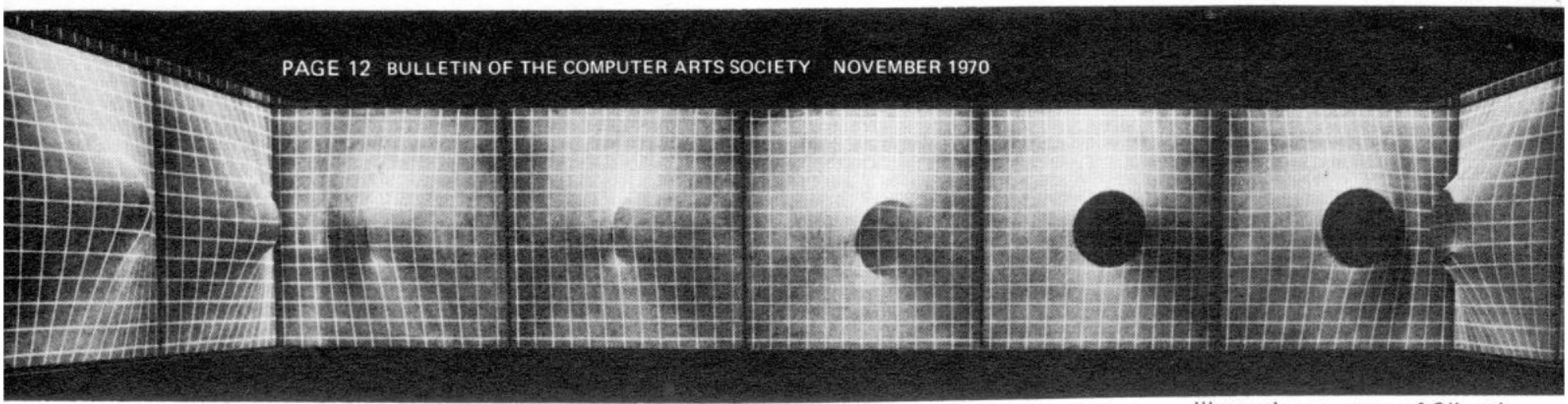


Illustration courtesy of Olivetti

SOVIET UNION

The first concert using electronic music in Moscow took place at the House of the Journalists on 27 May 1970. Works by E Artemiew, S Kreichi, S Gubaidulina', E Denisow and A Schnittke were performed. Melos, No 7/8, p 315, 1970

HOLLAND

The Computer Arts Society's travelling exhibition will form part of a show in Amsterdam from 11 - 31 December 1970. There will also be an evening of computer films. At G.H. Buhrmann's Papiergroothandel N.V., Keizersgracht 28 - 46, Amsterdam, Holland. Telephone: (020) 64422.

UNITED STATES

According to several reports, many of the exhibits in the SOFTWARE show at the Jewish Museum did not work, and the show will not transfer to the Smithsonian Institute as planned. Please check this before making the trip.

COMPUTER ARTS SOCIETY, AIMS AND MEMBERSHIP

The aims of the Society are to encourage the creative use of computers in the arts and allow the exchange of information in this area.
Membership is open to all at £1 or $3 per year; students half price. Members receive PAGE and reduced prices for Computer Arts Society public meetings and events. The Society has the status of a specialist group of the British Computer Society, but membership of the two societies is independent.
Libraries and institutions can subscribe to PAGE for £1 or $3 per year. Extra copies will be sent to the same address at half price. No other membership rights are conferred and there is no form of membership for organisations or groups.
Re membership, subscription, circulation and information; write to Alan Sutcliffe.

COMPUTER ARTS SOCIETY ADDRESSES

Chairman: Alan Sutcliffe, ICL, Brandon House, Broadway, Bracknell, Berkshire.
Secretary: John Lansdown, 50/51 Russell Square, London W.C.1.
Editor of PAGE: Gustav Metzger, BM/Box 151, London W.C.1.
Dutch Branch (CASH): Leo Geurts and Lambert Meertens. Mathematisch Centrum, Tweede Boerhaavestraat 49, Amsterdam, Holland.

MODULES/STRUCTURES/RELATIONSHIPS

Ideograms of Universal Rapport

MANUEL BARBADILLO

My knowledge of physics, chemistry and biology is limited. I am an artist and my education — even my artistic one — has been a bit anarchical. But if I am made up from the same matter as the rest of the world (any living matter, never mind how complex its organization, at a certain level of its structure consists of a few elements — hydrogen, nitrogen, oxygen, etc — which are also in other forms of life, and in the environment) what makes me an independent entity is not basically, a difference of ingredients, but rather the forces that keep those ingredients in certain relationships. In these relationships, it seems, not only the arithmetical proportions among the elements are of importance, but also their arrangement in space.

I believe this brief reference to something that happens with matter (and also in music and literature) to be a good introduction to any explanation of my work since, in my opinion, its main points deal with the manner in which the same basic forms may produce, by integration, new and more complex ones; forms which get transformed when their components' proportions are changed, but also when — even maintaining these proportions — their positions are modified or their postures are altered.

I have described this in detail, as well as the development of my work up to its becoming a modular system, in two articles that were published by the Centro de Calculo de la Universidad de Madrid together with other papers by various authors ("ORDENADORES EN EL ARTE", June 1969). I am writing here mainly about some of my own reflections on modular structure, and about the work carried out in the Centro during 1969 - 1970, and also concerning the new modules I have been experimenting with lately

If in a composition of forms enclosed in squares, on a reticulated plane, one of the forms is rotated, the composition is altered, unless that form is a circle or a regular polygon with four, or a multiple of four sides, whose centre coincides with the centre of the square. Thus, that form, in such a structure, acts as four different ones.

If such a form — represented by a continuous zone of one colour on the background of a different one — is designed in such a way that any part of its contour coincides with the side of the square that contains it, the form integrates with any other of the same characteristics placed in the appropriate location. Hence growing, and transforming itself:

a) In one direction: if its outline fuses with the side of the square only on one of the sides. 6A — 6A
b) In more directions: if that fusion takes place on more than one side. 6B — 6B

If rather than through the whole side of the square the fusion includes only half of it and the same form intervenes in positive and complementary versions (complementary: the one with the opposite colours), the integration may be:

a) Form with form and background with background.
b) Form with background of its complementary.

This enlarges the combinatory possibilities and at the same time the control of the compositions' growth.

Of course, these observations are the consequence of reflections subsequent to my work, rather than the converse, since its development has been determined by solutions to specifically aesthetic problems, having as the only guide sensibility and with reason scarcely playing any role. I mean a conscious role, for the functionality of its transformations do manifest the logic of the process. Even though the aims were at the time unknown. This is why I believe a fertile field of investigation in the relations of art with cybernetics is that of intuitive knowledge and the process of pure creation.

