

June 1989



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# MATHEMATICS AND MODERN ART: CHANCE AND ORDER

Ulrich Grevsmühl

Chance has been the subject of extensive investigations by mathematicians, physicists and philosophers. It appears that the only source of real chance is found in quantum phenomena following the statistical laws of quantum physics. Examples of true random events may be found in the radioactive decay of an atomic nucleus or in the irregular movement of an electron in an electric conductor. All other events like throwing a dice, tossing a coin, turning a roulette wheel are strictly determined by the laws of mechanics and therefore examples of pseudo-chance. It is only because in these events we cannot take into account all possible factors that we cannot foresee their results and regard them therefore as random.

Intuition must also depend on processes of chance as is known from problem-solving situations where the person confronted with a novel task may produce an innovating solution which cannot be derived from something known. This is confirmed by the fact that thinking itself is based on molecular processes and thus on random quantum events which finds its analogy in the random generators of computers. But when we think of the processes which lead to the solution of a given problem, we find that creativity does not only depend on spontaneous intuition but also on the determined, decisive thought by the help of which a selection from a given range of ideas is made. We may therefore conclude that only the combination of chance and order and their underlying generative laws produces an effective creative achievement.

In modern art chance is often used as a means to create complex structures. Here the distinction between Chance and pseudo-chance is not important as only the subjective, not the objective information matters. Whereas some artists try and create works of art by mostly spontaneous actions following their intuitions, others use technical means like dice, statistical tables or the random generators of computers in order to create random structures. In practice, however, it is difficult to produce structures without any order or generative law whatsoever as a certain degree of order is already achieved by the underlying grid and elements which are being used.

Apart from this the human brain tends to analyse all perceived information according to known patterns and tries to interpret it on the basis of similarities in order to reduce the flow of information in a complex environment.

Here various systems which are based on the more traditional use of chance are being discussed. More sophisticated examples will be dealt with in the following article in MT128 on computer graphics.

**FRANCOIS MORELLET** *Born in Cholet, France, 1926. Lives in Cholet.*

Morellet began practising systematic art in 1952 when he was 26 years old. He was the first and remained for a long time the only leading French artist to make use of this form of artistic expression. His intention has been to produce useless, and hence artistic, objects characterised by total absence of interest in composition and execution and by reducing his arbitrary decisions to a minimum. His works deal with simple, clear systems of basic geometric forms where the only “phantasies” arise both from the systematic use of chance and from the participation of the spectator in the process of perception [1].

Activity 1: Irrational number

His work 4 random distributions of two squares following the numbers 31-41-59-26-53-58-97-98 (1958, oil on wood, 60 x 60cm each) makes use of the first numerals of the irrational number  $\pi$ .

Find the generating principle of the work by use of the accompanying diagram. Calculate the number of possible works that could be produced with this method if the eight pairs of numerals are chosen at random

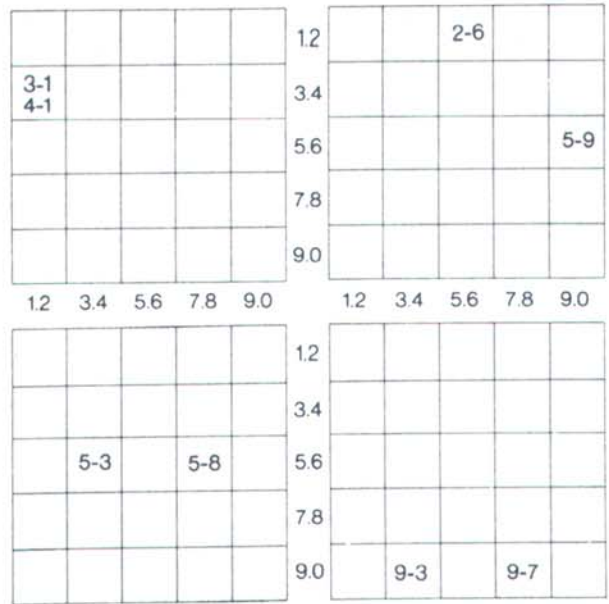
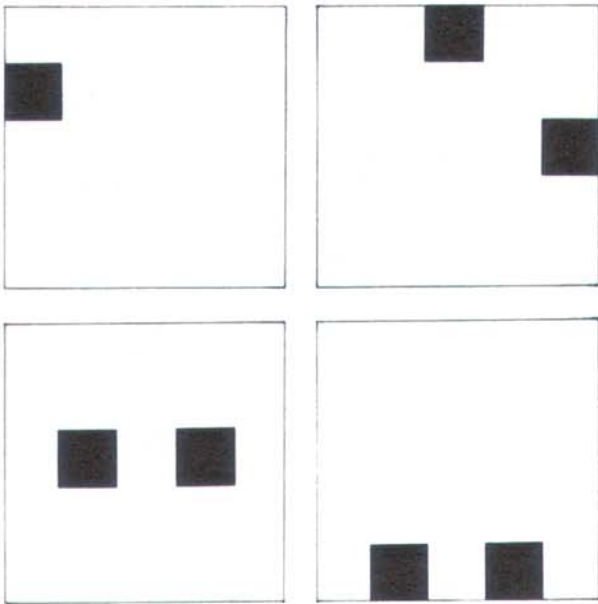
Activity 2: Random lines

