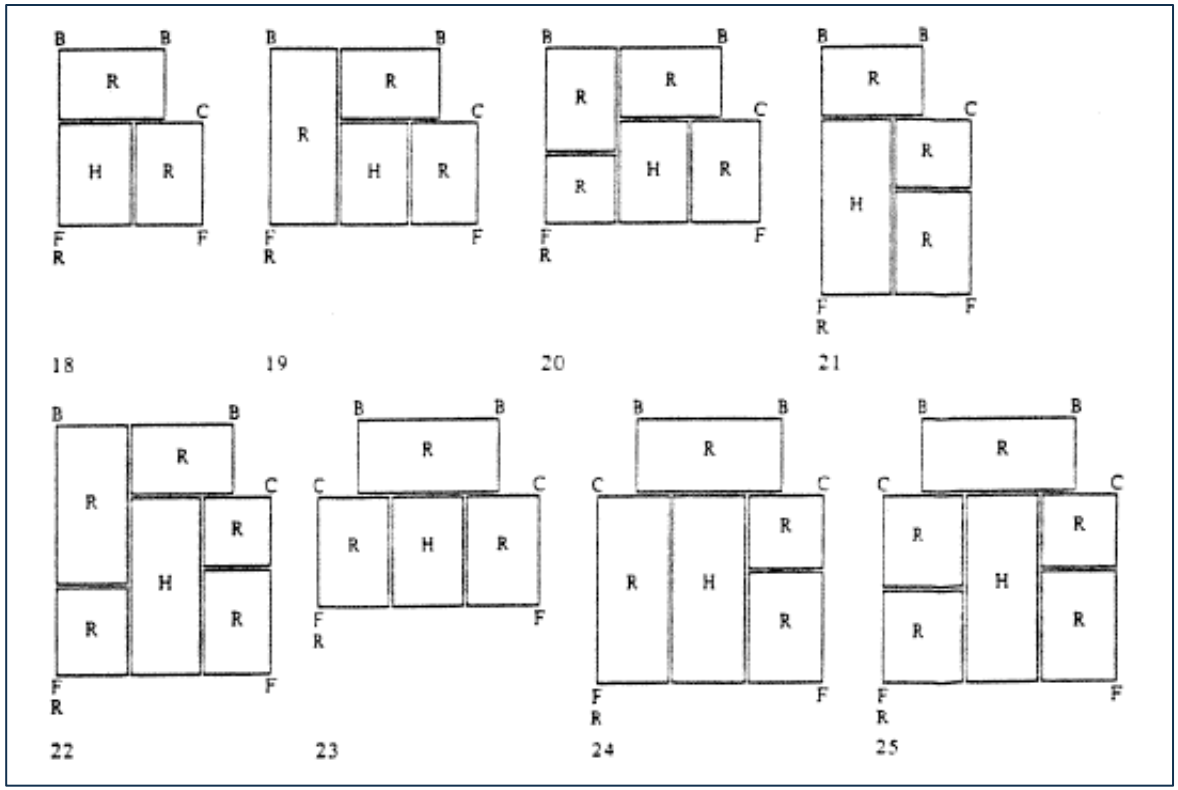


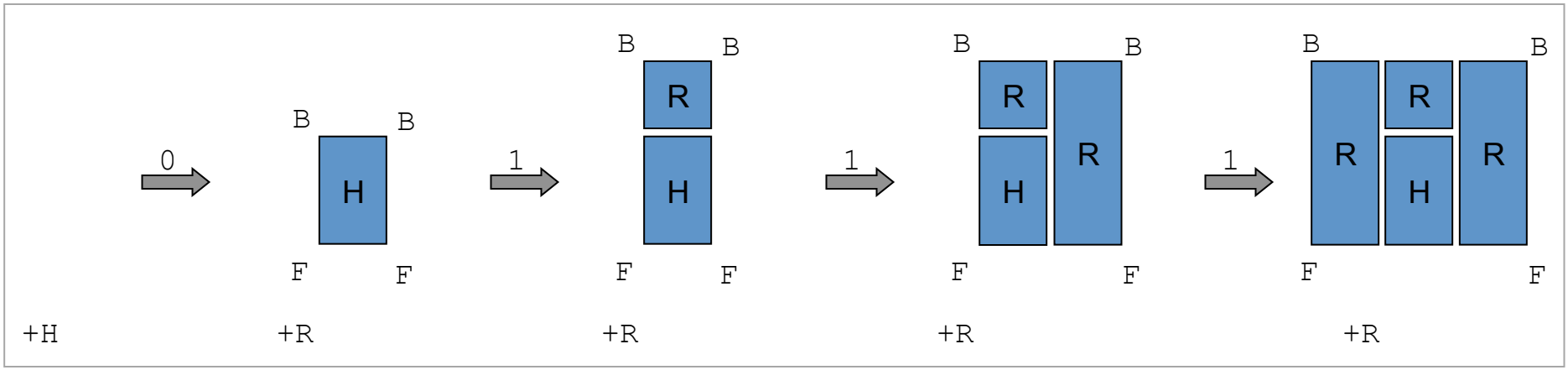
Rule 4

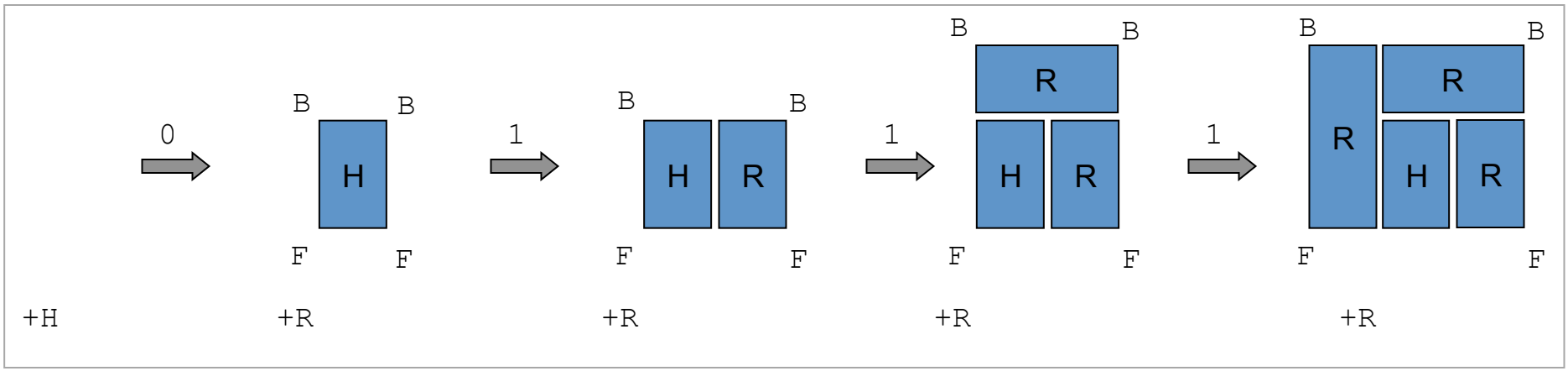


Rule 5

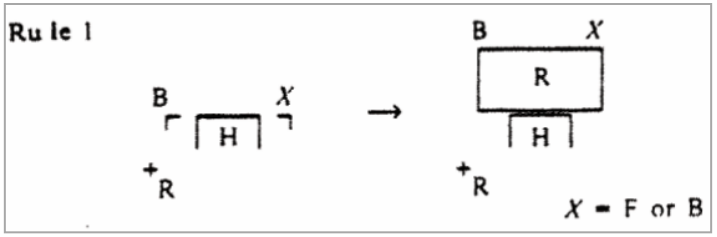


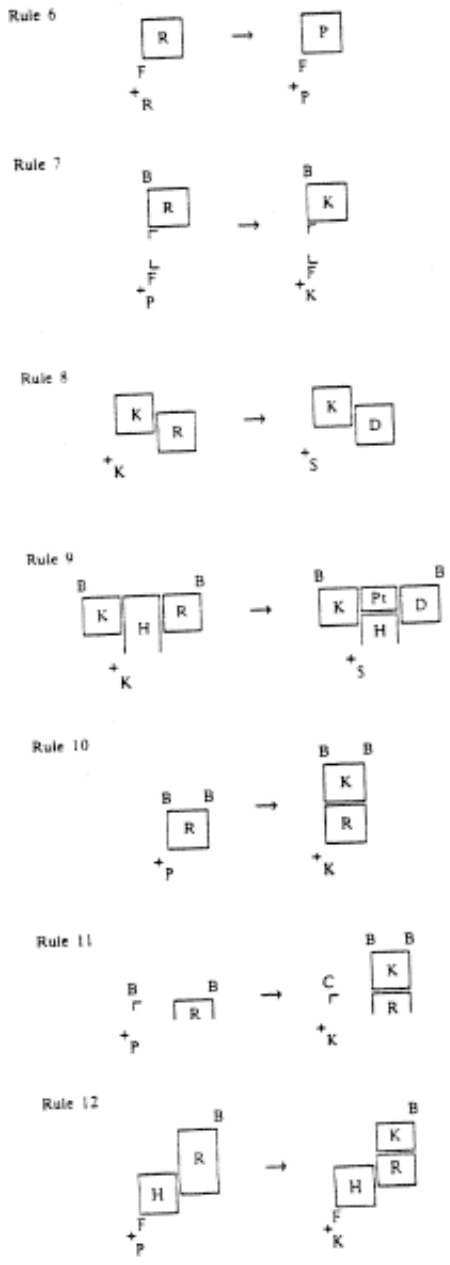






applying shape rules





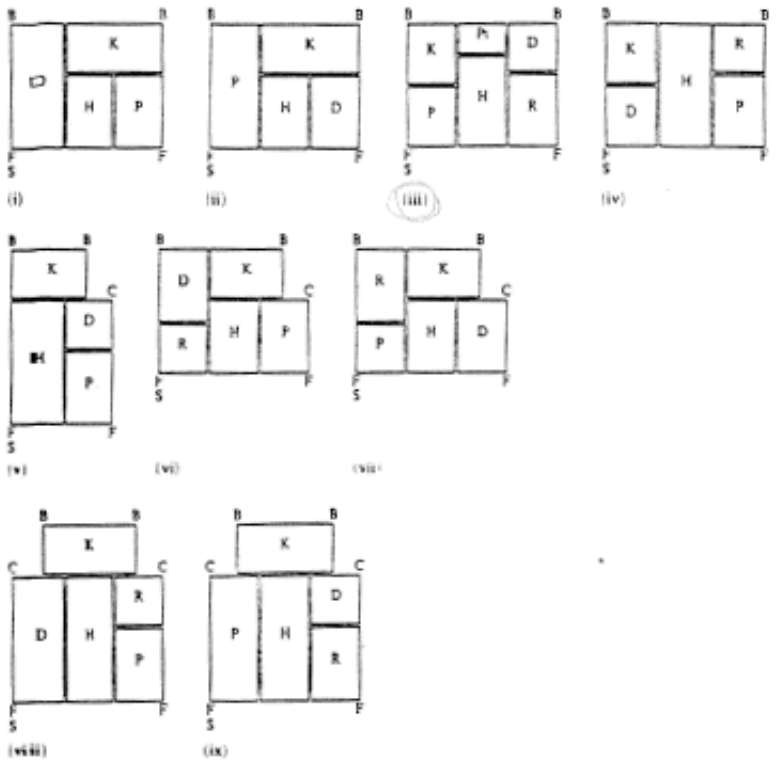