In the Summer of 1968, when I first consciously noticed these things, I was working with the four modules of the schemes reproduced (Figure 1). By a module I understand, as well the form, the portion of organized space it is enclosed in. The structures of these modules, as can be seen, are very similar; in the four of them the straight parts of the contour of the form coincide with the side of the square or with half of it. And the curved parts are either halves or quarters of a circumference whose radius is also equal to half the side of the square (the inner outline of one of the forms — a — where this condition does not seem to apply, is, ideally, a proportioned reduction of the outer one). I have named them alphabetically, following the order of their appearance in my work. Before finding these modules I experimented with a number of others of different shapes — mainly rectangular — but never producing many paintings with any one of them. The first one I worked with for a long period (and still continue using today along with others) was also the first of the series whose features I have just described. The reason is clear to me today; it was their square shape and their structural characteristics, which obviously were aimed at facilitating rotations and associations. I worked with this module exclusively during more than four years, from the beginning of 1964 to the Spring of 1968 when the other three were added. I was fascinated by the mixture of automatism and freedom implied in its design and by its extraordinary combinatory possibilities.

I said at the beginning that a form fitting certain conditions may work as four different ones. But the same one, oriented in the opposite direction (its mirror image), with rotation, works as four more different ones. The module — a —, then, with rotations (a_1, a_2, a_3, a_4,) and reflection ($-a_1$, $-a_2$, $-a_3$, $-a_4$) is equivalent to eight and its complement, black for white (a') to eight more. I refer to these variants of a single form as ELEMENTS. The combinations of this module with itself, with reflection and change of colour, and with rotations (the combinations among its elements) I calculate as follows:

In a four squares graticule	16^4
In a sixteen squares graticule	16^{16}
In a "n" squares graticule	16^n

These combinations, as far as formal variety is concerned, would range from just a simple juxtaposition of identical forms, aligned next to each other, to rather complex associations. The intervention of modules b, c and d, which are also square and have similar structures, and are relatable with a and with themselves, besides considerably enlarging the number of combinations, also augment the variety and the complexity of the designs.

Our studies with computers up to now have been on combinations of only the first of the mentioned modules. Continuing the work done during 1968 - 1969, which dealt with an earlier phase of my painting, this year we have been working with combinations of the elements of module a in compositions of 16 elements — upon a period of my artistic work ranging from 1965 to 1968. During that period I usually made the painting by grouping 4 elements in the first quadrant of the canvas (the top left one) and then filling the other three with just repetition, rotation, or reflection of that combination, or change of its elements to the opposite colour: thus using this group of elements as a new module. I call this grouping a molecule (or an association, a phrase, a stanza . . . borrowing the names from different fields).

We have been studying "sympathetic" relationships among the elements. "Sympathy" was felt to exist between opposites. As opposites, were considered: postural opposites (in respect to the vertical azis: a_1, a_3; to the horizontal one; a_2, a_4), colour opposites (a, a'), directional opposites or mirror images (a, -a).

Although it was changed a little, and was undertaken by series, the program was elaborated on the following instructions:

a) Once an element is placed in the first square of the first quadrant, fix it and fill the next square (the one to its right) with:

1 A repetition of it in the same colour
2 A repetition of it in the opposite colour
3 Its postural opposite in the same colour
4 Its postural opposite in the opposite colour
5 Its mirror image in the same colour
6 Its mirror image in the opposite colour

b) Every time the second square is filled, take the combination of elements in the first and second square as a unit and fill the two squares underneath with:

1 A postural inversion of it with its elements in the same colour
2 A postural inversion of it with its elements in the opposite colour
3 Its mirror image with its elements in the same colour
4 Its mirror image with its elements in the opposite colour

c) Every time the first quadrant is completed, take it as a unit and fill the next quadrant with:

1 A repetition of it with its element in the same colours as their counter-parts in the 1st quadrant
2 A repetition of it with its elements in the opposite colours to their counter-parts in the 1st quadrant
3 A postural inversion of it with its elements in the same colours as their counter-parts in the 1st quadrant
4 A postural inversion of it with its elements in the opposite colours to their counter-parts in the 1st quadrant
5 Its mirror image with its elements in the same colours
6 Its mirror image with its elements in the opposite colours

d) Every time the second quadrant is completed, take the first and second quadrants as a unit and fill the bottom quadrants with a combination which is:

1 A postural inversion of it with its elements in the same colours
2 A postural inversion of it with its elements in the opposite colours
3 A mirror image of it with its elements in the same colours
4 A mirror image of it with its elements in the opposite colours

The programmer was Lorenzo Carbonell Soto.

Besides the four modules I have called a, b, c and d, I am presently experimenting with an undetermined number of new ones whose designs also respond to the same structural principles thus carrying an automatism to associate with them too — as can be seen in the drawings of some of them accompanying this article (Figure 2). I have not chosen these for reproduction for any special reason, neither have I as yet given them any letter because I want to emphasize their experimental nature — even though this is perhaps unnecessary in the case of artistic work. The reason for this is the strange situation I find myself in now. Previously, the evolution of my work was the effect of causes of which I was not conscious (or not fully conscious) and althought at times I have gone through periods of great doubts, specially when there were changes provoking plastic configurations with which I was not fully familiar, I had learnt from experience to trust this "method". But now, that I have understood the structure of the modules and their function, I cannot avoid some caution about these new modules that so easily come to my hands. Perhaps because of the austerity of years of work with one alone. Also, since, the only measure I have of their validity in my work are the plastic results — their capability to bring forth an emotional response on my part, and the persistence of this quality — I have not yet enough perspective to evaluate them.

Bloques San Miguel, 1(3B), Torremolinos (Malaga) Spain
September 1970

AN APPLICATION OF GRAPH THEORY TO MODULAR PAINTING

M. THOMPSON September 1970

This is a brief progress report on work being carried out by the writer to develop a mathematical description of the modules of Manuel Barbadillo. This artist has emphasised the importance of Movement to counteract the sterility arising from the strict use of a module (note 1). The methods described here have a parallel emphasis on Movement (note 2). The writer has interpreted two of Barbadillo's modules (Figures 1 and 2) and has subjectively constructed 'directed graphs' (note 3) to describe some of their visual attributes. The arcs in the graphs have been assigned values; strong = 4, medium = 1, weak = ¼, which although arbitrary are nevertheless practical (note 4).

