

Rule-Based Automatic Generation of Logo Designs

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ABSTRACT

This article proposes the application of shape grammar to the automatic generation of logo designs based on artists' logo creation knowledge and visual structures of logos. The authors propose a set of rules to encode the design knowledge and enable automatic generation. They then present an experiment that was conducted to validate the feasibility of the proposed approach.

Rule-based grammars have been used to integrate professional knowledge for improving designers' creativity and reducing their repeated works [1–5]. This article proposes a progressive methodology for automatic logo generation based on the structure of logo types and their specialized design process. The generation process approximates ideal logo solutions by rounds of refinement, selection and revision guided by designers' preferences, simulating the manual creation continuum.

TRADITIONAL LOGO DESIGN

A logo is a distinctive graphic mark for a product, publication, service, company, organization or individual [6] and used as that entity's recognition cue. In logo design, visual elements are composed elaborately to convey ideas and identities according to highly demanding aesthetic rules.

Expert designers use certain tactics to achieve good visual quality. In a commissioned design job, common steps in logo design include information gathering, analysis and positioning, conceptual design, design development and implementation [7]. It is essentially a process of creation, elimination and selection, as outlined in Fig. 1 and described below.

Designers gather relevant information, such as competi-

tor's logos, image semantics associated with brand names, and the ideas, vision, goals and spirit to be visualized through the logo after in-depth communication with the client. As many as 2,000 logo sketches may be manually drawn on paper in brainstorming sessions. The best 10 percent are selected for further discussion. Then 3–5 options might be focused as candidate options and proposed to the client. Refinement in shapes, fonts and colors of the selected design may be required. The final design would apply to the corporate identification system.

In the traditional logo design process, repeated works are inevitable. Only consideration of a large number of ideas can guarantee quality selections. It takes about 3–4 hours per designer, in a group of 5–7 skilled members. By drawing monochrome graphics quickly in freehand, designers make attempts at different composition patterns and refinement solutions to figure out the best visualization. This labor-intensive and time-consuming process has significantly hindered rapid and creative idea generation and visual effect exploration.

We therefore propose an automatic design approach that significantly relieves designers of sketching effort. This approach would not replace designers' creativity but rather enhance their creativity by encoding their knowledge into algorithms and design rules.

COMPUTERIZED METHODOLOGY OF LOGO DESIGN

In the above traditional logo design process (see Fig. 1) "Idea Sketching" and "Refinement" are the most time-consuming steps. We propose to replace them with the semiautomated cyclical process of "Specifying/Refining Rules → Generating Designs → Selecting Designs → Modifying Rules," where "Generating Designs" and "Modifying Rules" in the oval nodes in Fig. 2 are fully automated steps, as described below:

- **Specifying/Refining Rules.** Based on the collected information and requirements for a particular logo, designers use their knowledge and experience to

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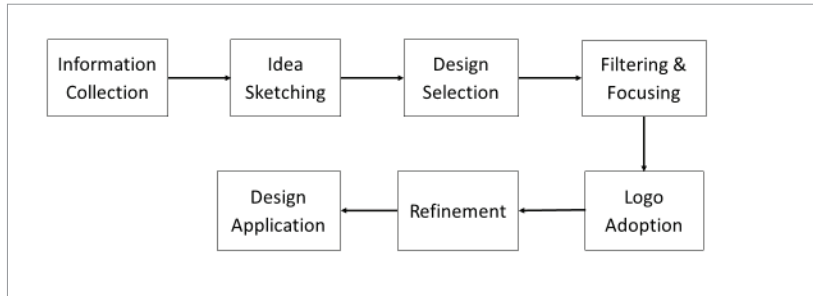


Fig. 1. Outline of the traditional logo design process. (© Yi-Na Li, Kang Zhang and DongJin Li)

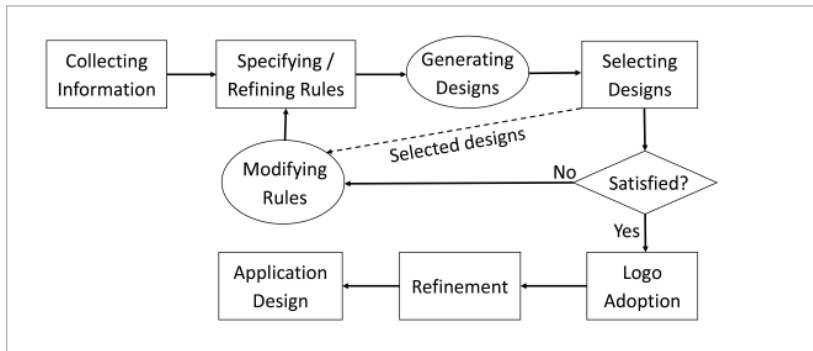


Fig. 2. Outline of a grammar-based semiautomatic logo design process. (© Yi-Na Li, Kang Zhang and DongJin Li)

specify design rules for graphic elements, composition and color combination in the first round of the design process. The design rules are based on a specific grammatical form. (The shape grammar [8] form is used in this article, though other grammar forms, such as the spatial graph grammar [9], may also be used.)