Figure 8. Layouts generated by application of kitchen rules 6–9 (see figure 7).

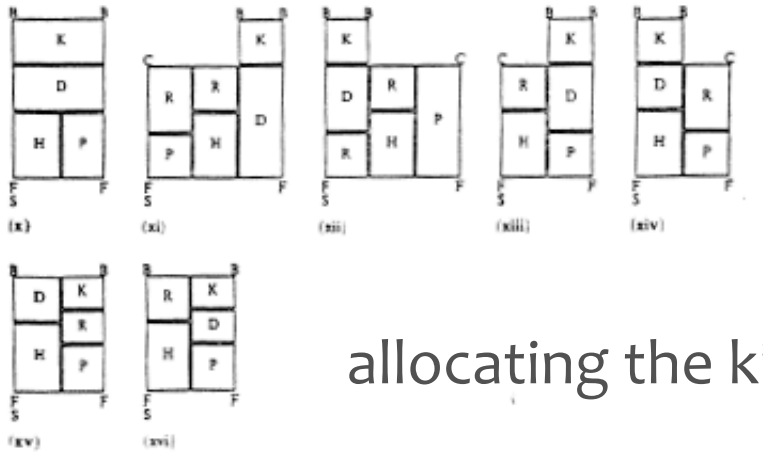
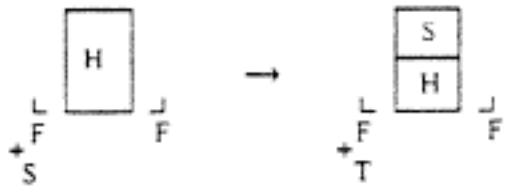


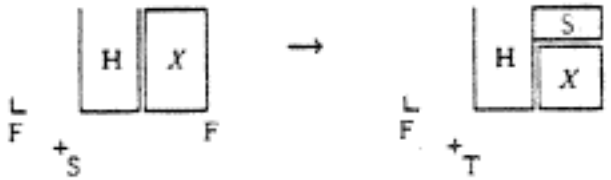
Figure 9. Layouts generated by application of kitchen rules 6, 8, 11, and 12 (see figure 7).

