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

the sources side hall plans
the source

corner hall plans
the source
center hall plans
corner room plans

the source
**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: +H

Rule 0

\[ \begin{array}{c}
B & B \\
& \downarrow \\
& +H \\
\end{array} \rightarrow
\begin{array}{c}
B & B \\
& +R \\
\end{array} \]

Rule 1

\[ \begin{array}{c}
B & X \\
& \downarrow \\
& +R \\
\end{array} \rightarrow
\begin{array}{c}
B & R \\
& +R \\
\end{array} \]

\[ X = F \text{ or } B \]

Rule 2

\[ \begin{array}{c}
B & X \\
& \downarrow \\
& +R \\
\end{array} \rightarrow
\begin{array}{c}
B & R \\
& +R \\
\end{array} \]

Rule 3

\[ \begin{array}{c}
B & B \\
& \downarrow \\
& +R \\
\end{array} \rightarrow
\begin{array}{c}
B & B \\
& +R \\
\end{array} \]

Rule 4

\[ \begin{array}{c}
B & B \\
& \downarrow \\
& +R \\
\end{array} \rightarrow
\begin{array}{c}
C & R \\
& +R \\
\end{array} \]

Rule 5

\[ \begin{array}{c}
B & B \\
& \downarrow \\
& +R \\
\end{array} \rightarrow
\begin{array}{c}
B & B \\
& +R \\
\end{array} \]
Initial shape: \(+H\)

Rule 0

\[ \begin{array}{c}
B & B \\
\hline & H \\
\hline & F \\
\hline & F \\
\end{array} \]

\(+R\)

\(+H\)

Rule 1

\[ \begin{array}{c}
B & X \\
\hline & R \\
\hline & R \\
\hline & R \\
\end{array} \]

\[ X = F \text{ or } B \]

Rule 2

\[ \begin{array}{c}
B & X \\
\hline & R \\
\hline & R \\
\hline & R \\
\end{array} \]

\(+R\)

Rule 3

\[ \begin{array}{c}
B & B \\
\hline & H \\
\hline & R \\
\hline & R \\
\end{array} \]

\(+R\)

Rule 4

\[ \begin{array}{c}
B & B \\
\hline & H \\
\hline & R \\
\hline & R \\
\end{array} \]

\(+R\)

Rule 5

\[ \begin{array}{c}
B & B \\
\hline & H \\
\hline & R \\
\hline & C \\
\end{array} \]

\(+R\)
applying shape rules
allocating the kitchen
adding a stair hall

Figure 11. Layouts generated by application of stair rules.
extruding the plan
exterior articulation
Figure 15. Rules to generate front and back walls.

$X = F$ or $B$

Figure 16. Rules to generate side walls.
Figure 17. Shapes generated by application of rules 1-8 (see figures 15 and 16).
generating roofs
growing porches
Figure 22. Bottom ends of chimney breasts.

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

chimneys
queen anne houses

generated by Jeff Heisserman
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
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**
the pilot approach

Feature input

Initial layout estimation

Layout tree pruning

Shape grammar

Layout refinement

Interpreter
and it does seem to work!