Instance and System: a Figure and its 2^{18} Variations

Univ.-Prof. H. E. Dehlinger, Dipl.-Ing, M.Arch., Ph.D. (UC Berkeley)
Kunsthochschule Kassel, University of Kassel, Germany
e-mail: dehling@uni-kassel.de

Abstract

From the structural characteristics of an existing figure - a graphical logo – a plausible solution space of related figures is constructed, which contains all other figures, which may be generated by systematically exploiting the structural characteristics of the input figure. The constructed space of figures can be understood to represent the solution space for the design of the logo. A designer, proceeding systematically by following some generative set of rules would have to construct this solution space at least to the point of a decision, if not entirely. In the presented experiment, this "solution space" will be exhausted completely and the resulting images (there are 2^{18} will be outputted graphically. Questions will be asked concerning the design process, the generative rules, and the selection of the *one instance* representing a solution. The presented results are to be seen as "work in progress".

Constructing and inspecting solution spaces

We regard here generative processes in designing and mean by that, processes, procedures, algorithms etc., which produce "designs". There are examples of generative processes in architecture in literature in music in design; in the fine arts and in a number of other areas. Many of them are represented at this conference [1]. Frequently (but not necessarily) such generative processes are based on very general and universally applicable rule systems that are not specific to the discipline they may serve (examples are the rules of logic or those of combinatorial mathematics). The existence of such "universally" applicable rules also brought out "universally" applicable methods for the treatment of any kind of problem. A well-known example is the method of morphological analysis suggested by Zwicky [2], which applies combinatorial rules to a structured matrix of parameters
Common to all these efforts is to find rule systems, which, when applied will produce solutions / alternatives fulfilling, more or less, the requirements of a set task. One imagines a solution space which we do not know yet but in which the searched for solutions already exist, however at unknown coordinates. They are made visible by a process of generative steps, which send the designer on a journey through the solution space, which ends at a discrete point ("the journey ends on a station". The rules for the generative process are instrumental rules, which actually lead in a finite number of steps to a defined point in the solution space. Thus, the rules must contain a stopping rule. In mathematics such procedural systems are known as algorithms. The imagination of an ordered solution space is useful, because it presupposes that the solutions contained in it possess a certain structure. If solutions are close to each other, they have similar properties. The differences become larger, the further apart from each other they are. However, all solutions are related structurally. The variations are controlled by a set of known parameters, which are manipulated through the rules. This demands they are defined (accepted, selected, have been

found, designed, etc.). With the generative approach to design the attention of designing is on the structural characteristics of a problem and on the manipulating rules. Each produced solution represents a valid instance from the system of all solutions conceivable. Depending upon the size of the solution space one can pursue two strategies:

(1) with a large solution space (and most problems require large solution spaces) one can:
- generate *one* solution and judge it immediately;
- generate small sets of solutions at a time, judge each one or compare them to find the "best one" in the set.

The focus of proceeding is here on the single instance, the unique piece, and if necessary on a small number. One can take the "first best" solution, or somehow produce a number of solutions, or inspect the solution space using any sort of criteria. This strategy is similar to the traditional process of designing: one tries to find a solution somehow and develops it, criticizing, changing, improving. Rather unusual (for good reasons) in the eyes of traditional designing is:

(2) the complete and systematic exhaustion of the entire solution space.

It is in principle impossible with real tasks of design to pursue this strategy (rationality dilemma of design) and it is not advisable for pragmatic reasons even with "small" problems (as we will see) the number of solutions residing in a solution space is very large, so large that we can not examine them all. Indeed, if not restrained artificially and with proper measures, the solution space to any design problem is of infinite magnitude. It is exactly the measures of restraining we apply which will determine the strategy which is open for the generative process. This, of course also holds for any other approach to design, but the explicit search and formulation of a generative rule forces consistently to focus on structure. The benefit is we can be "certain" no "good" solution will escape our attention. Normally, the designer is far away from such a position and applies heuristic methods to meet uncertainty. Design is afflicted in principle with such uncertainties.

