Teaching Style Grammatically, with an Example From Traditional Chinese Architecture

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ABSTRACT

Most analytical shape grammars have aimed at an authoritative definition of style. This approach deprives the student of an important way of understanding the style, by formulating its definition. But this experience can be understood formally and incorporated into the grammar. An example is given from the 12th-century Chinese building manual Yingzao fashi.

1.0 DEFINING LANGUAGES OF DESIGN

Shape grammars have been used in many studies of languages of designs, or styles, from Palladian villas (Stiny and Mitchell 1978) to Wrightian prairie houses (Koning and Eizenberg 1981), from traditional Taiwanese houses (Chiou and Krishnamurti 1995) to Hepplewhite chair backs (Knight 1980). Their purpose is to elucidate the languages by articulating complete generative definitions of those languages. A complete definition specifies all and only the designs in the language. A generative definition specifies the member designs by generating them; this contrasts with an enumerative definition, which lists the member designs.

Stiny and Mitchell (1978) propose three criteria for evaluating a characterization of a language of designs:

1. It should specify new designs in the language;
2. It should evaluate whether a newly obtained design is a member of the language; and
3. It should explain the perceived likeness of the designs.

As Stiny and Mitchell point out, a complete generative definition meets these criteria. First, it can generate all (and only) the designs in the language. Second, if a design can be generated by the definition, then it is a member of the language. And third, because the definition is generative, it is itself the explanation.

Contrast this with a complete enumerative definition – an exhaustive list. To specify a new design, pick one off the list. To judge whether a design is a member of the language, see whether it is on the list. However, the list has no explanatory ability.

2.0 HUMANS AND LANGUAGES

Beyond the strictly formal issue of the complete generative definition, there is the role of the human to consider. In fact, as Knight (1999-2000) points out, there may be more than one human role: the author and the user(s) of a grammar are not necessarily the same person. I see at least three roles.

First, when the source is a corpus of designs, there must be, as Stiny and Mitchell (1978) point out, some perceived likeness. That likeness is perceived by a human; without the human, there is no likeness. Which designs belong to the corpus, which do not, which are representative, which are exceptional, are all decided by a human.

Second, the grammar is a hypothesis, which is also a human construct. No human, no hypothesis. (However, with a grammar, the hypothesis can be formally – that is, objectively – articulated.)

Third, as with any hypothesis, the grammar's predictive power must be tested: does the newly generated design belong to the language? In design, the tests is almost always the judgement of a human. Contrast this with scientists, who use experiments to manipulate nature into judging their hypotheses. Downing and Flemming (1981) once wished for the same, to discover an unknown but genuine member design. Linguists seek native speakers to judge whether new sentences are grammatical. Duarte's (1999) rare fortune is to have a native stylist to judge his grammatical predictions. At the other extreme is Flemming's (1981) study of Terragni's Casa Giuliani Frigerio. With a corpus of one, the grammar is only as reliable as the human who judges its designs.

Traditional analytical grammars have not emphasized these human roles. The authors have played all three roles: they perceive the likeness, they write the grammar, and they judge the results. This authoritative approach is reasonable, since they are striving for the completeness of the definition.

However, for the student of the style, such a grammar is only a machine for generating legal designs. He has been shielded from the most meaningful parts of the exercise, namely composing and testing the hypothetical definition. The grammar presented here requires the user to participate in the definition, because it generates all and more than the designs that are likely to be in the style. That is, some designs are clearly legal, others clearly not, and still others questionable. It is the student's responsibility to evaluate them. The student, not the teacher, aims for the authoritative definition. He must confront the gap between what he knows and what he needs to know.

3.0 THE YINGZAO FASHI

To illustrate this approach, I present a grammar for teaching section diagrams according to the *Yingzao fashi* (Building standards).[1] This is a Chinese building manual, published in 1103. It was written by an architect in the Song court, Li Jie (d. 1110), who had two goals: to educate government officials who had to commission buildings, and to set standards among the builders who built those buildings.

Li's approach is generally rule-based. This reflected a tradition in which knowledge was transmitted orally in the form of easily remembered procedures. For instance, the method of determining the characteristic curved roof section, called *juzhe*, is a two-step process. A significant exception to Li's rule-based approach is the section diagrams. Instead of rules, we have a corpus of 18 drawings, each with a terse written description (*figure 1*; see also Liang 1983, 313-321).[2]

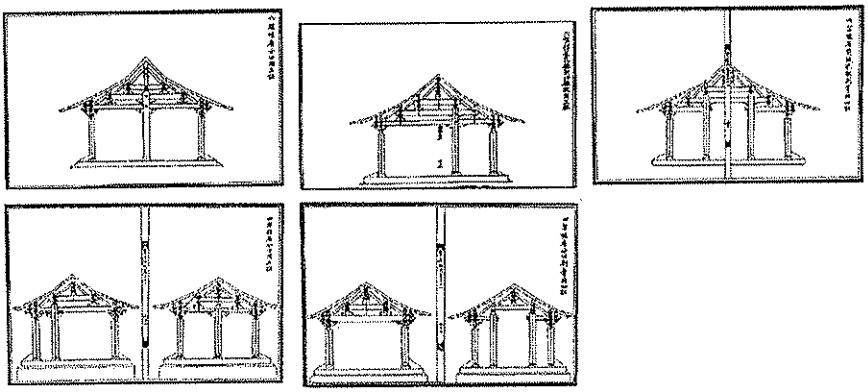

Figure 1. The corpus of section diagrams consists of drawings with descriptions of 18 ting halls from 4 to 10 rafters deep. Of the 18, three are of 6-rafter buildings, and four are of 4-rafter buildings. these are shown here. From Liang (1983, 319-321).