allocating the kitchen

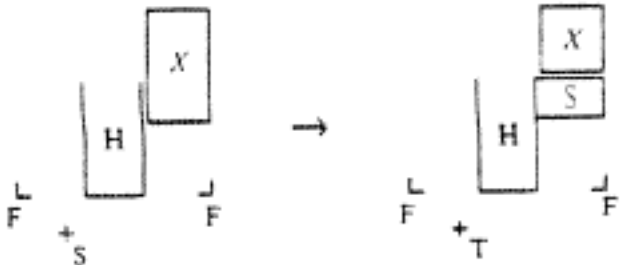
Rule 13



Rule 14



Rule 15



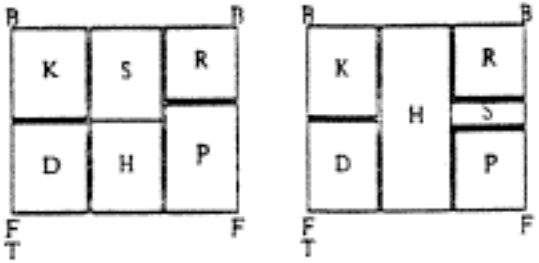
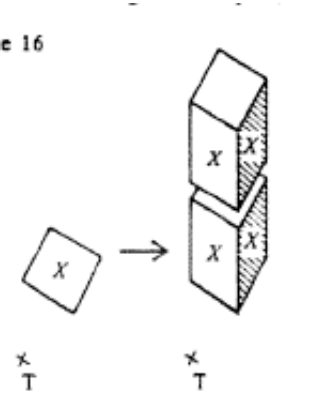
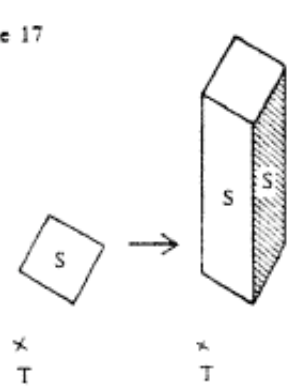
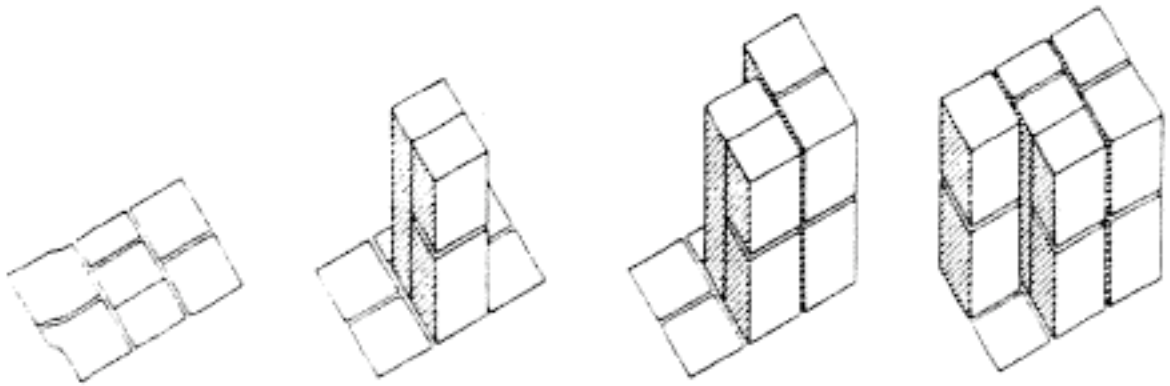


Figure 11. Layouts generated by application of stair rules.

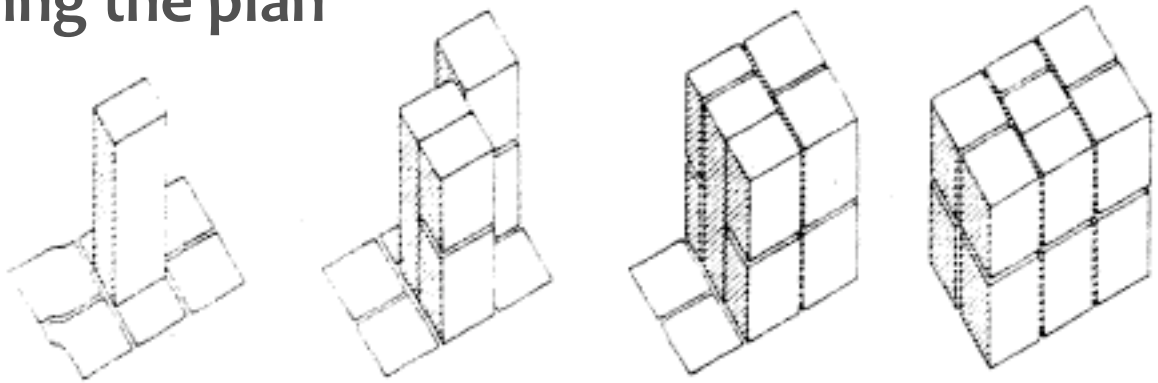
adding a stair hall







extruding the plan



exterior articulation

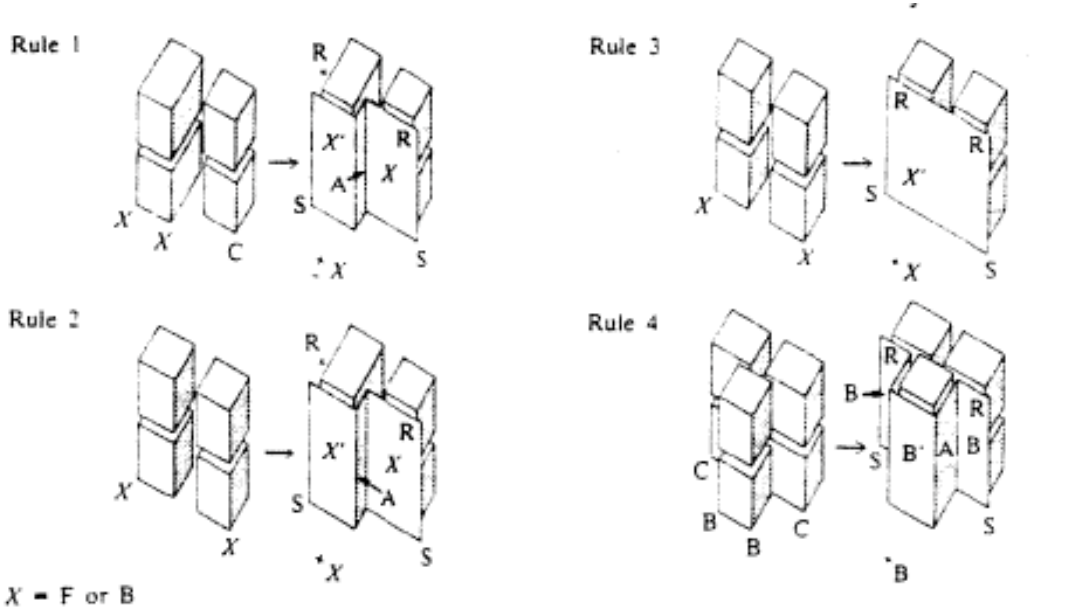


Figure 15. Rules to generate front and back walls.

