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Generative design aesthetics: a summary of principles and approaches

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Abstract

The article shows that generative design offers an organic, bionic, “extraterrestrial” appearance for parts and products. In industrial design, generative design offers many tools for automatic design that help optimize the manufacturing process, reduce product weight, and save materials. In conclusion, it is concluded that the hundreds of solutions, options, and forms offered by the computer are a fairly rich basis for further selection by the designer. The engineer and designer are freed from routine work and set themselves new creative goals: how to give the machine a task. In addition, generative design brings together the efforts of designers and engineers to create a new quality product: engineers become more creative, designers think more about functionality. Thus, generative design is one of the most promising and actively developing areas of industrial design.

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Keywords

Aesthetics, generative design, sociocultural transformations, information technology, environment.

Introduction

In the mid-18th century in England, a satirical treatise described a method for composing music. The method was to take an ordinary brush (one could use a toothbrush), dip it in the inkwell and running one's finger along the bristles, spray the ink onto a sheet of music paper. The resulting blots should indicate the position of the note on the musical scale. Then all that remains is to add bar lines, stems, etc. Moreover, all this was also not chosen arbitrarily, not at the whim of the "composer", but depending on which card he drew from the deck. After all these creative torments, the "essay" is ready for execution. It can be said that this description of the principle of generativity, in particular in art, was one of the first and it was described long before this method was mediated by computer programs.

Main content

The "cut-up method" had a significant impact on the development of electronic music and sampling as the most important technique in the modern music industry. In literature, the collage, random construction of statements from pieces of poetry and prose led to the collection of new texts, which were no longer distinguished by logic and harmony, but by suddenness and associativity.

One of the first drawings obtained automatically and marked with a certain aesthetic value was a drawing obtained using a harmonograph. This is a mechanical device that converts the oscillatory motion of pendulums into a graphic pattern. The final image depends on the amplitude, duration, and frequency of the pendulums' oscillations. The variety of resulting patterns is practically unlimited.

In the middle of the last century, the concept of "generative aesthetics" came into use. The concept of generativity has come to linguistics and art history, as well as to design, in the form of a new paradigm of form-generation. The beginning of generativity was the creation of a graphic image using an oscilloscope.

The generative method in design involves various types of interaction between the designer and the material, where he or her is either fundamentally inactive, taking the position of an observer, or becomes an active participant in the process. And turning to an autonomous system or random processes that are as close as possible to natural, and not directly dependent on humans.

Generative art is defined as any artistic experience in which the artist uses an autonomous system (a set of linguistic rules, a computer program, a mechanism, or a device) that participates in the creation of a work of art or wholly produces it.

Generative art reflects the principles of the Russian avant-garde, dadaism, surrealism, and minimalism. It is no coincidence that industrial design as a phenomenon was born at the same time as these styles.

Generative design also has a synonym – generative design. Generative design is an iterative, reusable design process that involves a program that will generate a specified amount of output that meets certain constraints. The designer himself can customize the feasible region by selecting specific outputs or changing input values, ranges, and distributions.

This method mimics nature's evolutionary approach to design through genetic variation and selection. The process, combined with the power of digital computers that can explore a very large number of possible solutions, allows designers to create and test entirely new options beyond what one person can accomplish to achieve the most efficient and optimized design.

Generative design is becoming increasingly important, thanks in large part to new software frameworks and scripting capabilities that make it relatively easy to implement ideas, even for designers with little programming experience. In addition, generative processes can provide solutions to sufficiently complex problems. This is also facilitated by tools from commercially available CAD packages. Not only are implementation tools becoming more accessible, but also tools that rely on generative design. Scientists predict that in 10 years the global market for generative design will increase fivefold.

Algorithms and programs, having received graphic content, become a significant component of modern design. Since the generative principle of shape formation is created by systems autonomous from humans, and it is too early to talk about the existence of independent artificial intelligence, the source of autonomy is randomness.

Generativeness allows the designer to "create a unique dynamic image where previously only static existed". Generative design is at the intersection of programming and multimedia projects, combining the principles of design thinking with the latest technologies.

The desire of generative design to create something "living" leads to the concept of something dynamic, capable of responding to external factors and changing. These changes are limited within a given program year, but there is some variability. The design becomes "independent" of the author. Nonlinearity, variability and proximity of generative design products to nature to some extent neutralize the position of the designer as an author.