- **Generating Designs.** Given the set of design rules, the Shape Grammar interpretation system automatically generates a large number of designs. These are essentially all combinations of graphic elements that satisfy the design rules. Some of the generated designs may not have been thought of or imagined by the designers. This step not only saves designers' time but also enhances their creativity and imagination.
- **Selecting Designs.** This step is the same as its counterpart in the traditional design process, except that the choices presented to the designers are automatically generated. In an electronic form, they are easily modifiable, selectable and printable.
- **Modifying Rules.** In order to exclude a large number of undesirable designs, designers must identify certain inherent patterns and apply guidelines and constraints. Our proposed shape grammar interpretation system could be equipped with an artificial intelligence tool, such as a constraint solver, that can extract the constraints used by the designers. It then uses the constraints to modify the design rules. These automatically modified design rules may or may not be further refined before another round of automatic design generation.

AUTOMATIC GENERATION RULES

This section provides a framework in which the viewer's perception and the attributes of a logo design interact through a system of rules. The elements in logos can be generally categorized in three types: (1) lines and shapes, (2) fonts and graphics and (3) colors. Rules govern the combination of elements and components. The following are step-by-step descriptions of logo generation rules:

- **Aesthetic Rules in Form.** Aesthetic rules describe the composition of lines and shapes in an abstract pattern that is independent of any physical object, indicating departure from imageries of reality. They include rules of relative dimension and rules of symmetry; the latter refers to reflection (bilateral), rotational (radial) and translational symmetries. Designers may adjust the shapes, parameters and the execution sequence of the rules to obtain different senses of aesthetics in their designs.
- **Font Recommendation.** Fonts have distinctive personalities. Thousands of available fonts of various languages make the selection difficult. We introduce the concept of "style" as the foundation of font evaluation and recommendation [10]. A multidimensional scaling approach would be used to associate a perceived graphic style with a font style [11]. The scale extracts the main dimensions of style from collected adjectives describing features of the logo using the Principle Component Analysis (PCA) method. We rank the most frequently used fonts in the dimensions given in the

scale according to designers' responses. After the designers rate all the fonts in the dimension or their expected style, fonts of similar style would be recommended.

- **Color Selection.** There are over 1.6 million colors in the current 32-bit RGB scheme, of which a limited number are used in logo designs. A color scheme is composed of a main color and complementary colors. There are generally two color selection methods: experience-based and image-based.

We provide a color selection interface similar to the one found on <www.colorsfire.com>. The designer chooses a base color according to his/her understanding of color semantics. For example, blue is associated with high tech, professionalism and business. Analogous colors, complementary colors, triad or tertiary colors, etc. may be chosen from a color wheel to obtain a color scheme. Experts may enjoy the freedom of creation; however, novices may suffer. The first method uses color scheme templates, which integrate the contemporary color fashion. The second method is based on an existing image. Colors are cues of typical scenarios, invoking memory of places and events. Designers take pictures as resources of inspiration. Color extraction rules may be used to reduce millions of pigments to a few colors (e.g. 5, 3 or even fewer). For instance, to design a coffee shop logo, the designer might take a close-up shot of a latte in a modern metropolitan coffee shop for reference. The logo might adopt a brown of varied brightness and ivory, indicating the mix of coffee and milk (<<http://labs.tineye.com/color/>>). The color selected by either method above could be created with gradient effects.

- **Spatial Composition.** Spatial composition rules define the spatial arrangement of graphics and text. There are essentially three compositions: portrait, landscape and beset. In a portrait composition, graphics and texts are placed vertically. Usually graphics are predominant with texts beneath. In a landscape composition, graphics and texts are arranged horizontally. For most cases, graphics are on the left and the overall composition is flat. In a beset composition, text surrounds graphics or is set as a part of the graphics (i.e. overlap or fill blanket space in a figure). Alignment and perpendicularity to tangent are accessory rules. Additionally, the overall contours of graphics and text are taken into consideration.
- **Accessory Ornament.** Lines and shapes also work as accessory ornaments of a logo, such as the frame of a badge, and dividing lines or shadow between graphics and texts. Ornamental visual elements can either highlight or buff the contrast of graphics and texts. Accessory ornament rules provide subsidiary revision tactics for spatial composition.

