Max Bense

projekte generativer ästhetik

unter generativer ästhetik ist die zusammenfassung aller operationen, regeln und theoreme zu verstehen, durch deren anwendung auf eine menge materialer elemente, die als zeichen fungieren können, in dieser ästhetische zustände (vertellungen bzw. gestaltungen) bewusst und methodisch erzeugbar sind. generative ästhetik ist also in dem sinne ein analogon zur generativen grammatik, als sie, wie diese, sätze eines grammatischen schema realisationen einer ästhetischen struktur liefert.

es ist klar, dass jeder generativen ästhetik, die natürlich eine ästhetische synthese ermöglicht, eine analytische ästhetik vorangeht, durch deren verfahren ästhetische strukturen aus vorgegebenen kunstwerken, die ihre träger sind, als ästhetische informationen präpariert werden. diese präparierten ästhetischen informationen müssen abstrakt beschreibbar sein, um in einer konkreten menge materialer elemente planmässig projektiert und realisiert werden zu können. es gibt gegenwärtig vier möglichkeiten einer derartigen abstrakten beschreibung ästhetischer zustände (verteilungen bzw. gestaltungen), die zur herstellung ästhetischer strukturen verwendet werden können. die semiotische, die klassifizierend vorgeht, und die metrische, statistische und topologische, die numerisch und geometrisch orientiert sind."

das semiotische verfahren benutzt die von Peirce u. a. entwickelten triadischen zeichenrelationen, um die ein künstlerisches objekt konstituierenden einzelnen und komplexen zeichen vermittels dreier haupt- und neun unterklassen in ihrem »objektbezug« »interpretantenbezug« und »mittelbezug« festzulegen. zur semantischen analyse eines kunstwerks ist die kenntnis seines aufbaus aus zeichenklassen ebenso unerlässlich wie zur synthetischen realisation von bedeutungseinheiten (»semantemen«) in einer menge materialer elemente.

das metrische verfahren, das im sinne älterer formaler schemtiken wie poetischen metriken oder kunsttheoretischen proportionenlehren numerische daten benutzt, die vom charakter eines »abstandes«, einer »distanz«, eines »rapports« sind, erreicht

vor allem den makroästhetischen aufbau eines kunstobjekts, also die komposition der »gestalt«, der »figur«, der »form«.

das statistische verfahren, das mit dem begriff der »häufigkeit« bzw. der »wahrscheinlichkeit« auftretender elemente oder numerisch bewerteter merkmale von elementen in deren gestalteten mengen arbeitet, erreicht vor allem den mikroästhetischen aufbau eines kunstwerks und präpariert nicht sein »prinzip gestaltung«, sondern sein »prinzip vertellung«.

das topologische verfahren schliesslich bezieht sich vorwiegend auf die »mengen« von elementen, die das künstlerische objekt konstituieren, und arbeitet mit so zentralen begriffen wie »umgebung« oder »zusammenhang«, »offenheit« und »abgeschlossenheit«, einfachheit und komplexität von mengen von elementen. das »prinzip menge« ist ein drittes neben »gestaltung« und »veteilung».

das effektive ziel des systems generativer ästhetik besteht darin, die charakteristiken ästhetischer strukturen, die in einer menge materialer elemente realisierbar sind, numerisch und operationell so zu beschreiben, dass sie als abstrakte schemata eines »prinzips gestaltung«, eines »prinzips verteilung« und eines »prinzips menge« gelten können und manipullerbar einer materialen, ungegliederten (»verdampften«) menge von elementen aufgedrückt werden können, um gemäss diesen »prinzipien« das hervorzurufen, was wir als »ordnungen« und »komplexität« makroästhetisch und als »redundanzen« und »information« mikroästhetisch am kunstwerk wahrnehmen. das aufdrücken ist indessen nicht als anwendung einer schablone zu verstehen, sondern als ein erzeugungsprinzip. auch »programme« in bestimmten »programmiersprachen« zur »maschinellen« realisation »freier« (stochastischer, intuitiver) oder »gebundener« (im voraus festgelegter, deduzierter) ästhetischer strukturen gehören zum system generativer ästhetik und ihren projekten, sofern sie metrische (abstände, wortlängen), statistische (wortfolgen, positionierungen) und topologische (verbindungen, deformationen) bestimmungen einkalkulieren, um »ästhetische information« zu erzeugen.

da nun ästhetische strukturen nur insofern »ästhetische information« enthalten, als sie innovationen aufweisen und diese natürlich stets nur eine wahrscheinliche, keine definitive wirklichkeit darstellen, kann man sagen, dass die künstliche erzeugung von

einer norm abweichender wahrscheinlichkeiten durch theoreme und programme das zentrale motiv der generativen ästhetik und ihrer projekte ist.