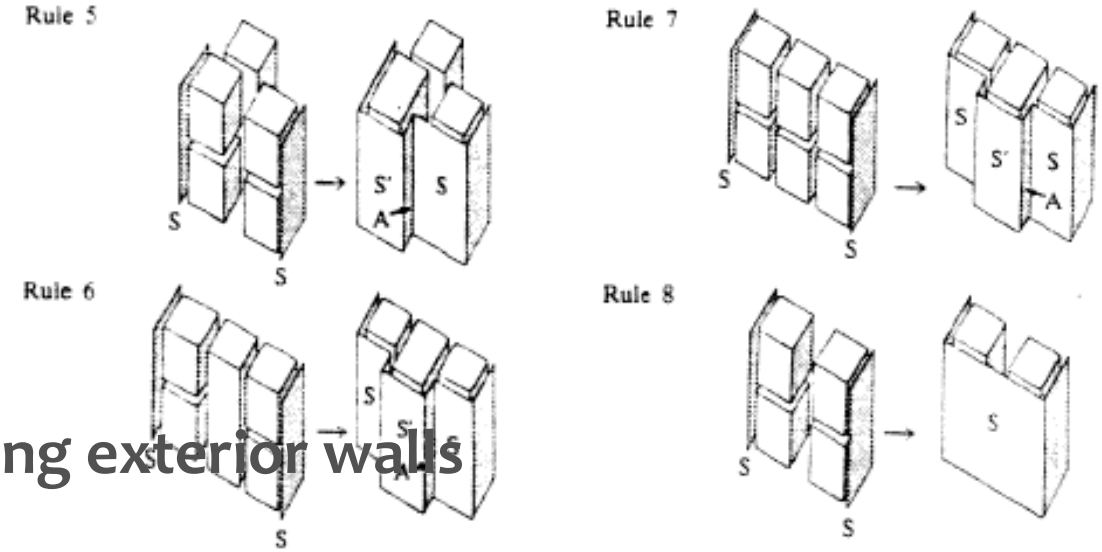


Figure 16. Rules to generate side walls.

generating exterior walls

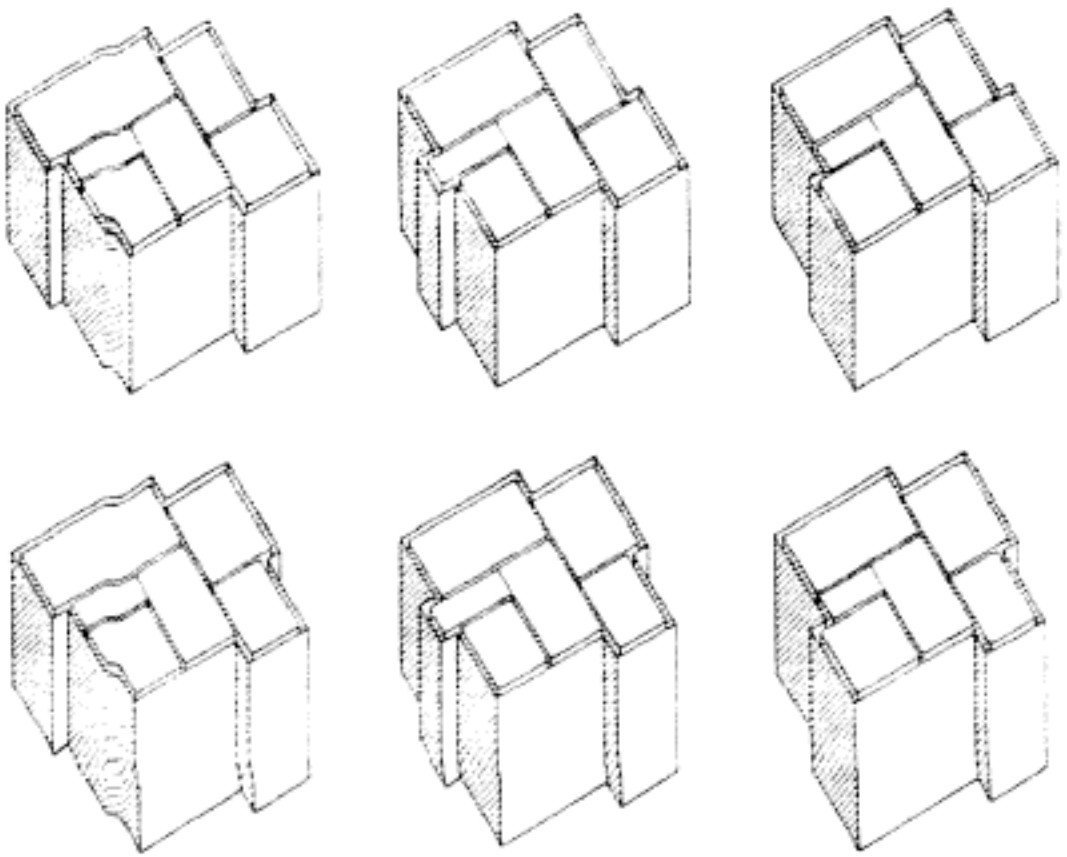


Figure 17. Shapes generated by application of rules 1 – 8 (see figures 15 and 16).

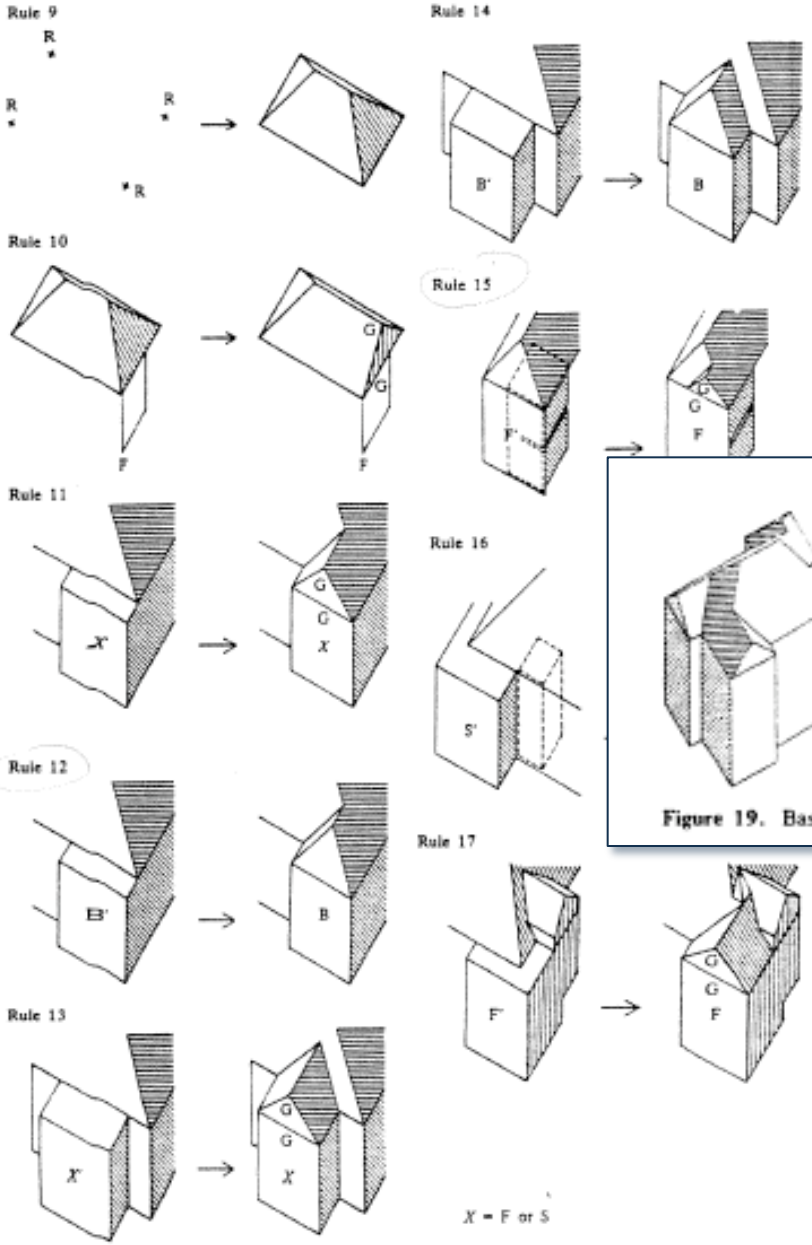


Figure 18. Rules to generate roofs.