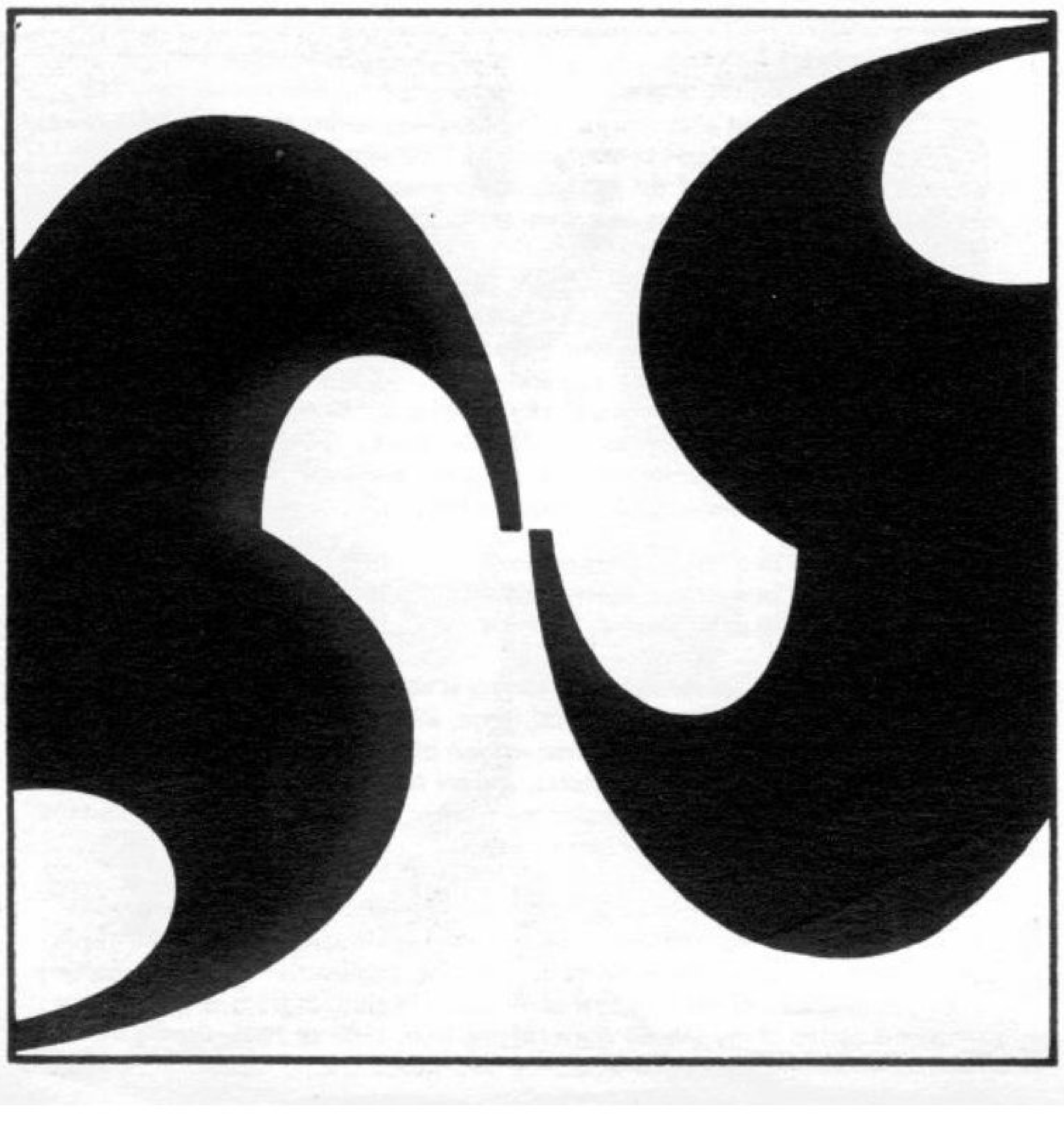
Two designs were chosen and first constructed with module A (Figures 3 & 5), and then with module B (Figures 4 & 6). Graphs were constructed for all four pictures (note 5), with the intention of making a quantitative comparison. The total value of the arcs in each of these four graphs was not found to be a useful quantity. A measure found to be valuable was an 'accumulating product measure' calculated for each point individually, with the score for the picture taken as 1A = 1163, 1B = 724, 2A = 1182, 2B = 1670. Both pictures using module A have almost identical scores, but module B seems particularly suited to the second design. Clearly, the properties represented in the graph of B integrate well in 2B, but poorly in 1B. (This does not necessarily indicate low aesthetic worth in the case of 1B). This method might form the basis of a quantitative way of describing the subjective views of artists.

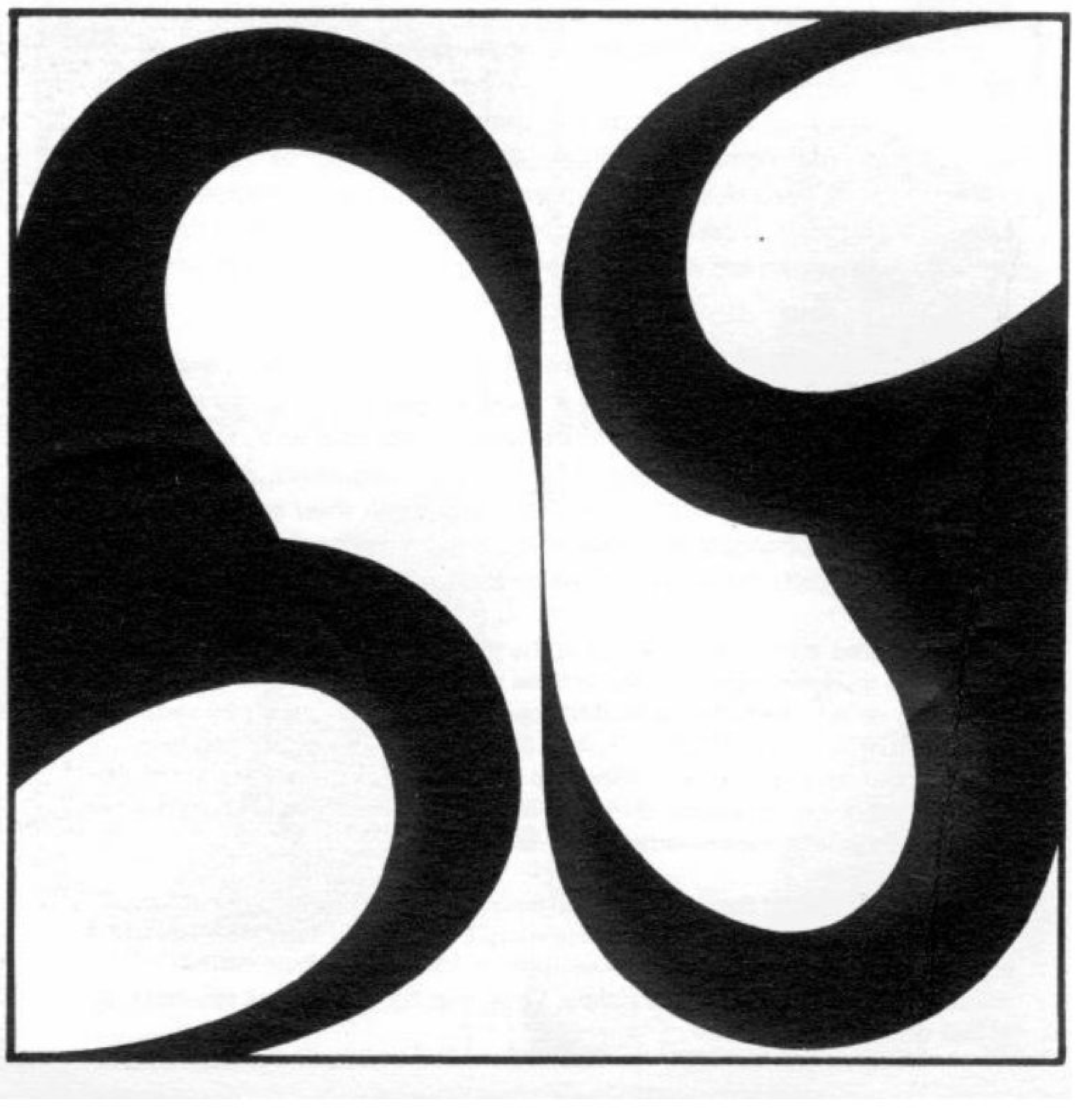
Another similar measure, the <u>latent root</u> (also called 'eigenvalue') has been studied because of its mathematical importance (note 7). Approximate latent roots have been computed for the graphs of pictures 1A and 1B, and also for their transposed graphs. A graph is transposed by reversing the direction of all its arrows (note 1). The latent root of the original graphs (on the left hand of each picture in Figures 7 & 8) are highest for sources of Movement, but these points are not visually interesting. On the right hand side of each picture, however, high values for latent roots of the transposed graphs, do, in the view of the writer, coincide with points of visual interest.