(in: Nees, G., & Bense, M. (1965). computer-grafik. Stuttgart: Walther.)

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The projects of generative aesthetics

Max Bense

'The aim of generative aesthetics is the artificial production of probabilities of innovation or deviation from the norm.' (Bense)

Today we have not only mathematical logic and a mathematical linguistics, but also a gradually evolving mathematical aesthetics. It distinguishes between the 'material carrier' of a work of art and the 'aesthetic state' achieved by means of the carrier. The process is devoid of subjective interpretation and deals objectively with speeffic elements of the 'aesthetic state' or as one might say the specific elements of the 'aesthetic reality'. These elements are pre–established and their appearance, distribution and formation is described in mathematical terms. Thus this new aesthetics is simultaneously empirical and numerically orientated.

The elements involve not only material or sensuous qualities such as sounds, colours, tones but also meanings to be deduced from objects, figures and words. We can there fore refer to 'aesthetic materials' as well as 'aesthetic semantemes'. The mathematical representation of this new aesthetics includes both, and is by no means concerned solely with the formal or syntactic associations as is often assumed.

Generative aesthetics therefore implies a combination of all operations, rules and theorems which can be used deliberately to produce aesthetic states (both distributions and configurations) when applied to a set of material elements. Hence generative aesthetics is analogous to generative grammar, in so far as it helps to formulate the principles of a grammatical schema–realizations of an aesthetic structure.

Any generative aesthetics which leads to an aesthetic synthesis must be preceded by analytical aesthetics. This process is responsible for the preparation of aesthetic structures based on the aesthetic information found in given works of art. In order to be projected and realized in a concrete number of material elements, the prepared aesthetic information must be described in abstract (mathematical) terms.

At the moment there are four different ways of making abstract descriptions of aesthetic states (distributions or configurations), which can be used to produce aesthetic structures–the semiotic (employing classifications) and the metrical, statistical and topological methods–the latter three are numerically or geometrically orientated.

The semiotic method uses triadic relations of signs in order to determine the single and complex signs which constitute a work of art, by means of three main and nine subclasses developed by Charles Sanders Peirce and others defining the sign in relation to its object, to its interpreter and the sign itself. For the semantic analysis of a work of art as well as for the synthetic realization of units of meaning (semantemes) in a number of material elements, it is necessary to be familiar with the construction of the work in terms of classes of signs.

The metrical method of describing an aesthetic state uses numerical data in the same way as older schematics, i.e. theories of proportion in art. This method will establish the macro-aesthetic constitution of an art object, in other words, the composition dealing with form, figure and structure.

The statistical method is involved with the concept of frequency or probability of appearance of elements. Also with numerically assessed characteristics of elements in their relationship and organization. Thus we arrive at the micro-aesthetic constitution of a work of art which can be used to arrive at, not the 'principle of formation', but the 'principle of distribution'.

Finally the topological method is mainly concerned with the sets of elements which constitute the work of art, based on notions such as environment, connexion, open state, seclusion, simplicity and complexity of sets of elements. With the formation and distribution principles, the 'set' principle is the third.

The system of generative aesthetics aims at a numerical and operational description of characteristics of aesthetic structures (which can be realized in a number of material elements) which will, as abstract schemes, fall into the three categories of the formation principle, distribution principle and set principle. These can be manipulated and applied to an unordered set of elements, so as to produce what we perceive macro-aesthetically as complex and orderly arrangements, and micro-aesthetically as redundancies and information.

This application is not merely the application or imprint of a pattern but a generative principle. Programs, in certain programming languages, can also be used for the mechanical realization of 'free' (stochastic), or 'determined' (established a priori, deduced) aesthetic structures. These also belong to the system (and products) of generative aesthetics, provided that the resulting aesthetic information is based on material determinations (e.g. distances and length of word), statistical determinations (sequence of words, positioning), and topological determinations (combinations and deformations).

Aesthetic structures contain aesthetic information only in so far as they manifest innovations, or rather innovations of probable reality. The aim of generative aesthetics is the artificial production of probabilities, differing from the norm using theorems and programs.

Hence, generative aesthetics is an 'aesthetics of production', which makes possible the methodical production of aesthetic states, by dividing this process into a finite number of distinct and separate steps which are capable of formulation. The aesthetic state could be interpreted as the order of innovation through the original distribution or formation of material elements or semantemes. 'The aesthetics of production' is concerned with bringing about 'orderly arrangements' which comprise the topological nature of 'form', and the statistical nature of 'distribution'.

Hence three schemes of generating arrangements of order become discernible:
1 producing order from disorder;
2 producing order from order;
3 producing order from a mixture of order and disorder.