In his work 20 chance lines (1971, oil on canvas, 140 x 140cm) Morellet starts with a quadratic frame where each of the sides has been divided into 25 units and where the resulting positions are numbered from 00 to 99. Then a page of a telephone directory is chosen at random and the second and third pairs of numerals (eg 05 and 48) from each of the six numerals of a telephone number are selected. On the page the first pair of numerals was identical in each number and therefore unusable. The two chosen numbers mark the positions on the frame which are connected by a straight line. Altogether 40 subsequent numbers are selected from the telephone directory to produce 20 lines which can also be seen in the accompanying diagram.

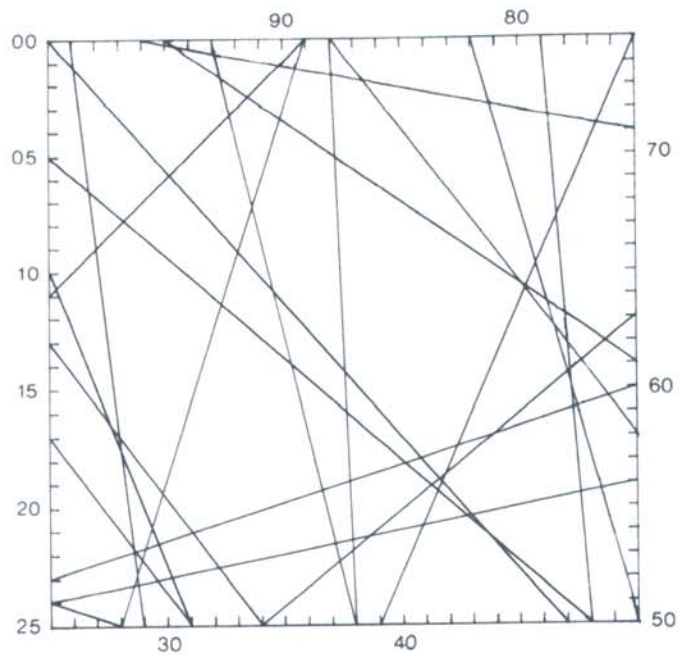
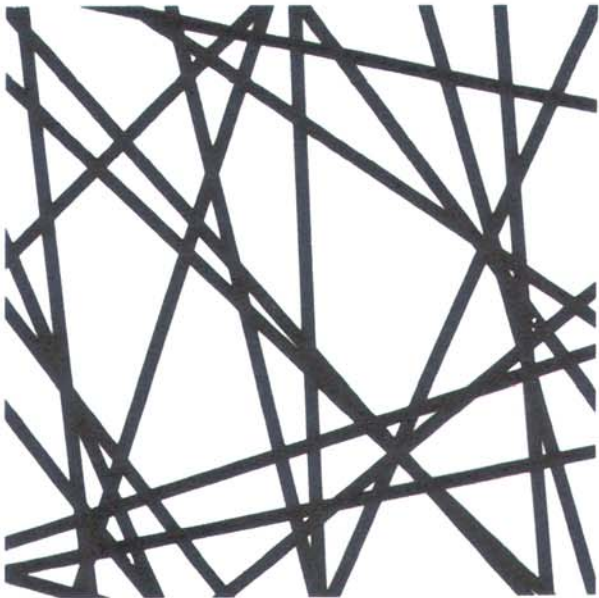
Find the total number of lines which can be drawn by connecting all 100 points of the quadratic frame. Consider also the case where all lines on the sides of the frame are excluded. How many pictures of 5, 10 or 20 different lines can be produced with the generative principle outlined above? What is the probability that a particular picture contains lines where only positions with even numbers are connected? Write a computer program for drawing works of art based on this generative principle.