The calculation of the values in Figures 7 and 8 was terminated after an arbitrary number of 3 cycles, which obscures a fascinating extra dimension. As computing progresses, each point influences other points further and further away from itself. In Figure 9, this progress is shown for the picture 2A. All the latent roots start off equal to 1/24 = 0.0416, as there are 24 points in the picture, and after twenty cycles are at the values plotted on the extreme right (note 8).

1 M. BARBADILLO, 'Matiere et Vie,' and 'L'Ordinateur' articles in 'L'Ordinateur et la Creativite' published by Centro de Calculo de la Universidad de Madrid 1970 (in French).

2 A. HILL suggests that intentions be 'ideas made concrete through the work' in DATA (Faber 1968) p251. M. THOMPSON argues for computer programs describing and leading to definition of intentions, in a paper presented at Computer Graphics 70 (Brunel University : to be published).





3 A directed graph is a collection of points some of which are joined by arrows ('arcs'). The arcs may be assigned a value, as a part of the logical connection between points, but in Figures 1 & 2, the lengths of the arcs, the angles between them, and their curves have no mathematical significance.

Mathematically, the 'matrix associated with a graph' of k points is a square of (k x k) numbers denoted by $\underline{A}$, such that the element a_{ij} in the ith row and the jth column has the arc value of the arc going from point i to point j. If this is zero, no such arc exists. The transpose of a graph is obtained by reversing the direction of all its arrows, and of the matrix by replacing a_{ij} by a_{ji} for all i & j.

4 Subjectively, module A in Figure 1 has a pronounced source of Movement in the lower left hand corner. Module B in Figure 2 is more balanced with a point in the middle as a source of gentle outward Movement. The arc values in modules A & B totalled 26 and 20¼ respectively. No attempt was made to develop a way of standardizing these values.

5 In combining four graphs to represent a picture, any arcs entering or leaving the picture were removed, and arcs crossing black-white boundaries between elements were set at half their original value. Note that the graphs for all the elements obtained by rotation, reflection, and black-white reversal are identical, so that characterisation of a picture depends on the fitting together of the elements.

6 For a path of arcs of value a, b, c, d, e. . . . leading from a point, then the accumulating product for that point is a + ab + abc + abcd + abcde + ... This could be continued to the end of the path, but in practice the graphs usually contain circuits, (that is, a path revisits a point). One can go around a circuit indefinitely, but when computing it is practical to stop after all paths up to a certain number of arcs length have been included.

If the matrix associated with the graph (note 1) is $\underline{A}$, then compute '$\underline{A}$ raised to the power λ' for $\lambda = 1,2. . . n$ where n is the maximum number of arcs distance we wish to travel from a point. The accumulating product measure for the ith point is

$$p_i = \sum_{\lambda} \sum_{j} \{a_{ij}\}^{(\lambda)}$$

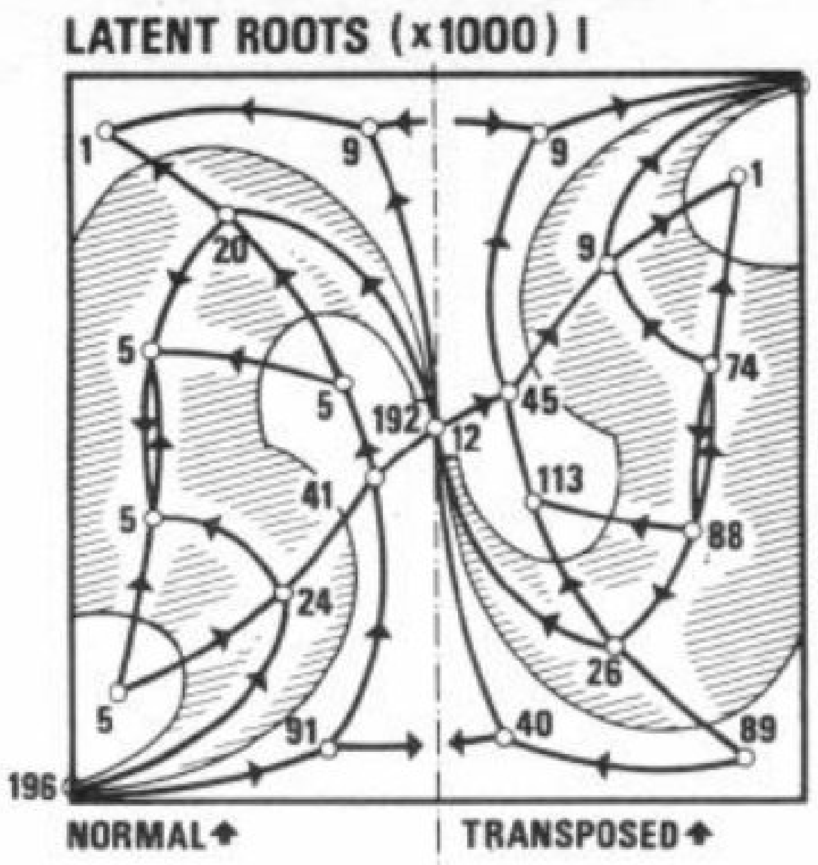
where $\{a_{ij}\}^{(\lambda)}$ is an element of $\underline{A}^{\lambda}$, $\lambda = 1,2. . . n$, and $j = 1,2, ... k$.