- **Color Assignment.** Color assignment rules assign colors in a given color scheme to shapes and texts. A closed curve defines a zone for a certain color. The main color in the scheme fills the dominant area. Relative sizes, attributes, positions and boundaries of shapes all influence visual effects.
- **Visual Weight Adjustment.** Visual weight indicates the perceived prominence of elements. The weights of elements vary after being assigned with colors. Generally, the weights in red, blue, green, orange and yellow are perceived descending. Full saturation and darker colors are heavier. Visual weight rules dictate adjustments in brightness, saturation and hue parameters to alter the contrast between colors, pursuing a sense of balance.
- **Rule Optimization upon Users' Preferences.** Rule optimization is a mechanism in which human perception factors are used to optimize the parameters in the rules. The factors include users' selection preferences at each step, eye fixations and gaze trace collected by an eye tracker. Patterns of composition would be revealed from those measurements, acting as a guideline for future designs. Style preferences in a given industry and culture could also be reflected, supporting decision-making and exploring aesthetic issues.

SHAPE GRAMMAR FORMALISM AND ITS INTERPRETER

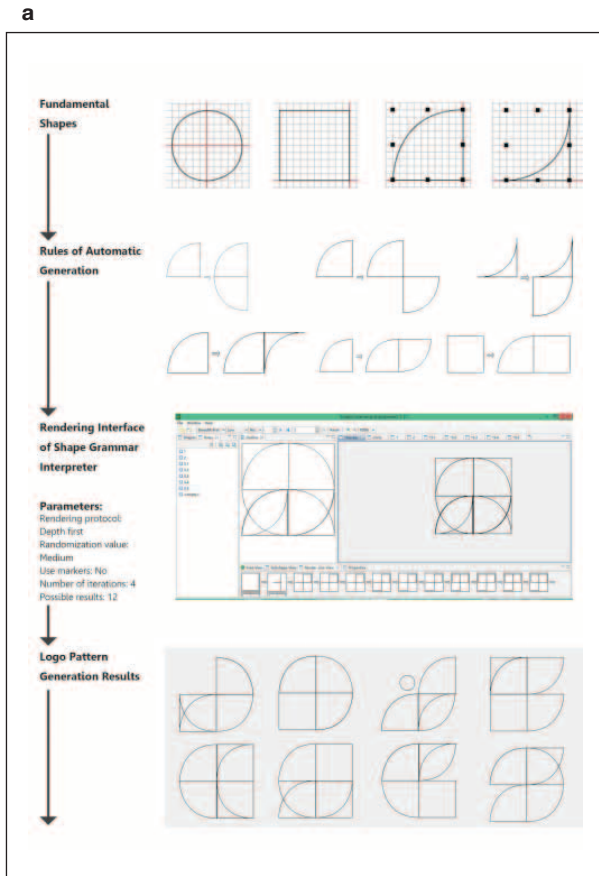
We use the shape grammar formalism [12] to build the automatic logo generation system. Shape grammars are a rule-based formalism, including the general definitions of shapes, weight and label algebras, shape boundaries, part relations, Euclidean transformations, maximal shapes and Boolean operations with shapes [13]. In the early 1970s, Stiny and Gips introduced the shape grammar and applied it to the creation of paintings and sculptures [14].

A shape grammar is composed of rules of primitive shape compositions. Each rule includes left-side and right-side shapes. A generation engine selects and processes shape rules to generate complex shape compositions. Three examples of shape rules are right-side shapes substituting, modifying or adding to left-side shapes. According to these rules, one can translate, scale, rotate and reflect the particular shape to match the conditions from the left side using the right-side shape [15]. A marker may be used on the left side to locate and orient the shape. We use a visual programming environment called Shape Grammar Interpreter (SGI) to generate abstract patterns [16] in our empirical experiment.

