What is computation?

What is a shape grammar?

How are shape grammars used in design?

How is a shape grammar developed?
What is computation?
Algorithm for designing a gothic spire
(Roriczer)

If you want to draw a base plan for a pinnacle, according to the masons’ technique [derived] out of correct geometry, then begin by making a square as shown hereafter with the letters \( a b c d \), so that it is the same distance from \( a \) to \( b \) as from \( b \) to \( d \), \( d \) to \( c \), and \( c \) to \( a \), as in the figure drawn hereafter.

Then make the square equal in size to the preceding; divide [the distance] from \( a \) to \( b \) into two equal parts, and mark an \( e \) [at the midpoint]. Do the same from \( b \) to \( d \) and mark an \( h \); from \( d \) to \( c \) and mark an \( f \); from \( c \) to \( a \) and mark a \( g \). Then draw lines from \( e \) to \( h \), \( h \) to \( f \), \( f \) to \( g \), and \( g \) to \( e \), as in the example of the figure drawn hereafter.

Then make the above-derived square equal in size to the preceding; divide [the side] from \( e \) to \( h \) into two equal parts, and mark a \( k \) [at the midpoint]. Do the same from \( h \) to \( f \) and mark an \( m \); from \( f \) to \( g \) and mark an \( l \); from \( g \) to \( e \) and mark an \( i \). Then draw lines from \( e \) to \( h \), \( h \) to \( f \), \( f \) to \( g \), and \( g \) to \( e \), as in the example of the figure drawn hereafter.

Then make the two squares \( a b c d \) and \( i k l m \) equal in size to the preceding, and rotate the square \( e h g f \), as in the example of the figure drawn hereafter.

Then when you eliminate the remaining lines that are not needed for the setting out, there remains such a form as shown below.
The columns in each order ought to be form’d in such a manner, that the diameter of the upper part of the column may be smaller than at the bottom, with a kind of a swelling in the middle.

As to the manner of making the swelling in the middle, we have no more to hew from VITRUVIUS but his bare promise; which is the reason that most writers differ from one another upon that subject.

The method I use in making the profile of the swellings is this; I divide the fuft of the column into three parts, and leave the lower part perpendicular; to the side of the extremity of which I apply the edge of a thin rule, of the same length, or a little longer than the column, and bend that part which reaches from the third part upwards, until the end touches the point of the diminution of the upper part of the column under the collarino. I then mark as the curve directs, which gives the column a kind of swelling in the middle, and makes it project very gracefully.

And although I never could imagine a more expeditious and successful method than this, I am nevertheless confirmed in my opinion, since Signor PIETRO CATANEO was so well pleased when I told him of it, that he gave it a place in his Treatise of Architecture, with which he has not a little illustrated this profession.

A B, the third part of the column, which is left directly perpendicular.
B C, the two thirds that are diminished.
C, the point of diminution under the collarino.
Computation is:

creative
descriptive
Algorithm for designing a gothic spire
(Roriczer)

If you want to draw a base plan for a pinnacle, according to the masons’ technique [derived] out of correct geometry, then begin by making a square as shown hereafter with the letters \(a\) \(b\) \(c\) \(d\), so that it is the same distance from \(a\) to \(b\) as from \(b\) to \(d\), \(d\) to \(c\), and \(c\) to \(a\), as in the figure drawn hereafter.

Then make the square equal in size to the preceding; divide [the distance] from \(a\) to \(b\) into two equal parts, and mark an \(e\) [at the midpoint]. Do the same from \(b\) to \(d\) and mark an \(h\); from \(d\) to \(c\) and mark an \(f\); from \(c\) to \(a\) and mark a \(g\). Then draw lines from \(e\) to \(h\), \(h\) to \(f\), \(f\) to \(g\), and \(g\) to \(e\), as in the example of the figure drawn hereafter.

Then make the above-derived square equal in size to the preceding; divide [the side] from \(e\) to \(h\) into two equal parts, and mark a \(k\) [at the midpoint]. Do the same from \(h\) to \(f\) and mark an \(m\); from \(f\) to \(g\) and mark an \(l\); from \(g\) to \(e\) and mark an \(i\). Then draw lines from \(e\) to \(h\), \(h\) to \(f\), \(f\) to \(g\), and \(g\) to \(e\), as in the example of the figure drawn hereafter.

Then make the two squares \(a\) \(b\) \(c\) \(d\) and \(i\) \(k\) \(l\) \(m\) equal in size to the preceding, and rotate the square \(e\) \(h\) \(g\) \(f\), as in the example of the figure drawn hereafter.