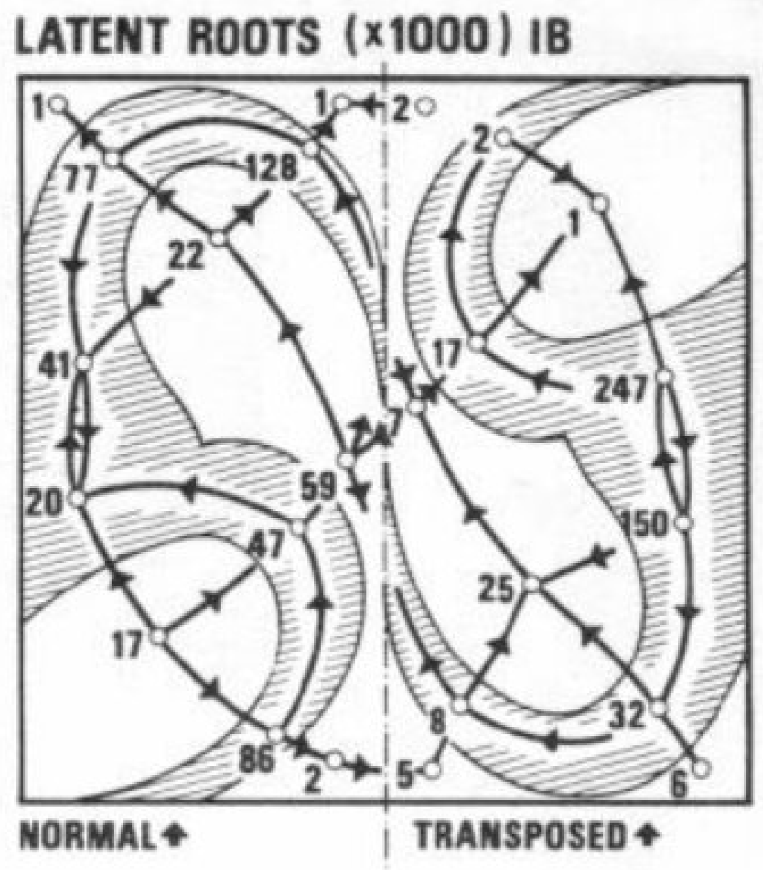
7 Latent roots are ratios indicating the relative 'importance' of the rows of a matrix. In our case the ith row contains the values of the arcs originating from the ith point on the graph, so that the ith latent root is a measure of the importance of the ith point. However the exact meaning of 'importance' is still obscure.

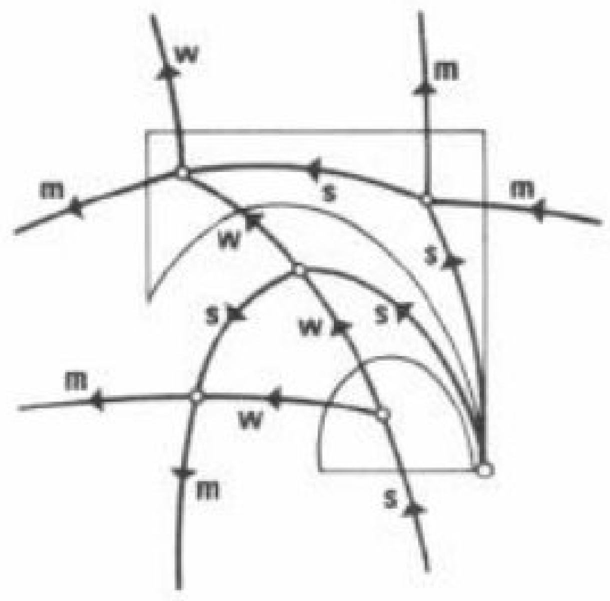
The computation is one of successively better approximation to the latent roots, which are never actually reached. In this paper, the values of the approximations at any stage in the computation have been referred to as the latent roots. Start with all the roots equal and then proceed as follows: to get the next approximation to the ith root, add to it for each arc leaving the ith point, the product of (arc value) x (previous approximation to latent root for the point at the other end of the arc). After each cycle, scale the roots by dividing by their total, so that they will all add up to one.

Compute as follows: (1) set all the elements of a vector $b^{(o)}$ of length k, equal to 1. The (o) indicates the zero th cycle of computation. (2) Reset $b^{(m)} = A\, b^{(m-1)}$ where A is defined in note 3. (3) Divide each element of $b^{(m)}$ by $\sum b_i^{(m)}$ where i = 1, . . . k. (4) Repeat (2) and (3) until the b tend to fixed values.

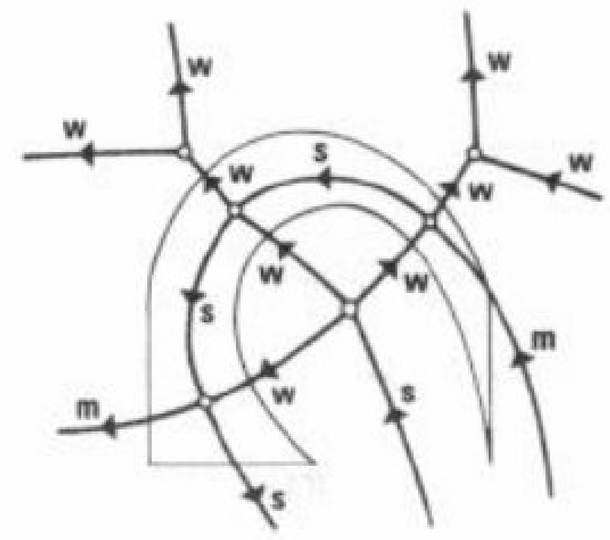
8 The latent root approximations for a low number of cycles might be regarded as a 'superficial' description of the picture, whereas those coming later would be more 'penetrating'. Clearly all this is speculative, but cognition is not an instantaneous process, and a quantitative system should involve time, implicitly or explicitly.