Activity 3: Random triangles

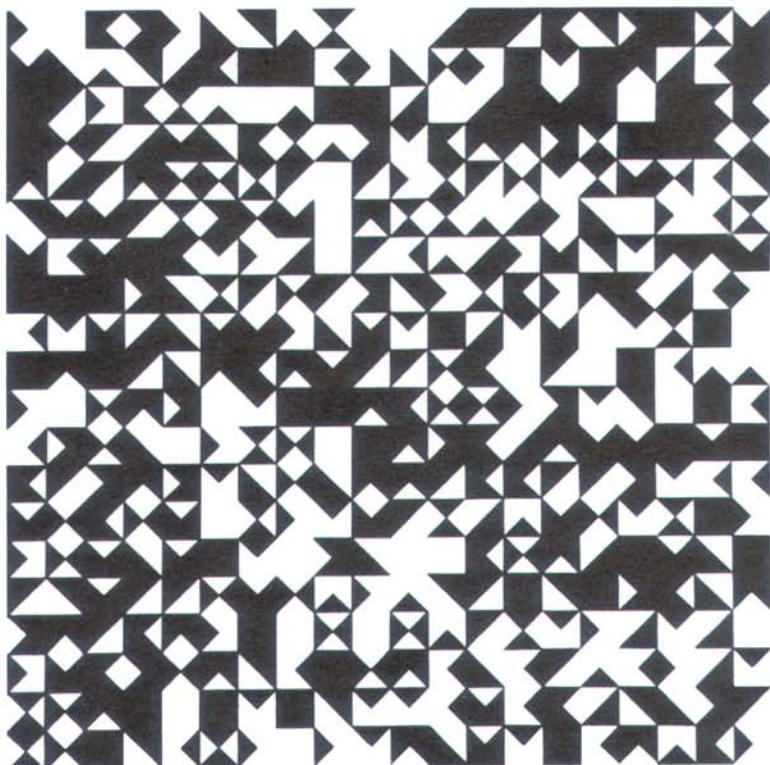
Morellet's work Random distribution of triangles following the even and odd numbers of a telephone directory (1958, oil on wood, 80 x 80cm) consists of 400 squares in quadratic format where each unit square has been divided by its diagonals into four right-angled triangles. Using again a telephone directory as a table for random numbers, each of the 1600 triangles is allocated to another numeral and coloured black or left white if the numeral is even or odd, respectively. Check the work that the even and odd numerals are equally represented in the four positions of the 400 unit squares. Consider the first square and calculate the probability for the case that none of the triangles, only one, two, three or all four of them are black. Repeat this investigation for the first two squares. Consider now all 400 squares and find the probability of producing one particular piece of work.



Activity 1: 4 random distributions of two squares following the numbers 31-41-59-26-53-58-97-98



Activity 2: 20 chance lines



FRANÇOIS MORELLET

Activity 3: Random distribution of triangles following the even and odd numbers of a telephone directory

## NORBERT THOMAS

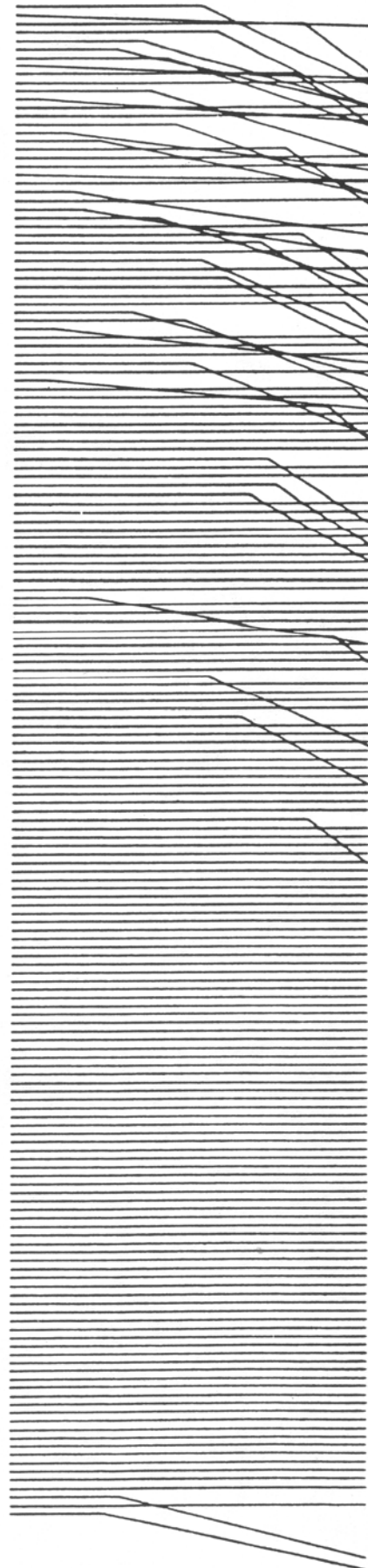
*Born in Frankfurt am Main, 1947. Lives in Essen.*

