Rues for the game

William Fawcett

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william.fawcett@carltd.com

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Rules for the Game

"l'architecture, c'est le jeu …"

William Fawcett

We all believe that computers will come to perform many little tasks in architects' offices. Will there be anything they can't do, when the computer will turn to a five-years-trained architect for help? Well, yes, I expect you will say – a computer can't be creative, it can't design!

Let's reserve judgment on that for a moment, and ask a simpler question: can computers assist an architect's creativity, without eroding it? The following scenario would allow us to answer "yes" to the reduced question: if we compare design to the very sophisticated use of a very sophisticated catalogue, from which the architect can invoke, manipulate, change, recombine elements. That creativity can lie in selection and combination, not solely in creation *ex nihilo,* is to-day a respectable idea[1]. And a giant electronic catalogue – so big, so fast, so flexible – coupled to a computer-graphic workstation would enhance creativity-as-selection. Here we have the computer participating with the architect in the creative process of design, but very much as a junior partner: no threat.

This scenario hits a problem, which could equally well be called a practical or theoretical problem. It is completely inconceivable to make catalogues big enough; and if you did, how could you use them? Consider a very simple catalogue, of possible rectangular floorplans composed of rectangular rooms. We spend – maybe waste – a lot of time when designing in scribbling different packings of rectangles within rectangles, but there are only so many possible configurations, so couldn't they be put into a catalogue once and for all? Next time the problem comes up, just refer to the catalogue. Actually, this has been done for plans of up to 7 rooms[2]. The catalogue is 19 pages long and the index to the catalogue takes a further 12 pages. That's a bit cumbersome, because there are 976 such plans. But there are 6465 plans of 8 rooms, and 578,663 of 10; no-one has counted higher. At a conservative estimate, for plans of up to 14 rooms you have to imagine a catalogue nearly 100 million pages long, about the size of HKU Main Library (and there's the index to add). This is hopeless, and it only covers

the simplest kind of description of architectural phenomena – packings of rectangles in two dimensions. Of course, for a given problem an architect would only be interested in a tiny part of a catalogue, and not a random part either: if – a big if – he could scan the catalogue he would be highly selective, in accordance with some definite selection principles relevant to the case in hand. Now, these principles effectively partition the catalogue into two parts – the part that is of interest and the part that is not. And actually the catalogue doesn't need to exist at all, if the interesting entries can be *generated* when required. You could say there is a virtual catalogue, of possibilities that are only generated when called for. There are fewer limitations to the size of a virtual catalogue. It's like a long menu at a good restaurant, which describes "virtual" food that is only cooked when required. If you're limited to food that already exists, you have to put up with a MacDonalds scale of menu. Or the colour-charts with 1000 colours – there aren't warehouses full of paint in 1000 colours – a colour is mixed when ordered.

If we can state criteria sufficiently clearly, then a computer-based system can generate what we want, when we want it. We have to feed the system some rules telling it what to generate. These rules are equivalent to rules used to make selections from a catalogue, but there is a significant difference. With a catalogue the rules can be implicit rather than explicit: they are revealed by the selection and may never be stated explicitly. That's one of the appeals of a catalogue – you get the chance to test your reactions to the items available. For generation, however, the rules must be explicit. You only see what they generate, not what they don't; so it's hard to be sure you have the right rules just by looking at what they produce. With a computer-implemented rule-based generating system you begin to wonder who's in control; the rules begin to cloud the benign architect-catalogue relationship – whose side are the rules on, the architect's or the computer's?

We eliminate gargantuan catalogues, but at the price of a new problem: the design of the generating rules. Impasse? I doubt it. It's a complicated affair, but that's nothing unusual for architectural design, when no issues in theory or practice over seem very pure. Nevertheless, even when tracing a course between constraints and opportunities of many kinds, architects still believe, don't they?, that creativity is possible.

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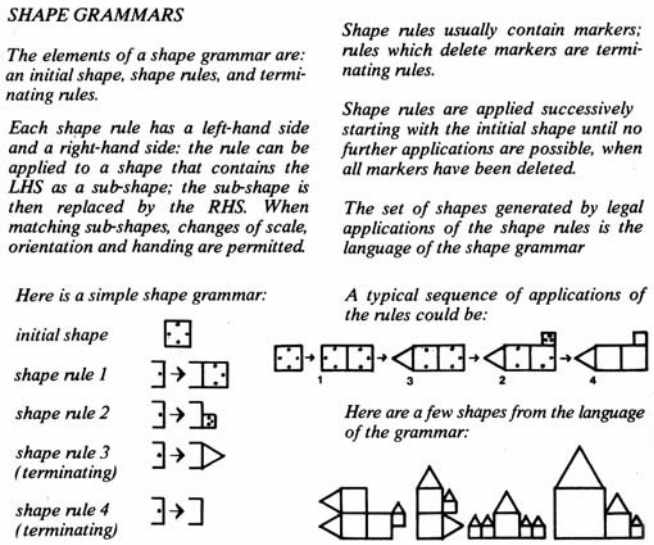
The distinction between our two approaches is fundamental. H A Simon[3] referred to the same distinction when comparing the use in design of constraints embedded in tests and constraints embedded in generators: given a problem subject to constraints, either generate candidate solutions



without reference to the constraints, then test them; or use the constraints to limit generation to satisfactory candidates. I believe that the model of constrained generation is more deeply ingrained in our intuitive design processes than we sometimes realise, even down to the trivia of building codes; so that we don't think of designs and then reject them because they conflict with the codes, but rather we allow the codes to mould our powers of invention so that we are only capable of thinking of designs that do conform. To move from a context under the thrall of one set of arbitrary codes to one ruled by another equally arbitrary but different set, is very damaging to one's sense of rationality. But most culture is the belief that arbitrary rules are somehow "natural".