For the strategy under (2) there are interesting "cases" in literature: in the description of the "academy of Laputa" in Gulliver's Travels by Jonathan Swift [3], Gulliver is confronted with a "…project on the improvement of speculative knowledge…" where "…even the most uneducated person at a reasonable charge and with some physical labour can write books in philosophy, poetry, politics, law, mathematics and theology, without the least assistance from genius or learning". The "Library of Babel" of Jorge Luis Borges [4], is a further example from literature. Somewhat absurd are both, because most of the generative results produced turn out to be nonsense and obviously our capacity is not fitted to handle such tremendous number of possible events. We can interpret the machine in the academy of Laputa as a monitor screen on which each pixel can accept a certain range of values. The output of this system will then be the whole of all representable texts and pictures.

A figure and its variations

For experimental considerations, despite all objections, we now want to design a case of complete exhaustion of a solution space. For an already existing design, a logo [5], designed by the office of Graphic Designers Stankowski + Duschek, (see Fig.1), a solution space will be designed containing all related instances, following the structural properties of the input figure.

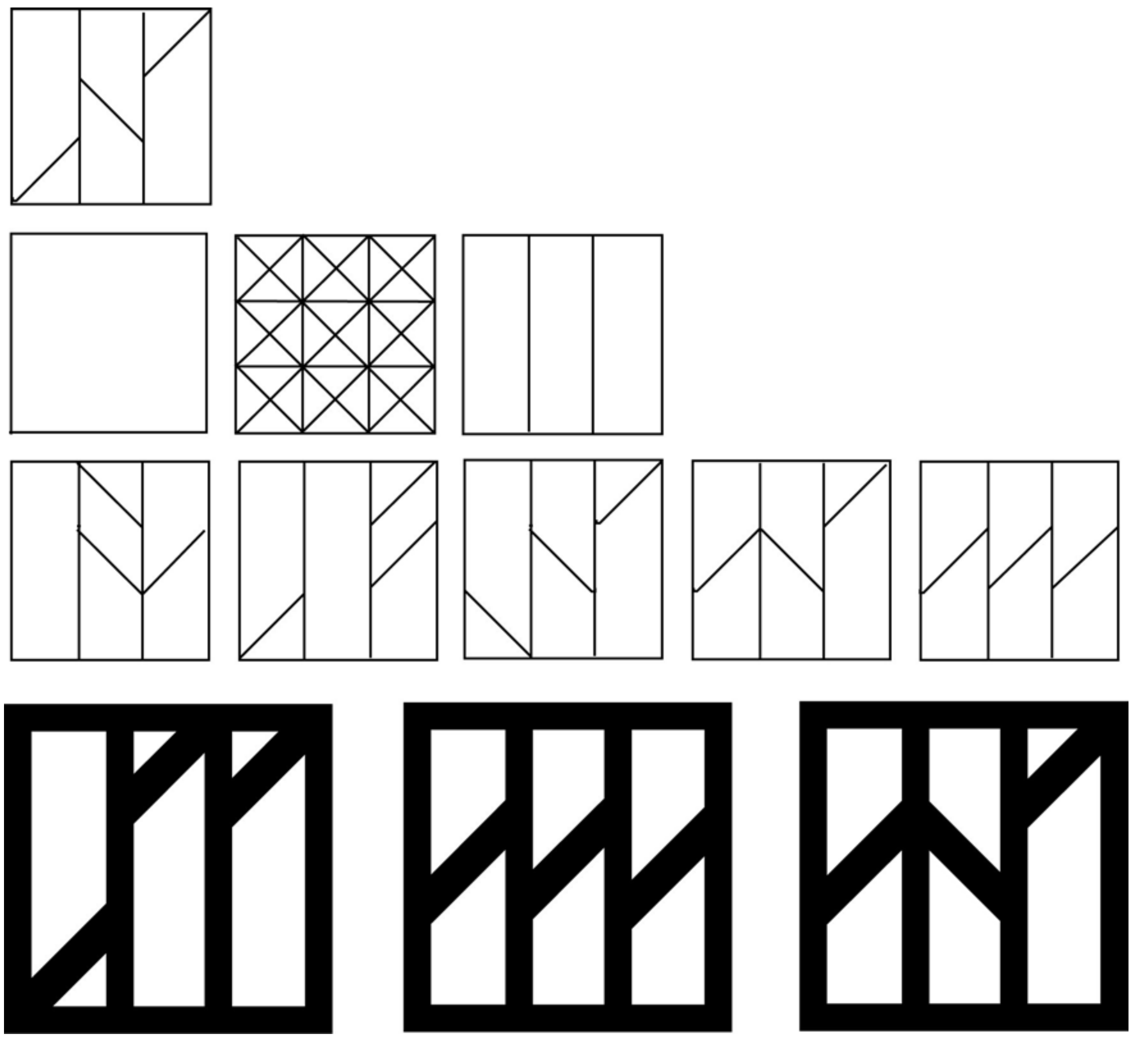

Figure 1
Top: Original Fig.
Row2: Structural System
Row3: Examples using 3 strokes
Row 4: Enhanced

We strictly follow the matrix of these structural properties and only use as variational parameters the short strokes located in defined positions. It seems they represent a substantial characteristic of this logo. Some of the variations are shown in Fig: 2, Fig. 3 is a collection of all possible figures using 3 strokes only (like the initial figure). The structural "system", which defines the logo and all its variations, is a square that is subdivided into nine smaller squares (see Fig.1). In order to construct the solution space to which the figure and its variations belong, we analyse the structural system of the figure and we select the following list of parameters:

geometry of figure: ………………………………. square
structure of matrix: ………………………………. orthogonal
number of cells vertical / horizontal: …………….. 3 / 3
number of stokes per cell: ………………………… 2
subdivision: ………………………………………. two vertical divisions