The visualisation of random processes is one of the major themes in the works of Norbert Thomas. His works are based on systems where the macro- and microstructures are determined by systematic constructive order and random processes, respectively. For him the planning of chance is not a contradiction in itself. Rather, the pre-planned and verifiable chance gives the observer more opportunities —more freedom of perception [2].

### Activity 4: Random positions and angles

The work *Repertoire: 42 positions, angles 1° — 42°* (1975) is a visualisation of the random process of choosing 42 different numbers aleatorically, ie by methods of chance. The basic element of the work is the horizontal straight line of 21cm length where 42 positions are marked off at equal distances. For each line a Position is picked at random and associated with an angle which determines the decline of the line, eg at the position 21 the line declines by an angle of 210. In creating this work 42 cards with numbers 1 to 42 are placed in a box, drawn at random one at a time and then immediately put back. The procedure ends when each of the 42 cards has been drawn at least once. In this work a draw of the same card does not affect the line and is represented by a vertical line. In other works (not shown) the repeated draws have been taken into account by further declining lines [3].

Write a suitable computer program to simulate this procedure, first without, then with taking into account the repeated draws of the same cards. The number of draws determines the format of the procedure. Investigate this number empirically and analytically.

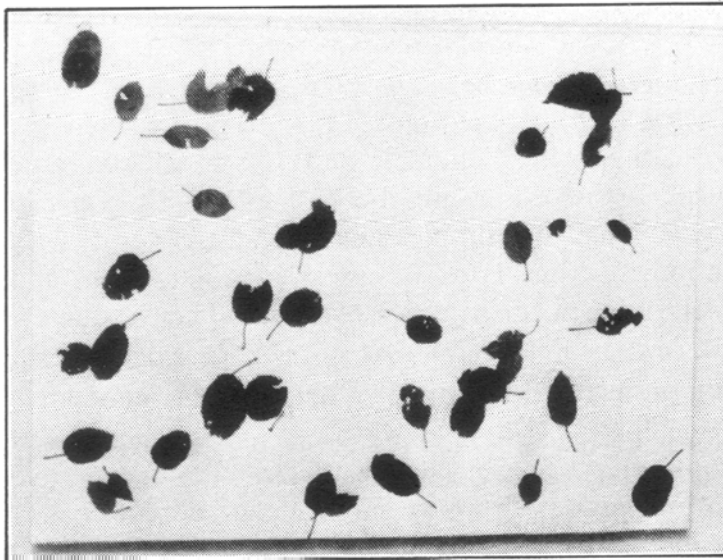


*Repertoire: 42 positions, angles 1°-42° (1975)*

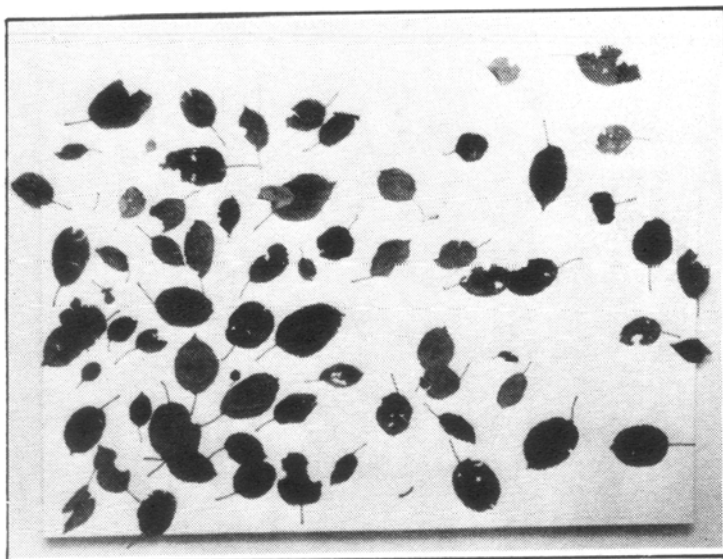
## HERMAN DE VRIES

*Born in Alkmaar, Netherlands, 1931. Lives in Eschenau near Knetzgau, West Gerinany.*