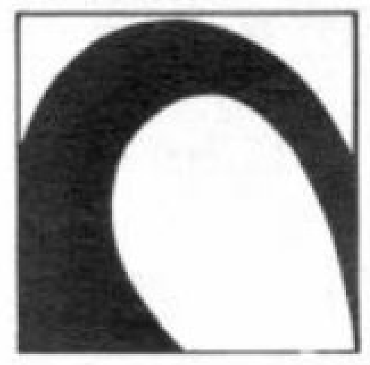




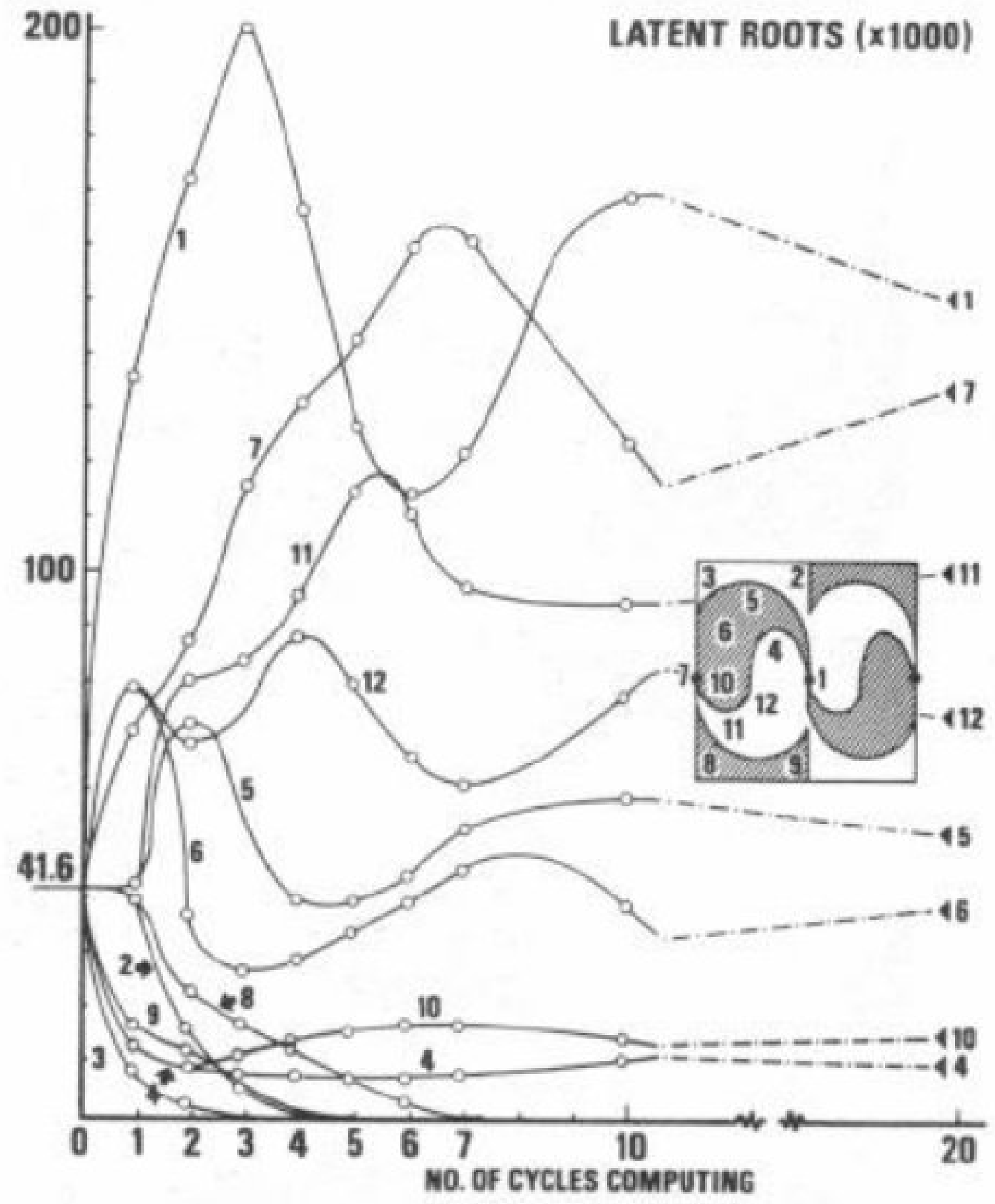
MODULE A