* * *

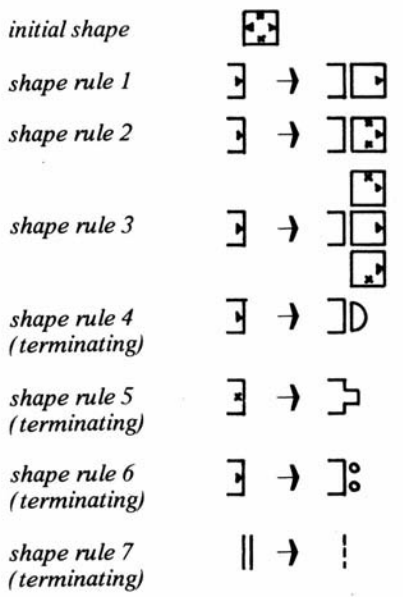
Let us consider one proposal for a methodology by which designs can be generated with rules, using shape grammars[4]. Evidently this is an analogy from language to architecture, and not the first, for the rather vague notion of architectural language is a commonplace. However this analogy is quite precise, applying a formal model of the grammar of natural languages.

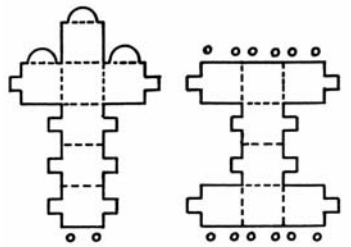
A shape grammar contains a number of shape rules, which cause transformations: by applying the rules simple shapes are transformed into more elaborate ones. Typically, the rules can be applied in different ways and thus one grammar can generate many shapes, which can be called the language of the grammar. The relationship between the shape rules and the language of shapes is interesting. They are not the same but they are tightly connected. From one point of view, the language is already implicit in the grammar, although opaquely, because a grammar generates a unique language by deduction. On the other hand, a grammar corresponding to a set of shapes can be derived by induction, on the assumption that the set is a fragment of a language. There may be more than one grammar consistent with the set, treating the set as an identical fragment of different languages.

Which comes first, the language or the grammar? Take the case that the language precedes, and a corresponding grammar is induced This has been done for quite a few cases: Palladian Villas, Frank Lloyd Wright's Prairie Houses, Moghul gardens, Terragni's architecture; as well as Chinese lattices, and Hepplewhite chair backs[5]. Such a grammar is a precise way of representing an intuitively recognisable style, and also permits the generation of new designs in the language that satisfy all criteria of genuineness; except authorship.

Or take the second case, when the grammar comes first: what can a designer do with it? I presented B.Arch, Yr.1 students at HKU with such a situation in a written exam in May 1983. They were given a

The shape grammar given to B. Arch., Yr. 1 students in May 1983:



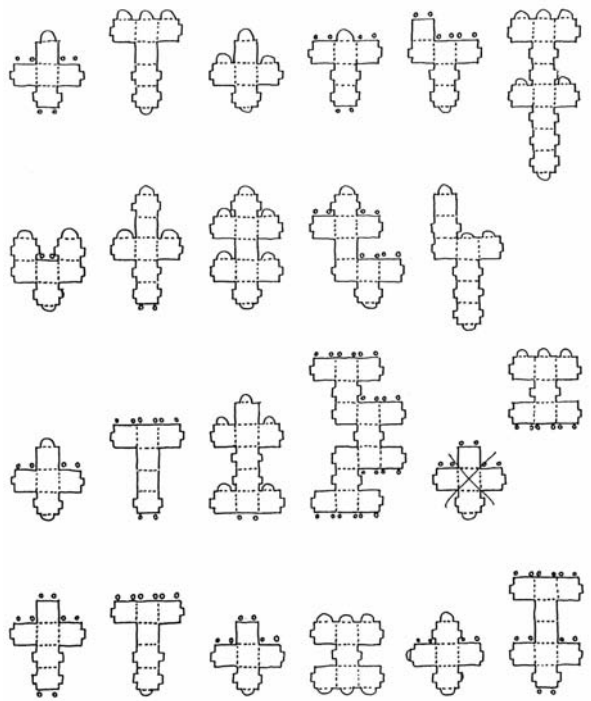


Two example shapes produced by the shape grammar.

grammar, and in this case two specimen shapes from its language, and were asked to generate a new shape in the language. I got 23 new shapes, of which two were identical; so we end up with 24 different shapes from the language. Now, the complete language of even this very simple grammar is colossal, so big it could hardly be catalogued. Had the catalogue existed, could we have considered the students' act of selection as a creative act? Is the students' generation shapes using the rules of the grammar fundamentally different? What was my role, the author of the rules but not of the students' shapes?

The structure of generating rules and their application, whether in a shape grammar or an alternative methodology, has no inherent need for a computer – our little example was entirely written and applied by hand. But in examples of realistic complexity the storage of rules and the manipulation of shapes in accordance with rule applications would be tasks readily handed over to computers. It is only a small step to envisage meta-rules – rules about how to use rules – and then our computers wouldn't just be applying rules, they'd be deciding which rules to apply. Of course, we'd still be in charge of meta-meta-rules ...

What I called the catalogue scenario of computer-aided design is appealing in two ways – it is elegant, and it clearly demarcates the roles of the architect and the computer. But I believe that their future will be much more intertwined; that the roles of architects and their computers will be so hard to differentiate, the line between creativity and computation will be so fine – finer than the finest Rotring.



The 23 shapes (including a duplicate) produced by the students in the exam.

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