AN AUTOMATIC GENERATION EXPERIMENT

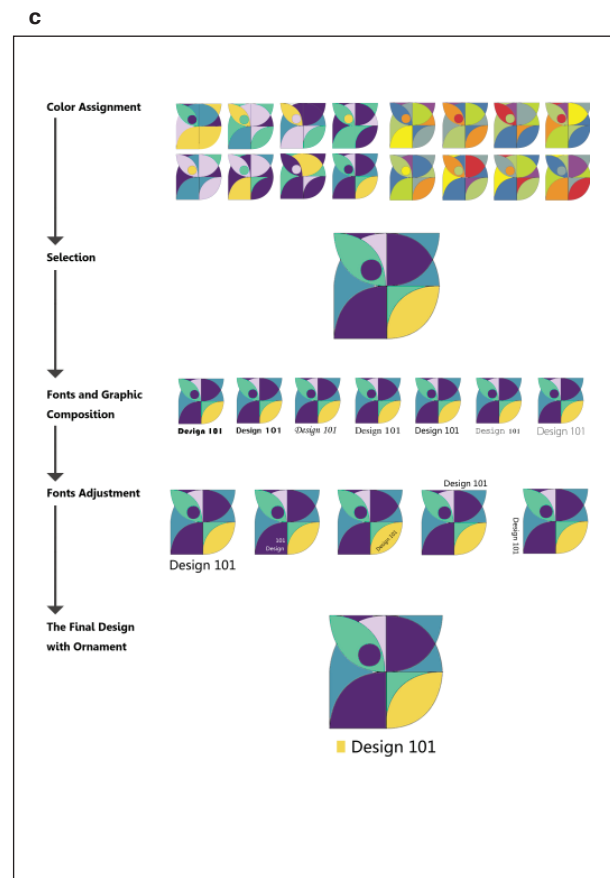
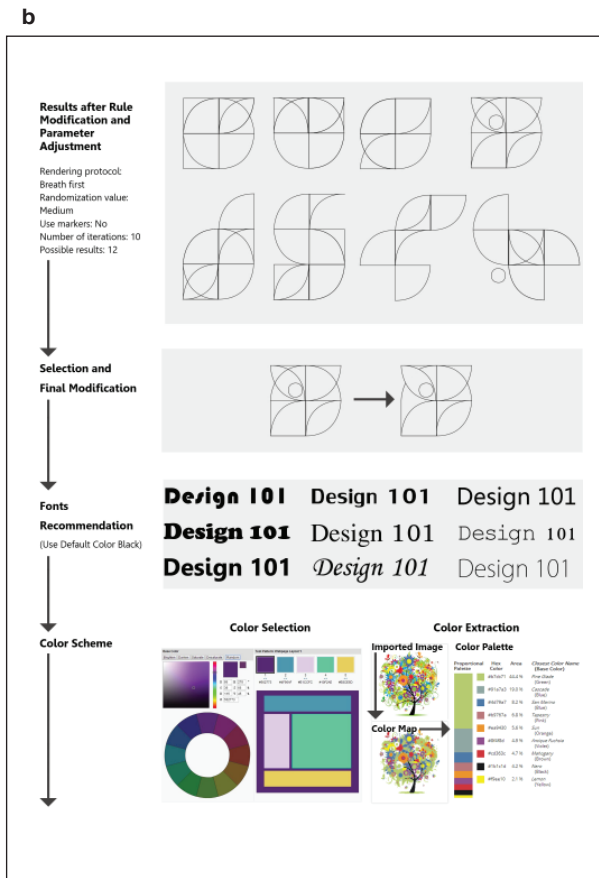
We conducted an experiment of automatic logo generation based on the shape grammar and color grammar. The rules and results of each step are represented in Fig. 3.

A creative logo, called Design 101, is used as an example of automatic generation techniques. Design solutions are interpreted as magic compositions of simple shapes. We chose a



circle, a square, a quarter circle and the nonoverlapping area of a quarter circle and a square as fundamental elements, as illustrated in the first line of Fig. 3a. The automatic generation provided about 60 options, as shown in the selected samples in the “Results after Rule Modification and Parameter Adjustment” step (Fig. 3b). We expect a visually appealing abstract pattern without any particular semantic meaning. However, a shape that looks like an owl with a pair of short ears and one open eye attracted our attention. It is extremely simple, abstract and balanced. We naturally projected our imagination and memory of schemas onto shapes in the selection process and got an unintentional combination. An owl usually represents wisdom and sharp eyes in Western folklore, quite fittingly in a symbol of design creativity and talent. Therefore the abstracted owl image was adopted for further design. In the traditional design process, a semantic meaning leads to the shape and image references. In contrast, the reverse process occurred in our experiments, i.e. the semantic meanings are accidentally identified to match our original expectation from a combination of the given set of shapes. In our selection process, a cute animal, an owl, is recognized when relative images of real animals and cartoon

Fig. 3. The automatic generation process for the creation of the Design 101 logo.
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animals are recalled. This illustrates Gombrich's statement that understanding images is a process of projecting interpretations. Human beings tend to compare their expectations with the messages received by their perceptual system [17]. An image, with its semantic ambiguity, is meaningfully projected by the designer's expectation and imagination, creating an interesting, sometimes unexpected, design work.

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CONCLUSION

This article has shown the feasibility of automatic generation of logos using a grammatical formalism. The logo is a typical type of graphic with all types of 2D graphic elements. The exploration of logo composition rules is applicable to other areas of graphic design, such as designing cards, posters and even user interface.

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