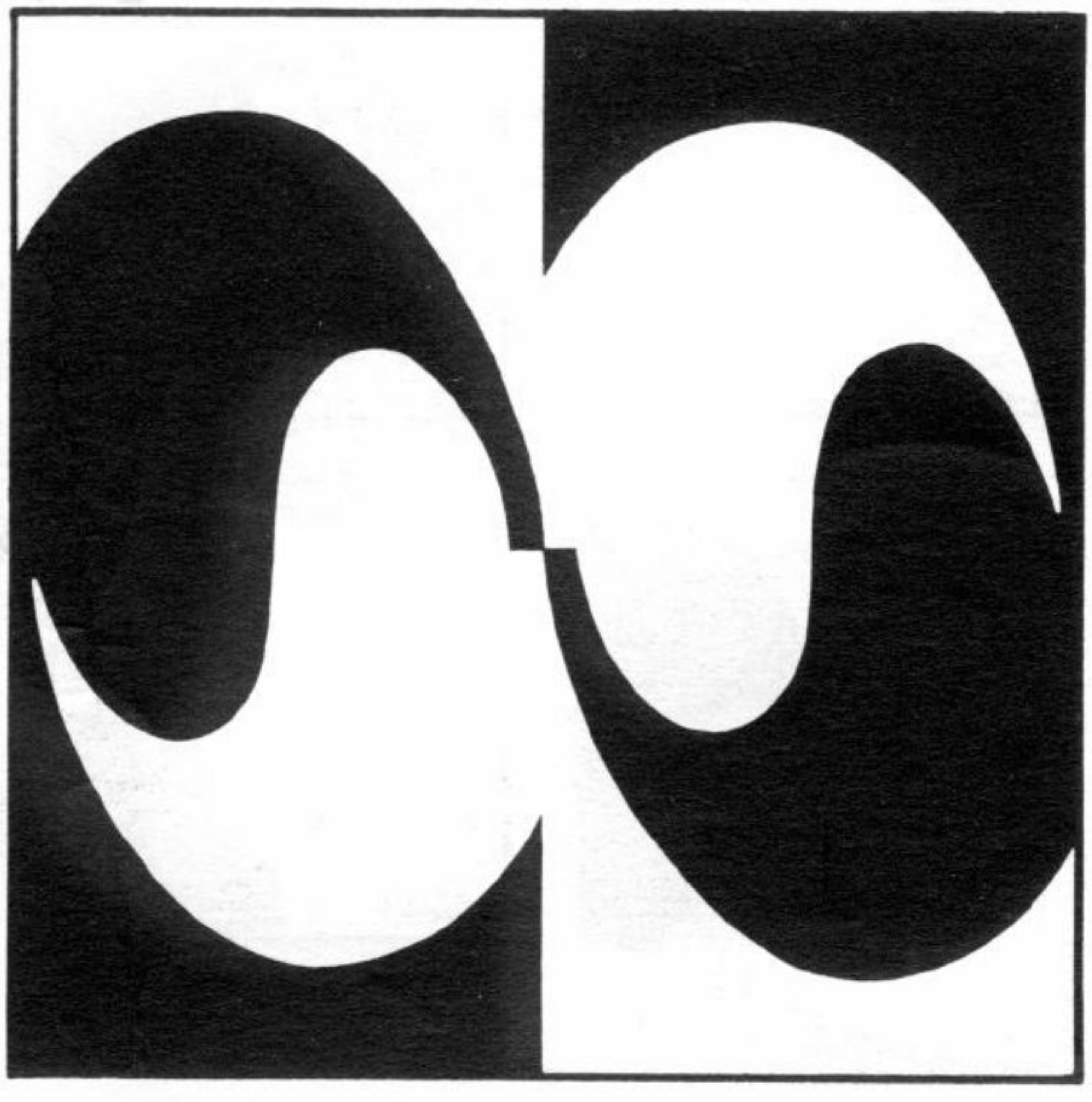


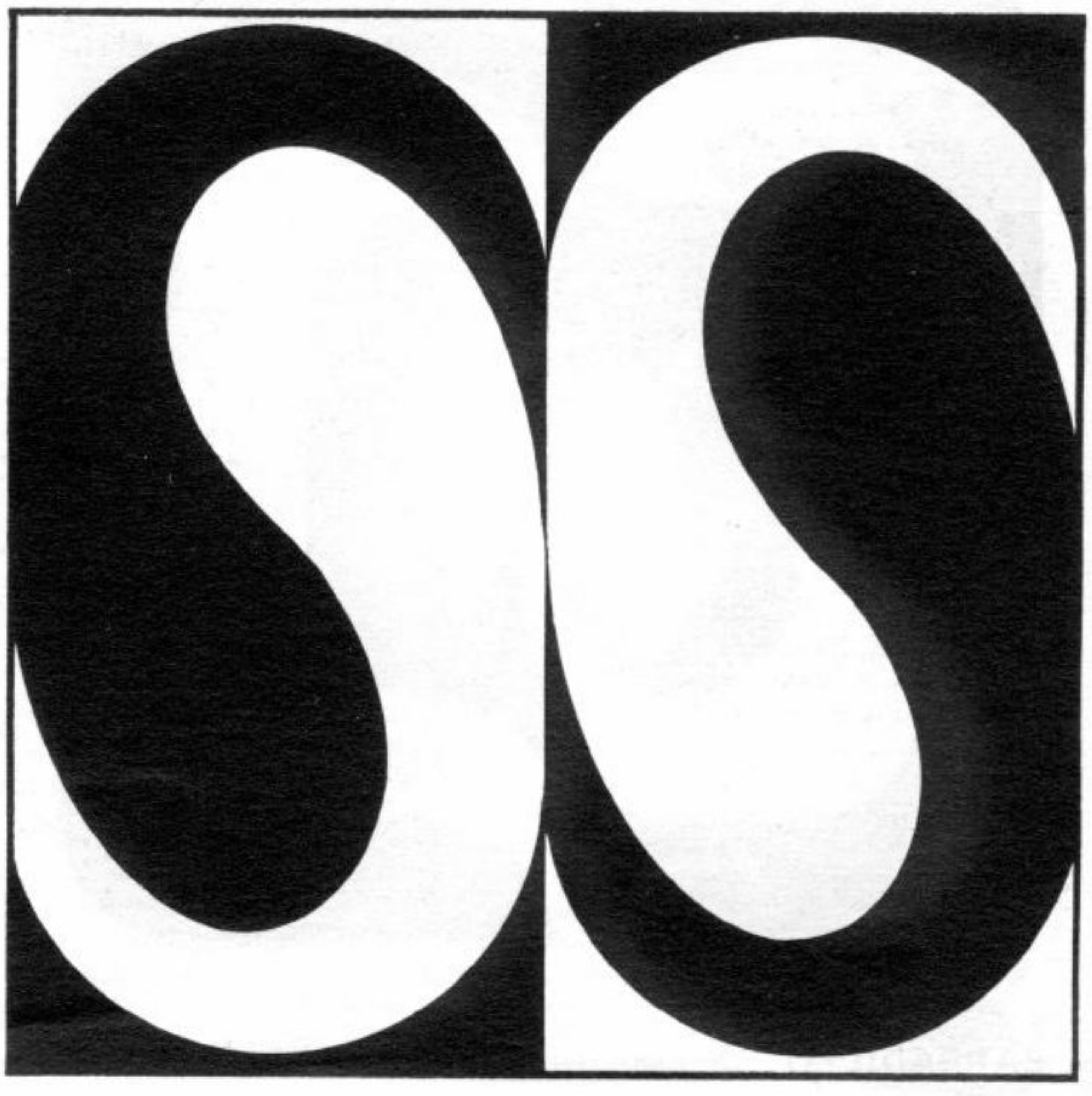
MODULE B