The dynamism of the generative approach gives rise to the possibility of many options. Generative design further makes it possible to achieve system flexibility and independence; to create a new design element one no longer need a designer, one just need to set the parameters, and the program will produce a set of patterns; the designer's task is only to choose the best. The basis of generative design is shaping programs.

Generative design is actively used to create virtual and real art objects, as well as in industrial design. Generative analysis technology is used as a critical design tool. Generative analysis provides "optimized geometry of complex shapes that can only be achieved using casting or additive technologies". The result of generative design can be image, sound, animation, and architectural models.

Today there are a large number of programs for generative design. The most popular of them are Autodesk Fusion 360 (design, engineering calculations and preparation for printing on CNC-CAD machines; work is carried out in the cloud); Autodesk Within (software package for lightening weight, creating lattice structures, for 3D print); NX (Universal Design System); Altair OptiStruct (topology optimization and complex lattice structures for 3D printing).

Generative graphic design is actively used not only in printed and computer graphics, but also in cultural and entertainment projects. To create flat and three-dimensional structures, various mathematical methods are used today, such as fractals, "artificial life", "cellular automaton", Lindermayer systems, mathematical chaos, randomization, and others.

Randomization leads to the imitation of natural processes. However, the work is not limited to imitation: "Generative design methods make it possible to obtain a product with new aesthetic characteristics by synthesizing the algorithms embedded in the program and the algorithms used by the author. This requires a feedback loop that can range from simple decisions, where the algorithm takes its own output as input, to complex ones involving design evaluation procedures.

The principles of bionic design are associated with the imitation of natural forms, with curvilinearity and nonlinearity, and kinetic structures.

The basis for generation forms are the following natural forms:

– cone of gravity;

– spatial lattice systems, such as spongy bone, wood leaf;

– thin-shell constructions – shells, eggs, skull;

– variability of design form;

– cable-stayed and rod-cable systems, such as musculoskeletal, spider webs;

– patterns of repetition.

Generative design, like architecture, is closely related to nature's shaping.

We can identify a sequence of basic levels of working with the generative design system. The first stage is the formulation of the task (goal setting of the result, basic specification). The second is setting the parameters/characteristics that the generated solutions will correspond to. The third is generation according to algorithms and data; visualization of objects and processes; rejection of non-intelligible material (for example, that does not comply with the laws of physics). The fourth is the selection of objects by the user. The choice of option that meets the designer's requirements is based on taste, that is, it is not determined by machine technology.

Conclusion

Generative design offers an organic, bionic, “out-of-this-world” appearance to parts and products. In industrial design, generative design offers many tools for automatic design that help optimize the manufacturing process, reduce product weight, and save materials.

The hundreds of solutions, options, and forms offered by the computer provide a fairly rich basis for further selection by the designer. The engineer and designer are freed from routine work and set themselves new creative goals: how to give the machine a task. In addition, generative design brings together the efforts of designers and engineers to create a new quality product: engineers become more creative, designers think more about functionality. Thus, generative design is one of the most promising and actively developing areas of industrial design.

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Эстетика генеративного дизайна: обобщение принципов и подходов

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Аннотация

В статье показано, что генеративный дизайн предлагает органический, бионический, «внеземной» вид деталей и изделий. В промышленном дизайне порождающее проектирование предлагает множество инструментов для автоматического проектирования, которые способствуют оптимизации процесса изготовления, снижению массы изделий, экономии материалов. Делается вывод о том, что предлагаемые компьютером сотни решений, вариантов, форм являются достаточно богатой основой для дальнейшего отбора дизайнером. Инженер и дизайнер освобождаются от рутинной работы и ставят перед собой новые творческие цели: как поставить машине задачу. Кроме того, генеративный дизайн объединяет усилия дизайнеров и инженеров для создания нового качественного продукта: инженеры становятся более креативными, дизайнеры задумываются в большей мере о функциональности. Таким образом, генеративный дизайн представляет собой одно из весьма перспективных и активно развивающихся направлений промышленного дизайна.

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Ключевые слова

Эстетика, генеративный дизайн, социокультурные трансформации, информационные технологии, окружающая среда.

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