Before examining the description, it should be remembered that, unlike western buildings, in which the rafters support the purlins, in Chinese buildings the purlins *(tuan)* support the rafters *(chuan)*. The rafters are segmented and make possible the curved roof section. A rafter is not more than 1.80 meters long in horizontal projection, and is used as a unit of length for beams and of depth for buildings. Hence we speak of three-rafter beams *(sanchuan fu)* or four-rafter buildings *(sijia chuan wu)*.

Each description has the three parts described below. Each part characterizes one aspect of the transverse frame.

1. Depth (in rafters). This is an even number.
2. Disposition of beams, expressed in various combinations of three terms: *clear span, central division,* and *beams*. Of the 18 descriptions, none containing the term *clear span* also contains the terms *central division* or *beams*. A description not containing *clear span* contains *central division* or *beams* or both.
   a. Clear span *(tong yan)*. In a clear-span building, there are no interior

columns, only the two in the front and back walls.

b. Central division *(fen xin)*. In a centrally divided building, there is a column in the central position, below the ridge purlin.

c. Beams *(fu)*. The length of the beam indicates the size of the bay it spans. Only the outermost beams are specified; the inner beams are merely implied.

3. Total number of columns. The minimum is two, in a clear-span building. The maximum is one more than the number of rafters, but this possibility is not seen among the 18 variations.

As an example, consider this description:

> 6-rafter building, centrally divided, 2-rafter beam in front and back, with 4 columns *(liujia chuan wu, fen xin, qian hou rufu, yong si zhu)*.

The building has three divisions, each of which is two rafters deep. The two outside divisions are specified; the inside division is merely implied *(figure 4)*.

The 18 descriptions form a partial enumeration of the language they belong to. From this we can hypothesize a partial generative definition of the set of descriptions. This takes the form of an initial description and a set of description functions, each one associated with a shape schema.[3] That is, the algorithm to generate the descriptions also generates the shapes. This is valuable, because the descriptions register features important to Li Jie and his readers which, 900 years later, are otherwise invisible to us.

4.0 THE ALGORITHM

The grammar is parametric. The algorithm has three stages, as follows.[4] First, prepare the initial section diagram with the appropriate depth. It consists of a base and two columns, one in the front wall and one in the back wall. This stage involves shape schemata only (B11-B15) and is deterministic *(figure 2)*.

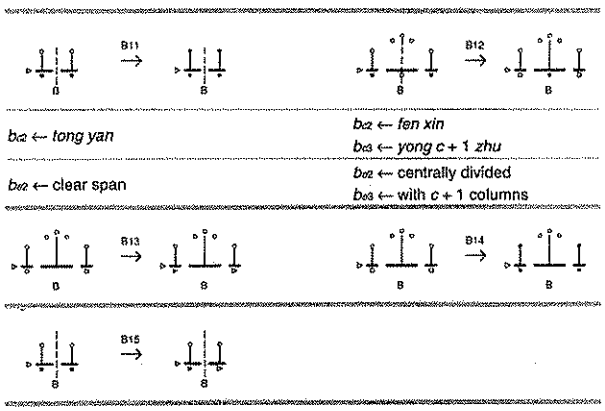

Figure 2. Schemata for preparing the initial design.

Then, set the salient parameters. That is, create the characteristic features of both the section diagram and its description; each step involves a shape schema and an associated description function. This stage is nondeterministic.

At this point the section diagram consists of a base and two columns. The algorithm instantiates each beam specified in the description and the columns that support it (B16-B27). It works from the outside in: first the front, then the back, repeating once if necessary. With each shape schema are associated two description functions. One operates on the Chinese description; the other operates on an equivalent English description *(figure 3)*.