In this context 'disorder' is expressed by an even and regular distribution of elements or particles (dots or syllables) in a given space; whereas 'order' means exactly the contrary, i.e. the irregular distribution of elements. Thus a text consisting of one word, for example 'is is is is is . . .' would be an example of 'disorder' without any innovation whatsoever. It can be transformed into an order incorporating innovation if every 'is' will be associated with a noun, preferably each one containing a different number of syllables, e.g. 'snow is thunderstorm is rain is summer is lightning is . . .'.

Following these assumptions Claude Shannon's wellknown, gradually selected approximations of letters to 'real' words, or of words to 'real' expressions in a language, can be seen as a generative aesthetic process.

The first stage of approximation is performed by picking words at random from a vocabulary or a dictionary where every word occurs-once, thus making sure that every word has an equal probability of coming up. The result:

very funny kept adhere scale incomplete me blows subject investigate the itself send into for accept daring

The second approximation stage consists of choosing at random from a repertoire of words where proportions correspond to the typical word frequency of distribution of a particular author. In this particular case the translation of a work by Francis Ponge:

keeps flee complete smaller dreams hither over run this way finest has'power to sky rely put many thousands line-ahead never border

The third and following approximation can be made -, making a random selection from a repertoire where their occurrence approximates to their combined appearance in twos and threes:

milieu of during attack only the pebble entirely eternal towards as terrestrial globes yet so proud of renounced

Now, if a certain frequency is introduced between the nouns and the genitive elements and morphemes into the repertoire of the next stage of approximation, metaphoric forms cannot be avoided and are easily identifiable:

perhaps to begin with really only skin of a butterfly white carefree imagined above thine gone

The statistical approximation of a 'real' text by means of stochastic selection is aesthetically and semantically identifiable, although the aesthetic identification is of the lowest order.

Artificially generated texts which have been produced since 1960 could be seen as a product of generative aesthetics. The artificiality can be increased by carrying out the random selection by means of a randomizer in a computer system. Such texts have been produced at Stuttgart in collaboration with the Elektronische Recheninstitut in 1960. In 1963 Nanni Balestrini published artificial, mechanically produced texts in his book Come si agisce. These were not developed like the Shannon approximations, but were programmed on IBM 7070 in 1200 instruction codes in relation to combinations of 10 given elements following rules of syntax.

In America Lejaren A. Hiller and his collaborators were particularly successful with a systematic investigation of composing music with the aid of computers. The first successful results date back to 1957 and the *Illiac Suite* for string quartet. The composition was programmed on the Illinois University computer–ILLIAC. In 1963 the famous *Computer Cantata* was composed by Lejaren A. Hiller and Robert A. Baker. Hiller wrote about it as follows: 'Computer music as we see it is therefore produced in

two stages. First we create a state of randomization, and then a higher or lower order is superimposed or forced onto this chaos.'

We thus have a process of producing order from disorder or order from order. Three additional compositional considerations provide the basis of a computer music program:

1 The conditions for the composition are set up and introduced by the programmer, i.e. rules of composition such as counterpoint, conventional harmonies, serial sequences, graphic transpositions, or even arbitrary restrictions invented by the composer.

2 Statistical conditions derived from the statistical analysis of any style or compositional method, or from freely invented tables of probability. (In Germany, for instance, Wilhelm Fucks and his collaborators at the Aachen Polytechnic found numerical material suitable for programming through careful analysis of classical and modern compositions.)

3 One can employ schemes which are produced directly and automatically by the computer operation itself.

In the case of the *Computer Cantata* the computer was used to produce musical orders in a cantata form by a stochastic selection. The words used for the cantata consisted of those arrived at . by Shannon's approximations, using the stages of stochastic approximations to spoken English based on a series of phonemes selected at random. Thus the statistical musical structure was given a textual correspondence.

Finally I want to mention the computer graphics made by Georg Nees at Siemens in Erlangen which were developed deliberately as aesthetic objects. The programming was done in ALGOL and the random number generator was used to provide the stochastic dispersal of graphic elements, e.g. the positioning of connecting squares. In this particular instance a randomizer was used which repeats itself only after 2^{30} values. Instructions for another program by Nees could be expressed in an everyday language as follows: draw 60 lines parallel to the narrow side of a rectangle inside its framework, in such a way that the parallels accumulate towards the narrow sides with random abscissae (fig. 18).

We can see that the improbability of aesthetic states can be produced mechanically through a methodical combination of planning and chance. In this way the demand which aesthetic objects have to satisfy–namely, to be unpredictable–is combined precisely with their planned construction. It is obvious that even the machine is unable to produce an identical repetition of a product if chance is introduced by means of a random number generator. The uniqueness of aesthetic objects–even those made with the aid of a machine–is maintained in a pseudo-individual or pseudointuitive way.

(in: Reichardt, J. (1971). Cybernetics, art and ideas. London: Studio Vista.)

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