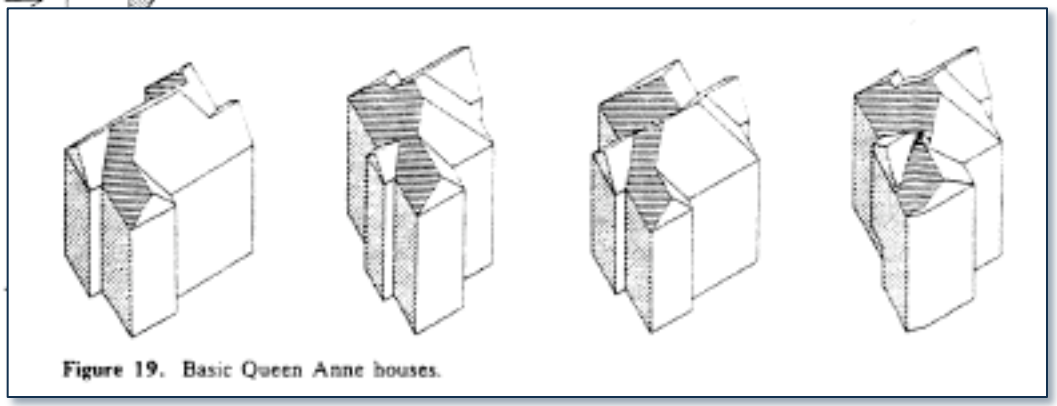


Figure 19. Basic Queen Anne houses.

generating roofs

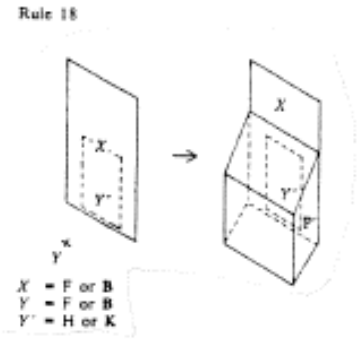
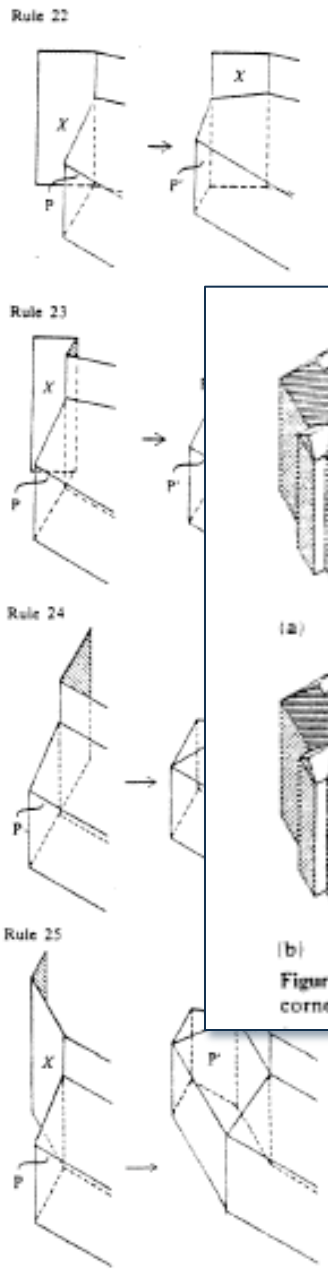


Figure 20. Rules for addition of porches.



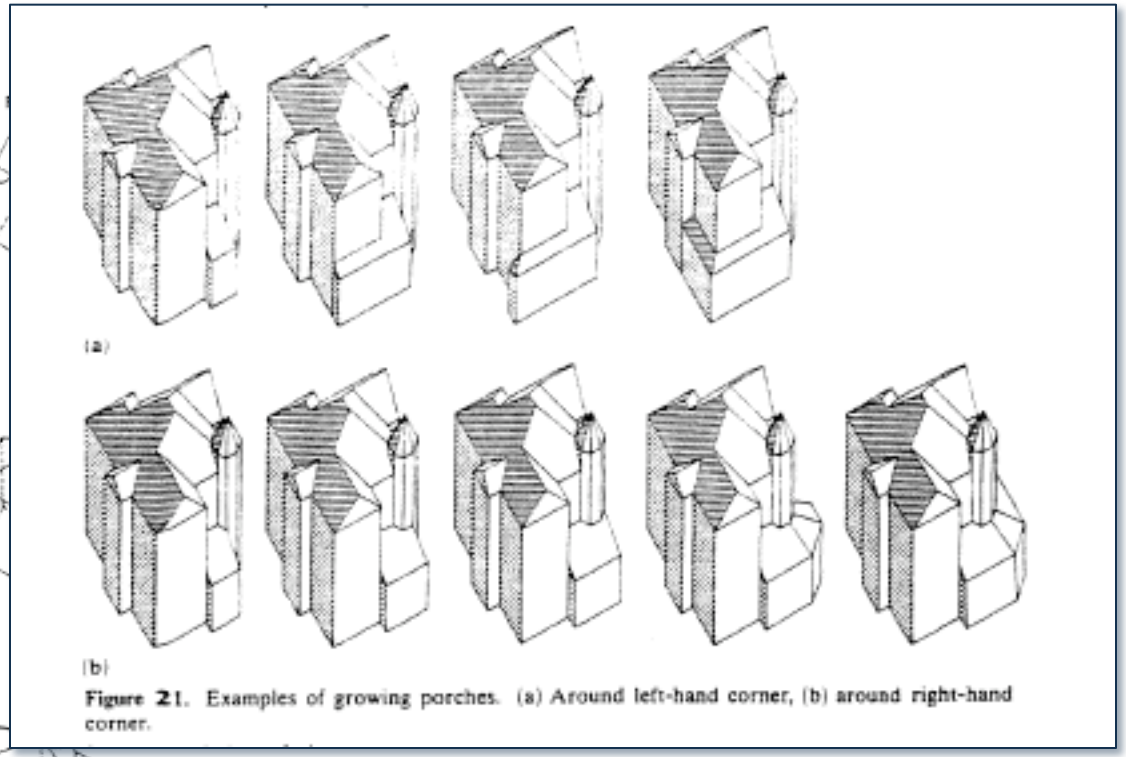


Figure 21. Examples of growing porches. (a) Around left-hand corner, (b) around right-hand corner.