positions of strokes (angles): …………………….. 45 degrees, (+/-)
variation in line thickness: ……………………….. none
trimming of edges: ……………………………… sharp, no offset
line type: ………………………………………… straight line
etc.

We can now try to design a solution space for the generation of all figures related to the input figure. There are 2^{18} possible instances, see Fig. 2 for a fraction of them. With a relatively simple program one can draw them all (for which 10 sheets of size A0 are needed if each figure occupies somewhat less than a square centimetre). We imagine a systematically working designer, who, before making a choice, wants to know all of the possible variations and has constructed them. He must now device rules of evaluation (selection, judgement), by which all but one of the instances may be rejected. In a design process we normally assume a limited number of alternatives has been developed by the designer from which the best is selected. Two fundamental problems arise, which are characteristic for all design processes: How does one arrive at a solution space? (generation of variety); and: Which selection (decision) rules to use? (reduction of variety). It is hardly possible to imagine a more dramatic contrast between the procedure of complete exhaustion of a solution space and the traditional way of designing. I do not know, how the logo in Fig.1 was developed, but it is safe to assume, the designer did not survey the entire solution space suggested by the structural system, which of course was chosen quite deliberately.
Questions that arise: How would one have to change the generative rules, in order to produce few "useless" solutions? Which changes in the structural system would open further "meaningful" solution spaces? With respect to the suggested figure, are there still figures remaining in the constructed solution space which would be classified by an expert as "better"? Some examples to changes in the structural properties of the initial figure are listed in Fig. 4, where each entry is suggesting an own and differently structured solution space compared with the described one.

Could we formulate guiding statements, agreeable for the majority of the design community, to control the generative process? For the figure under consideration here, some candidates for such statements may be:
- simplicity is good
- a diagonal from bottom left to top right is dynamic, optimistic
- order is preferable over disorder
- geometry generates order
- etc.