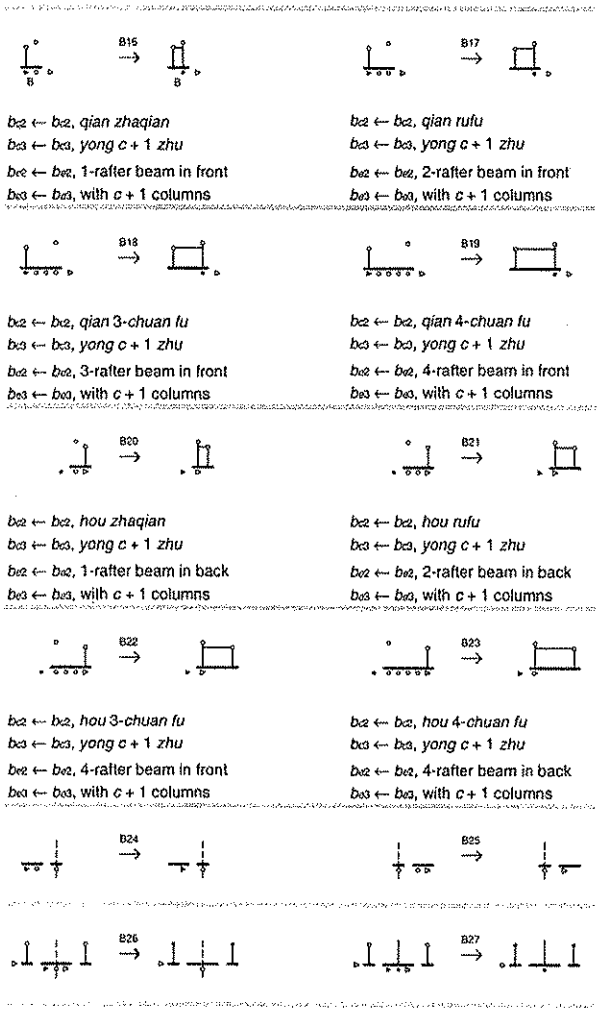

Figure 3. Schemata for instantiating beams.

Finally, complete the design. This means completing the section diagram (shape schemata only), and reducing the description from its characteristic form to that found in the text (description functions only). This stage is deterministic (shown in Li 2001, figures 9a-9b).

5.0 DEFINING THE LANGUAGE OF SECTIONS

Let us imagine that a student uses this grammar to generate a section diagram and description of a 6-rafter building, 1-rafter beam in front, 2-rafter beam in back, with 4 columns. Then he may generate, say, four more, for a total of five designs as follows (*figure 4*; the derivations are shown in Li 2001, figures 11-15):

1. A 6-rafter building, centrally divided, with double 1-rafter beams in front and back.
2. A 6-rafter building, clear span, with 2 columns.
3. A 6-rafter building, with a 1-rafter beam in front and a 2-rafter beam in back.
4. A 6-rafter building, centrally divided, with 3 columns.
5. A 6-rafter building, centrally divided, with a 1-rafter beam in front and back.

Of these five designs, only one (the fourth) is in the corpus and can safely be considered legal. What of the other four? My own thinking is this. The first is full of columns, difficult to use, and probably illegal. The second is probably legal. The third is almost definitely legal. The fourth is in the corpus and definitely legal. The fifth is probably legal.

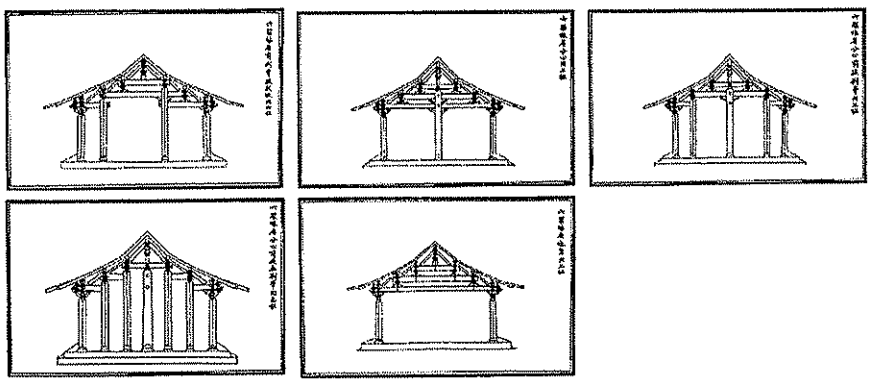

Figure 4. Five 6-rafter section diagrams with descriptions. Whether or not they are legal is for the user to determine.

The student is free to disagree with my interpretations, but in any case he must define his own interpretation, possibly by adding constraints on the application of the beam-instantiating schemata. He might, for instance, suppress the first section diagram by allow 1-rafter beams to be instantiated only once and at the front and back of the building. Thus he refines the generative definition of the language of sections.

As we discussed in the introduction, humans do more than just decide which rule to apply under which transformation. They play a critical role in defining style, and our grammar reflects that role. As a definition of style, the *Yingzao fashi* is incomplete,

and our grammar reflects that too. If the student wants to know what the style of the Yingzao fashi "really is," he must complete the definition himself. This he can do only by examining all the evidence, formulating and testing a hypothesis, and coming to his own conclusion; this is what the connoisseur does, and it is important for the student to know this. The lesson here is that style is not "out there"; it is a human construct. As March and Stiny (1985) say: "The designed world is one of our own making, and its making is our responsibility alone." What better lesson for a student of design?

NOTES

1. This work is part of a larger grammar accounting for the global features of ting halls (Li 2001). An earlier version is Li (2000).
2. These drawings are about 500 years more recent than the text, so the details are anachronistic. However, the global features, as reflected in the descriptions, are probably reliable.
3. For the technical details of descriptions, see Stiny (1981). Note that I use the term *description function* differently from Stiny. He means the ensemble of the initial description and the individual functions, analogous to a shape grammar. I mean the individual function.
4. The rules are presented and discussed in complete detail in Li (2001).

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