growing porches

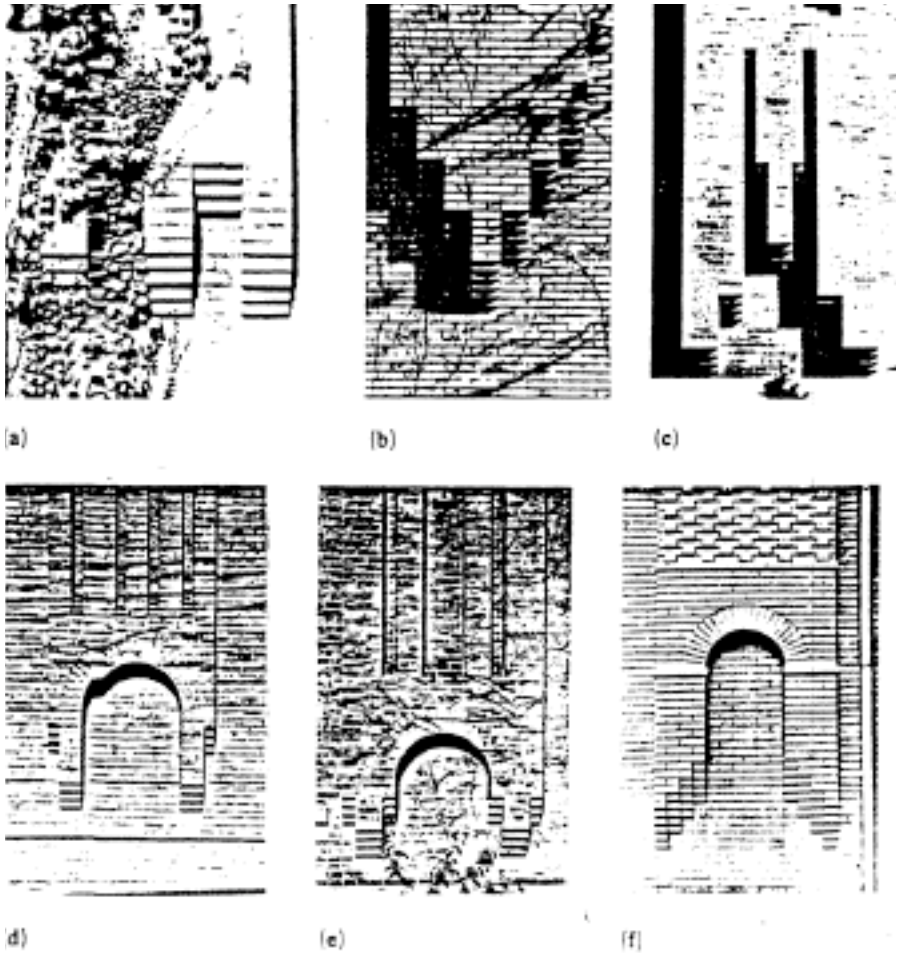


Figure 22. Bottom ends of chimney breasts.

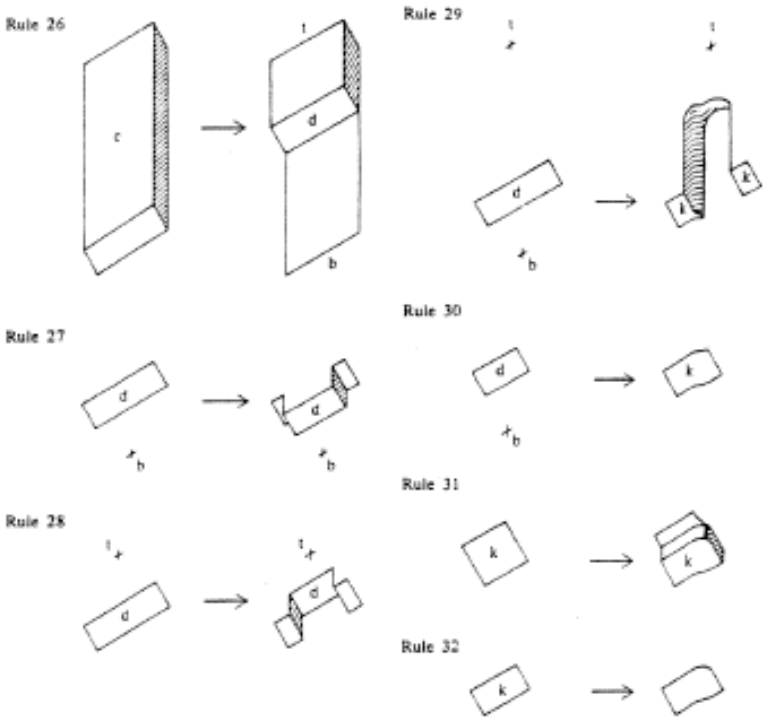
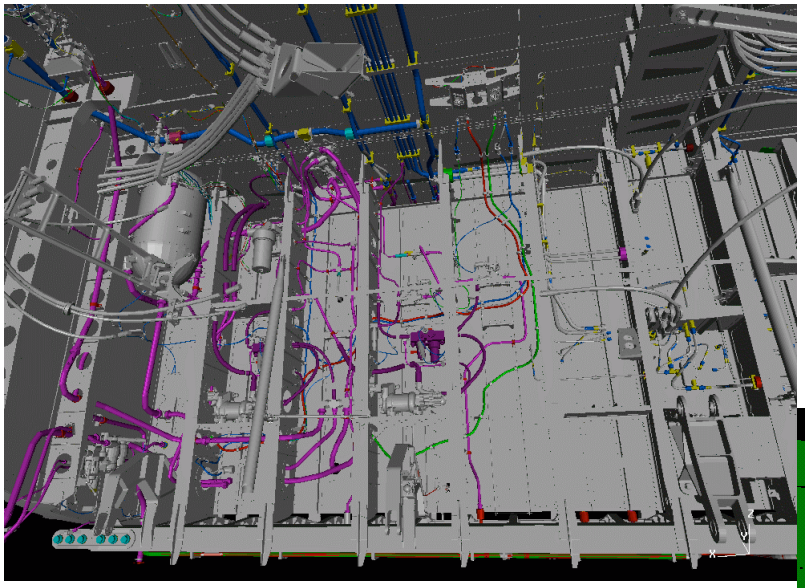


Figure 23. Rules to generate bottom ends of chimney breasts.