In 1962 I had given my method and my works of programmed chance the name 'random-objectivation'. In the beginning the use of chance was primarily meant as a means to exclude the personal, always partial angle of viewing. By this the work should gain a more general validity and also give the spectator an unrestricted freedom. We may say that a more or less personal concept is objectivated by chance: it gives us an opportunity to choose from an inconceivable, vast series of possibilities from which we cannot say if the one is better than the other (at the most the degree of identification is different for different people and different opportunities). Therefore chance gives us also the opportunity to discover facts, structures and aspects of reality which we would have not thought of otherwise. Later I found that it also makes sense to make chance (and causality) perceivable



*One hour under my apple tree on the 31st October 1975*



*Three hours under my apple tree on the 31st October 1975*

### Activity 5: Chance in nature

Since his early childhood Herman de Vries has felt closely bound to nature. After studying horticulture he worked in biological research departments for several years. His unusual collages *One hour ...* and *Three hours under my apple tree on the 31 October (1975)* give rise to a great deal of speculation and may serve as a basis for making and testing hypotheses:

- How did he collect the leaves?  
What does he mean by "under my tree"?  
What effect did the wind have?

...

- Suppose the leaves for both collages were collected in four successive hours. Can you find an algebraic function which approximates the number of fallen leaves? Are there several solutions to the problem? How does a time gap between the finish of the first and the start of the second collage affect your results? What happens if both collages were started at the same time?

**RYSZARD WINIARSKI** *Born in Lwow, Poland, 1936. Lives in Warsaw.*

When I start to construct a picture or an object, I first determine the rules for composing the picture, the rules of the game, and then I invite chance to take part in the realization of these rules. Like Game 10 x 10 many of Winooski's works show a fascinating interplay and competition between logic and chance where surprising results are generated by the mere choice of a particular method or rules of the game. [5]

#### Activity 6: Permutations and order

His series Game 10 x 10 (1976, acryl on linen, 100 x 100cm each) is based on a 10 by 10 grid where each square has been divided into 100 small quadratic elements which are numbered 1 to 100. In Game 10 x 10 No. 1 the composition is aleatoric. Cards with numbers from 1 to 100 are drawn at random and determine the distribution of the small black squares. In contrast to this Game 10 x 10 No. 16 is determined by a logical structure. What are the generative principles used in both works? Again write a computer program to simulate the generative principle of both works and calculate the number of possible works that could be obtained with the chance method of work No. 1.

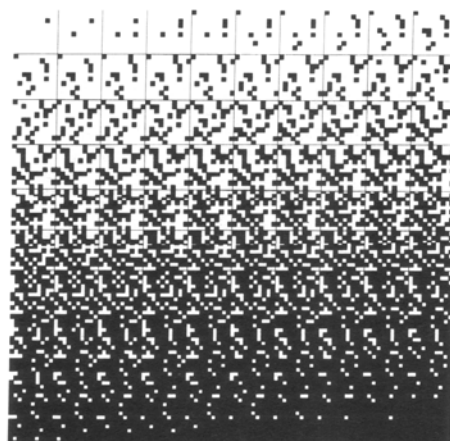
Pädagogische Hochschule Freiburg, West Germany

#### Acknowledgements

I am indebted to H de Vries and N Thomas for their collaboration.

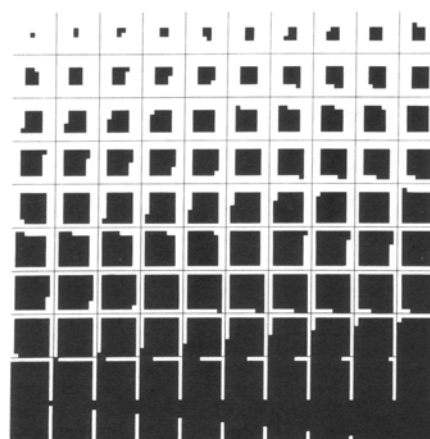
#### References

- 1 François Morellet, Nationalgalerie Berlin, Staatliche Museen, Preußischer Kulturbesitz, 1977
- 2 N Thomas, *Vorgestellt: Norbert Thomas*, circular 20 + 21, 1978
- 3 N Thomas in *rationale konzepte*, galerie pa szepan, Gelsenkirchen, 1975
- 4 H de Vries, *Random objectivations*, Amodulo, Villanuova sul clisi, 1972
- 5 R Winiarski in *System + Zufall*, Galerie Mueller-Rosh, Stuttgart, 1978



RYSZARD WINIARSKI

*Game 10 x 10 No.1*



*Game 10 x 10 no.16*

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