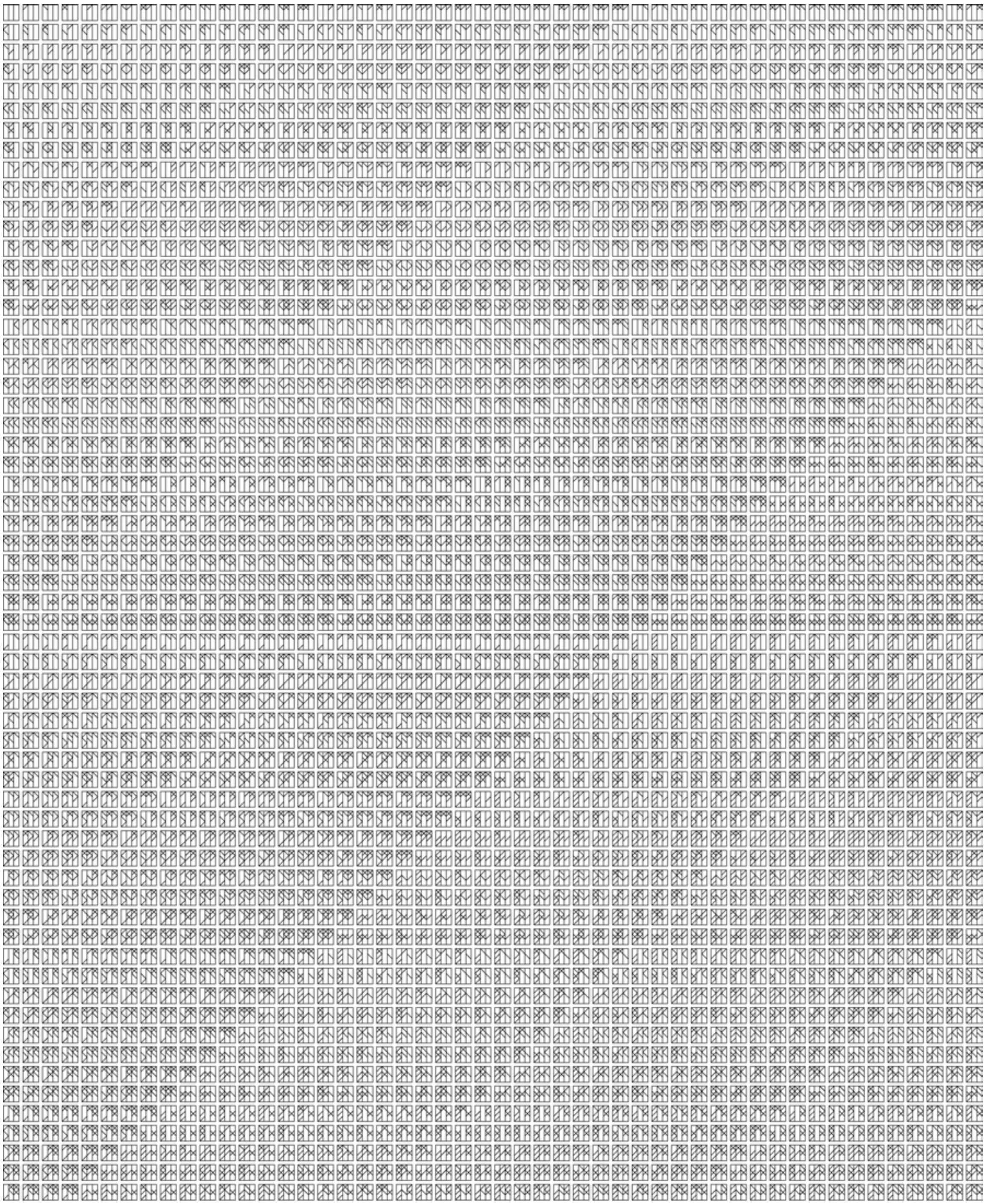

Fig. 2
Fraction of the solution space for „logo“

If we obey such rules, they can provide constraints in generative process like:
- strokes in a few positions only

- no crossing of strokes
- combine two diagonal strokes of same tilt to a double stroke
- occupy only diagonal squares
- etc.

The value of the approach to completely exhaust a solution space may be questionable. But there is also an aesthetic to the produced results, that is quite unique.

Fig. 3
All figures out of 2^{18}, which occupy 3 positions

References

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