chimneys

generated by Jeff Heisserman

queen anne houses

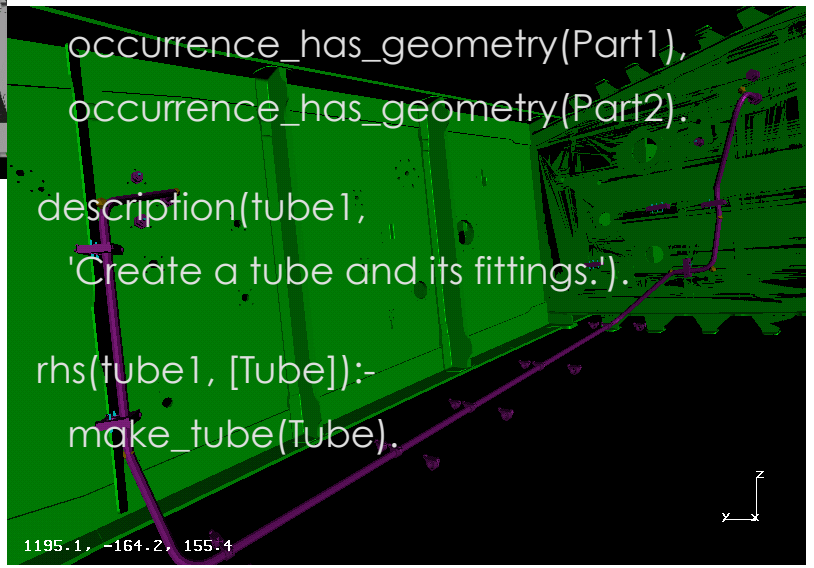


```
condition(tube1,
    'Tube has no geometry.').

lhs(tube1, [Tube], [Part1, Part2]):-
   schematic_tube_connections(Tube, Part1, Part2),
    in_context(Tube),
    not occurrence_has_geometry(Tube),
    occurrence_has_geometry(Part1),
    occurrence_has_geometry(Part2).

description(tube1,
    'Create a tube and its fittings.').

rhs(tube1, [Tube]):-
    make_tube(Tube).
```



piping in the landing bay – boeing 777

an aside

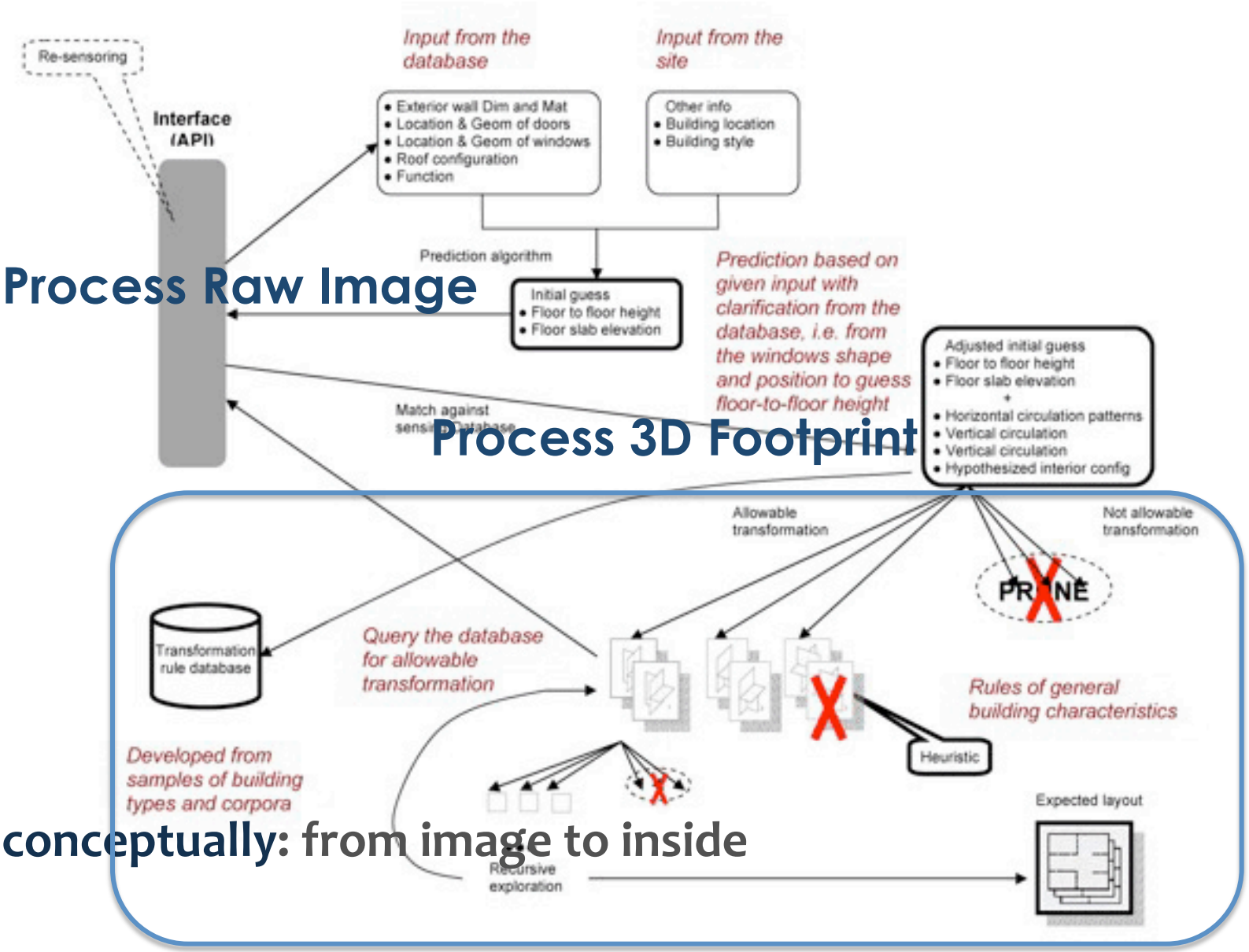
humans can roughly guess
the interior layout of buildings
without physical entry.

can computer programs? or,
rather, *what does it take for a computer program to do so?*

back to the **worlds I study**

Process Raw Image

Process 3D Footprint



conceptually: from image to inside

Formally, we seek an algorithm given:

the footprint;

a reasonably complete set of exterior features, e.g. windows, chimneys and surrounding buildings;

a shape grammar describing the building style

Initial test cases:

Baltimore rowhouse

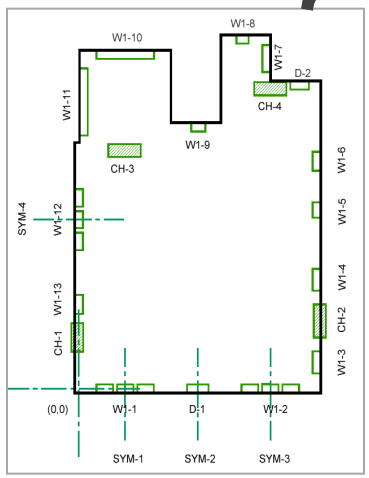
Queen Anne house

specific problem

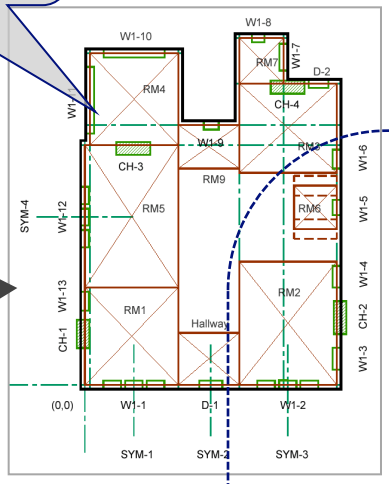
Initial layout estimation

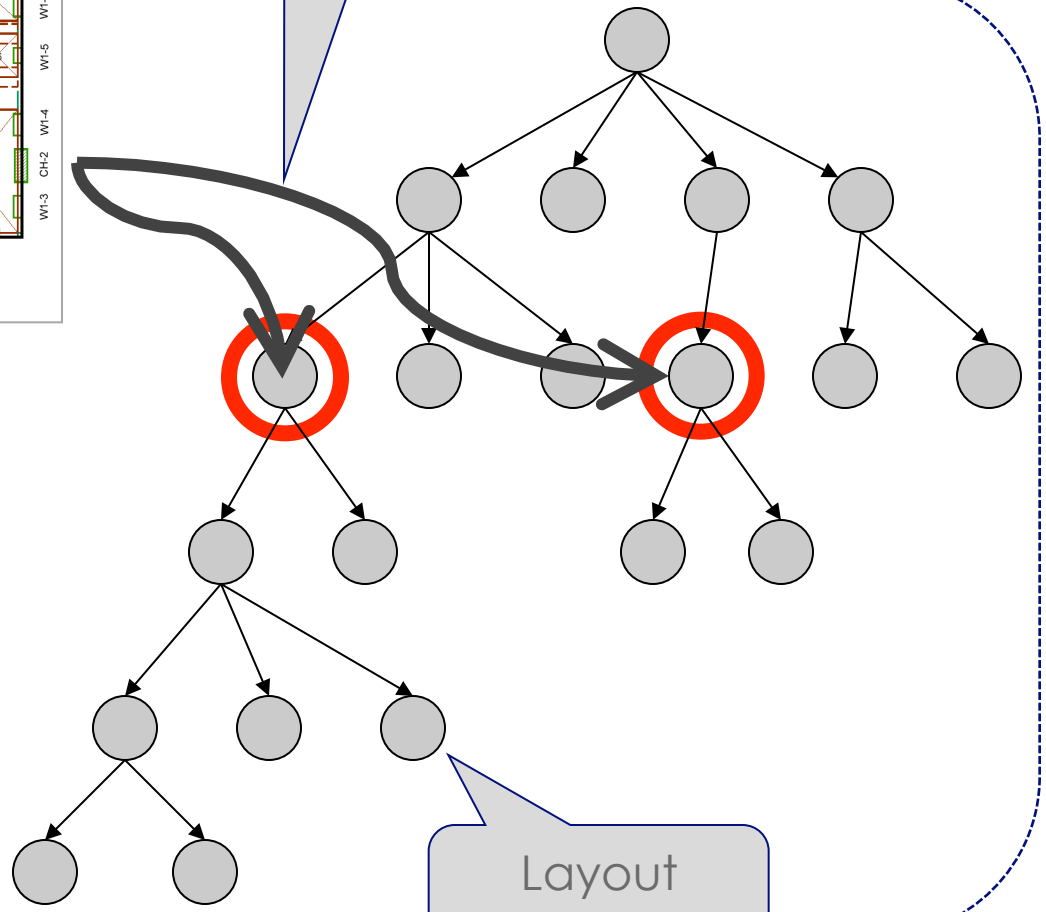
Layout tree pruning

Shape grammar



Feature input

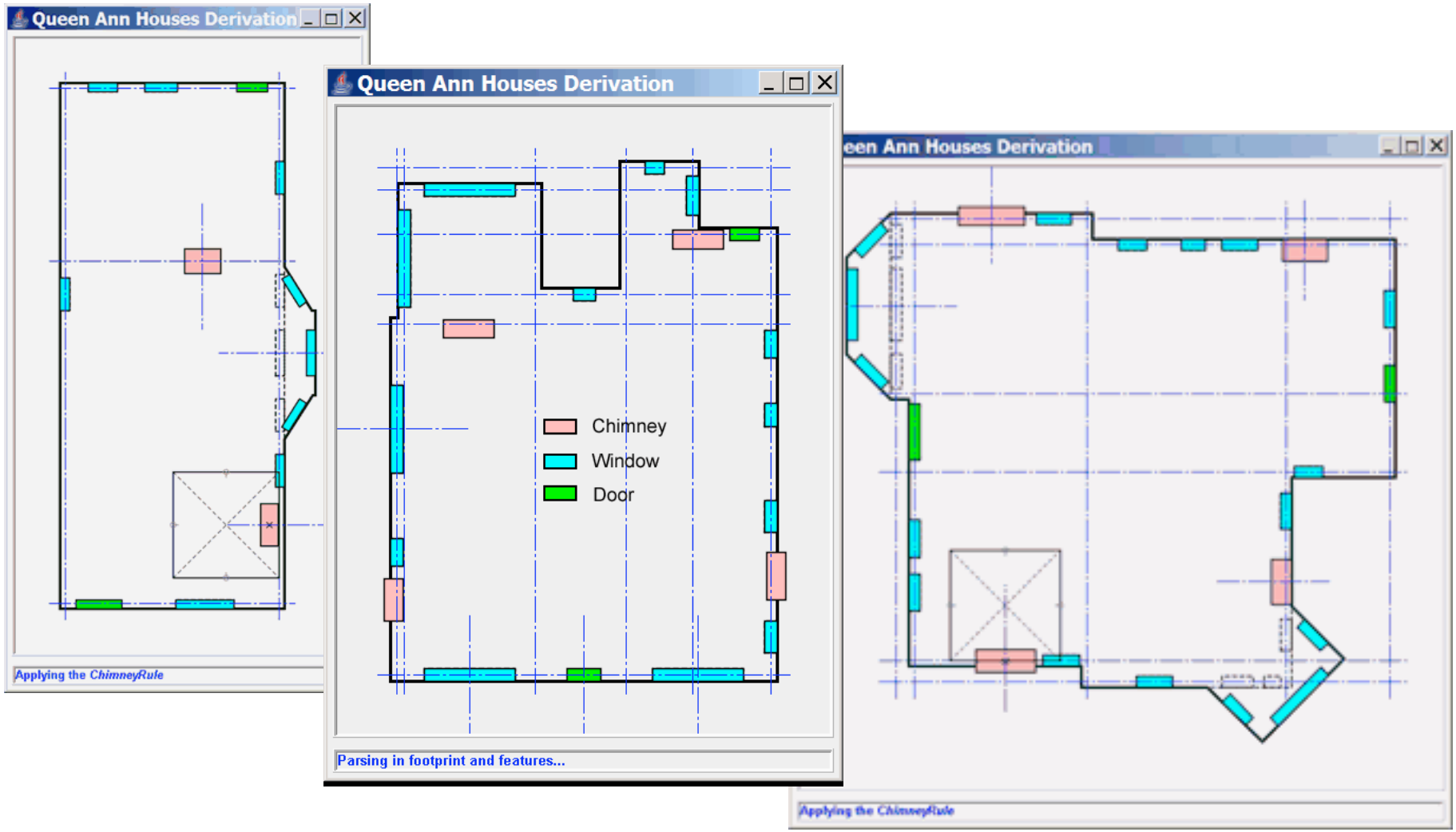




Layout refinement

Interpreter

the pilot approach



and it does **seem to work !**