Then when you eliminate the remaining lines that are not needed for the setting out, there remains such a form as shown below.
What is a shape grammar?
Shapes

Spatial relation

SHAPE GRAMMAR

rule

DERIVATION
OTHER DESIGNS IN THE LANGUAGE
How are shape grammars used in design?
Shape grammar applications

analysis

original design
Ice-ray grammar
Mughul garden grammar
original design applications
Apartment building in Manhattan
Cultural history museum in LA
Ocean museum in California
How is a shape grammar developed?
Stages of shape grammar development

shapes
↓
spatial relations
↓
rules
↓
shape grammar
↓
designs
shapes

basic components of grammars and designs
shapes
spatial relation

arrangement of shapes
spatial relations
shape rules

shapes: A, B

spatial relation: A + B

rules: A → A + B
B → A + B
spatial relation

rule

\[
\begin{array}{c}
\text{→}
\end{array}
\]

\[
\begin{array}{c}
\text{→}
\end{array}
\]
rule → shape ⇒ possible results

⇒

⇒

⇒

⇒

or

or

or

or
labels

symbols that say how to apply a rule
rule

\[
\begin{array}{c}
\quad \rightarrow \\
\end{array}
\]

labeled rule

\[
\begin{array}{c}
\bullet \\
\quad \rightarrow \\
\end{array}
\]
applying a labeled rule
A → A + B

match the labeled shape A
with a labeled shape in a design

add the labeled shape B
to the design
spatial transformations

translation

rotation

reflection

scale
translation
rotation
reflection
scale
combinations of transformations

translation

reflection
labeled rule
derivation

a sequence of designs where each design is generated from the previous design by applying a rule

design 1 ⇒ design 2 ⇒ design 3 ⇒ design 4 ⇒ . . .
labeled rule

\[ \begin{array}{c}
\text{\textbullet} \\
\rightarrow
\end{array} \quad \begin{array}{c}
\text{\textbullet} \\
\text{\textbullet} \\
\text{\textbullet}
\end{array} \]

derivation

\[ \begin{array}{c}
\begin{array}{c}
\text{\textbullet}
\end{array} \\
\Rightarrow
\end{array} \quad \begin{array}{c}
\begin{array}{c}
\text{\textbullet} \quad \text{\textbullet}
\end{array} \\
\Rightarrow
\end{array} \quad \begin{array}{c}
\begin{array}{c}
\text{\textbullet} \quad \text{\textbullet}
\end{array} \\
\text{\textbullet} \quad \text{\textbullet}
\end{array} \quad \Rightarrow
\begin{array}{c}
\begin{array}{c}
\text{\textbullet} \quad \text{\textbullet}
\end{array} \\
\text{\textbullet} \quad \text{\textbullet}
\end{array} \quad \begin{array}{c}
\begin{array}{c}
\text{\textbullet} \quad \text{\textbullet}
\end{array} \\
\text{\textbullet} \quad \text{\textbullet}
\end{array} \quad \begin{array}{c}
\begin{array}{c}
\text{\textbullet} \quad \text{\textbullet}
\end{array} \\
\text{\textbullet} \quad \text{\textbullet}
\end{array}
\end{array} \]
labeled rule

\[ \square \cdot \rightarrow \square \cdot \square \cdot \square \cdot \]
derivation
labeled rule

\[ \bullet \rightarrow \bullet \rightarrow \bullet \]
derivation
labeled rule

\[ \begin{array}{c}
\bullet \\
\rightarrow \\
\bullet \\
\end{array} \]
derivation
labeled rules

\[ \bullet \rightarrow \bullet \]

\[ \bullet \rightarrow \bullet \]

\[ \bullet \rightarrow \bullet \]

\[ \bullet \rightarrow \bullet \]

\[ \bullet \rightarrow \bullet \]

\[ \bullet \rightarrow \bullet \]

designs

\[ \]

\[ \]

\[ \]

\[ \]

\[ \]

\[ \]
spatial relation

rule

→
labeled rules
labeled rule

\[ \begin{array}{c}
\text{square} \\
\rightarrow \\
\text{square} + \text{square}
\end{array} \]
derivation
labeled rule

\[
\begin{array}{c}
\bullet \\
\rightarrow
\end{array}
\begin{array}{c}
\bullet \\
\bullet
\end{array}
\begin{array}{c}
\bullet
\end{array}
\]
derivation
spatial relation

rules

\[
\begin{align*}
\text{rectangle} & \quad \rightarrow \quad \text{rectangle} \\
\text{square} & \quad \rightarrow \quad \text{rectangle}
\end{align*}
\]
labeled rules

example labeling: 8,3

example labeling: 4,4
derivation
(labeling 8,3)
labeled rules

example labeling: 8,3

example labeling: 4,4
derivation
(labeling 4,4)
Courtyard houses in Malibu
Cultural history museum in LA
1. Go back to the example grammars from today’s lecture. Try applying labeled rules that you did not do in class.

2. Read the online paper: “Shape grammars in education and practice: history and practice”