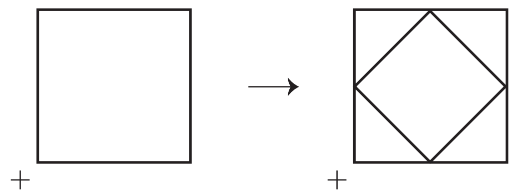
Q1. What is a shape grammar? If you were to write one down on a piece of paper to show someone, what would it look like?

A1. A shape grammar is a way to calculate visually, entirely in terms of what I see. In math and logic, and for computers, calculating is symbolic, that is to say, defined for indivisible units or atoms – for 0's and 1's or A's, B's, and C's. This is key in Alan Turing's famous 1936 paper on computable numbers, that's the gold standard against which all calculating is measured. In "Turing machines" and equally for computers, calculating is essentially counting units and their combinations in this way or that. Shape grammars allow for symbolic calculating as a special case, going beyond this for shapes that aren't made up of units, or divided/analyzed into parts of any kind. There are no underlying structures for shapes to put into descriptions of them – divisions in shapes depend on calculating, and vary as it unfolds. In shape grammars, units and parts result from calculating; they aren't a prerequisite. Shapes are infused with ambiguity. The willingness to make use of ambiguity freely and not to worry about it, is key in visual art and design; otherwise, shapes and pictures would always stay the same – inert, fixed and dead in every respect. There'd be no reason to look at them even once, simply describing them, counting out units and parts, would be ample for memory and use. In visual calculating in shape grammars, rules are used for seeing and doing; rules exploit ambiguity in order to supersede counting. There's the kind of "negative capability" that John Keats prizes in Shakespeare – the knack for ambiguity, contradiction, discontinuity, uncertainty, and open-ended change.

The visual basis of shape grammars makes them easy to define – any pair of shapes is all it takes to make a rule. It's OK to draw these shapes – any two drawings make a rule

$$\text{drawing1} \rightarrow \text{drawing2}$$

that I can use recursively to calculate. For example, drawing1 might be a square – easy enough – and drawing2, the square in drawing1 with another square half its size inscribed inside it, vertex to edge. The rule looks like this:



Of course, drawing2 with the parts I've described might also be four triangles, pairs of pentagons in six ways, double hexagons, letters of the alphabet – maybe K's and k's – or anything else I find. Shapes are what I see – what I "embed" in them – not merely what I think I've drawn. I can put into them anything I choose. One way to explain this is that shapes have indefinitely many symbolic descriptions – but for any given shape right now, I have to calculate to figure out which descriptions work best. The shape is thus and such with distinct parts if I stop, although this isn't fixed if I decide to go on calculating. Pointing to my rule is probably a good way to talk about it, without trying to describe what's in drawing1 or drawing2, or naming them and their parts in terms of the shapes I know or like. If I want to play it safe, the most I can do is to say

$$\text{this} \rightarrow \text{that}$$

My rule drawing1 → drawing2 applies to a given shape, also rendered in a drawing, to change it. If part of this drawing looks like drawing1 in some way – tracing paper is a real help here – then I can erase it or take it away to add in another part that looks like drawing2 in exactly the same way. The original part is to drawing1 as the new part is to drawing2, in a kind of analogical relationship with a rule of three – for example, a linear transformation or more narrowly, a Euclidean transformation for an isometry or a similarity. In essence, I can embed a copy of drawing1 in my drawing and then replace the copy with a copy of drawing 2. Maybe I calculate so:

Moreover, adding is seamless. Everything “fuses” as one as I change my original shape to draw a new one – boundaries blur and fade away. The next time I try a rule, the part I’ve added or drawn in may have disappeared; there’s no memory of it. Yes, it’s visible – I can see it if I have rules to look for it (memory, like structure, is lodged in rules and their use, not in shapes) – but untold other parts may pop out, too, those neat surprises I can’t ignore, that appear as I go on trying rules. It doesn’t take much for visual calculating. Drawing, according to drawings in rules, is pretty much it – it’s simply seeing and doing, with no intervening structure or anything else to block the way. One of my research students tells me that he took a graduate subject with a computer scientist and linguist, who’s sure that drawings alone aren’t enough for rules – symbols are necessary to calculate. But drawings are all I need to get the forms I want, and many other, extravagant things, as well. Shape grammars let me exceed any intentions and plans I may have had to start; they work for what I see now, cool to definite ends and goals, and indifferent to what I think I’ve done – this history is easy to invent and reinvent as rules are tried. It isn’t necessary to know anything in advance to go on. Prior knowledge isn’t required – there’s nothing to learn or to keep in memory, or that’s hidden from view – so everyone has the same chance to join in. There’s nothing about visual calculating that curbs what anyone sees – rules find it whatever it is, whether it’s commonplace or strange, from memory or totally out of the blue. No one is privileged when it comes to putting things into shapes, resolving their parts, or seeing and saying what these are. Everyone is free to enter this process at any time and to participate fully on equal footing, separately or collectively. The key is embedding, in shapes that fuse as rules are tried – participation for one acting alone without outside influence is no different than participation for many interacting cooperatively or competitively, in concert or at odds. One sees the same as many, and many see as one. Everything is wide open for individuality and likewise, for multiplicity and diversity.