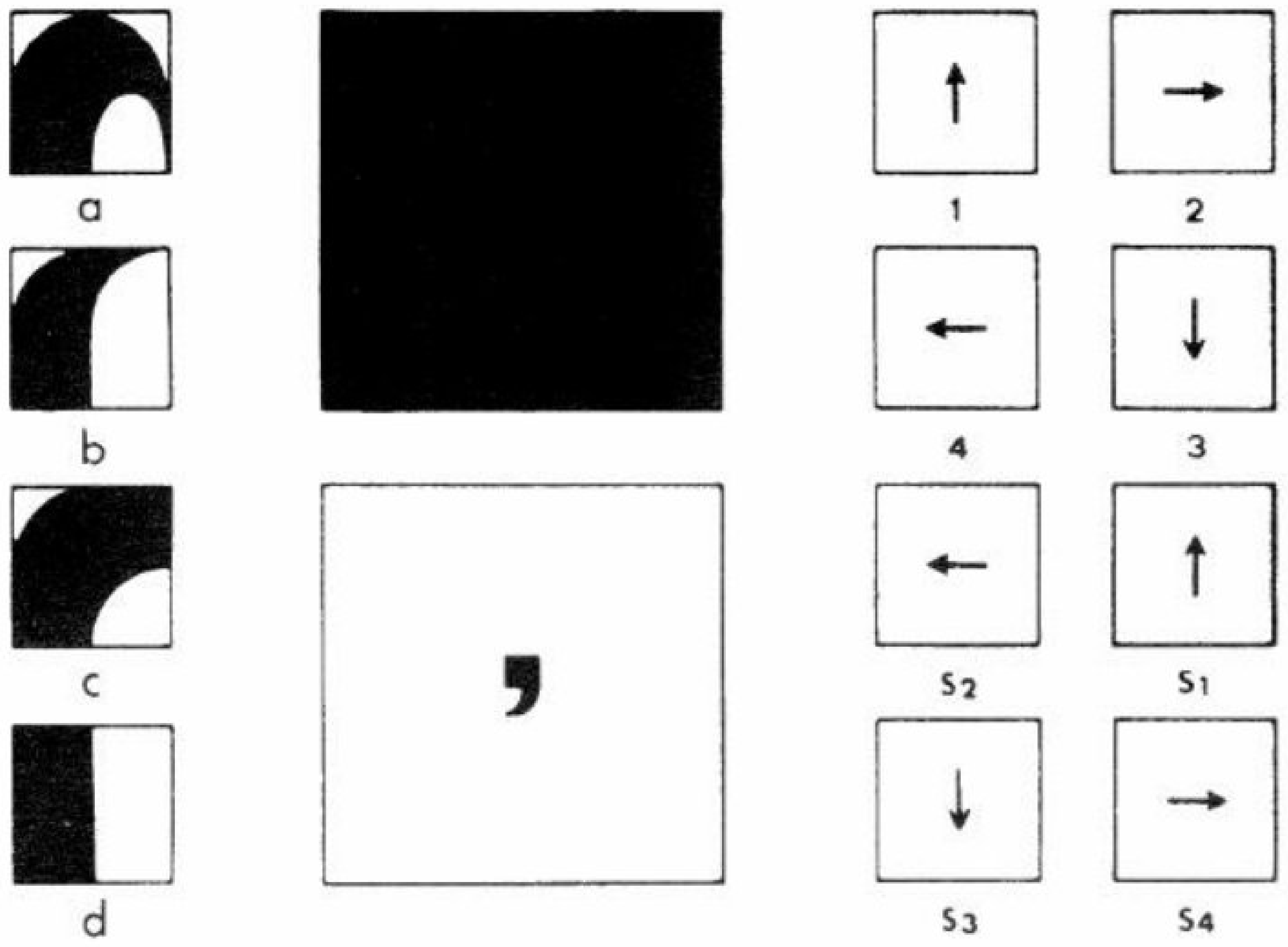


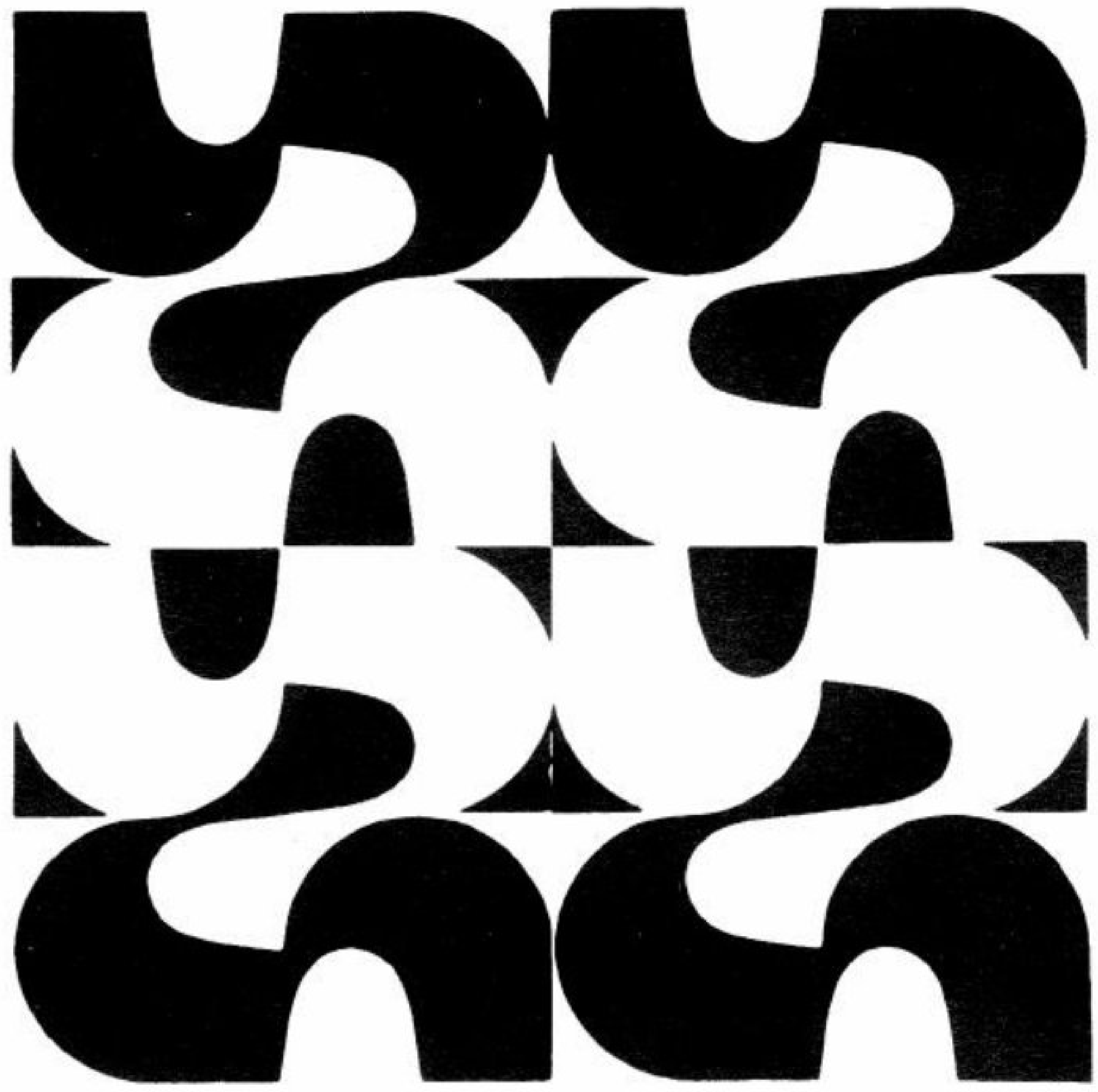
		7	8
		1	
		2	
			9
3	4	5	6

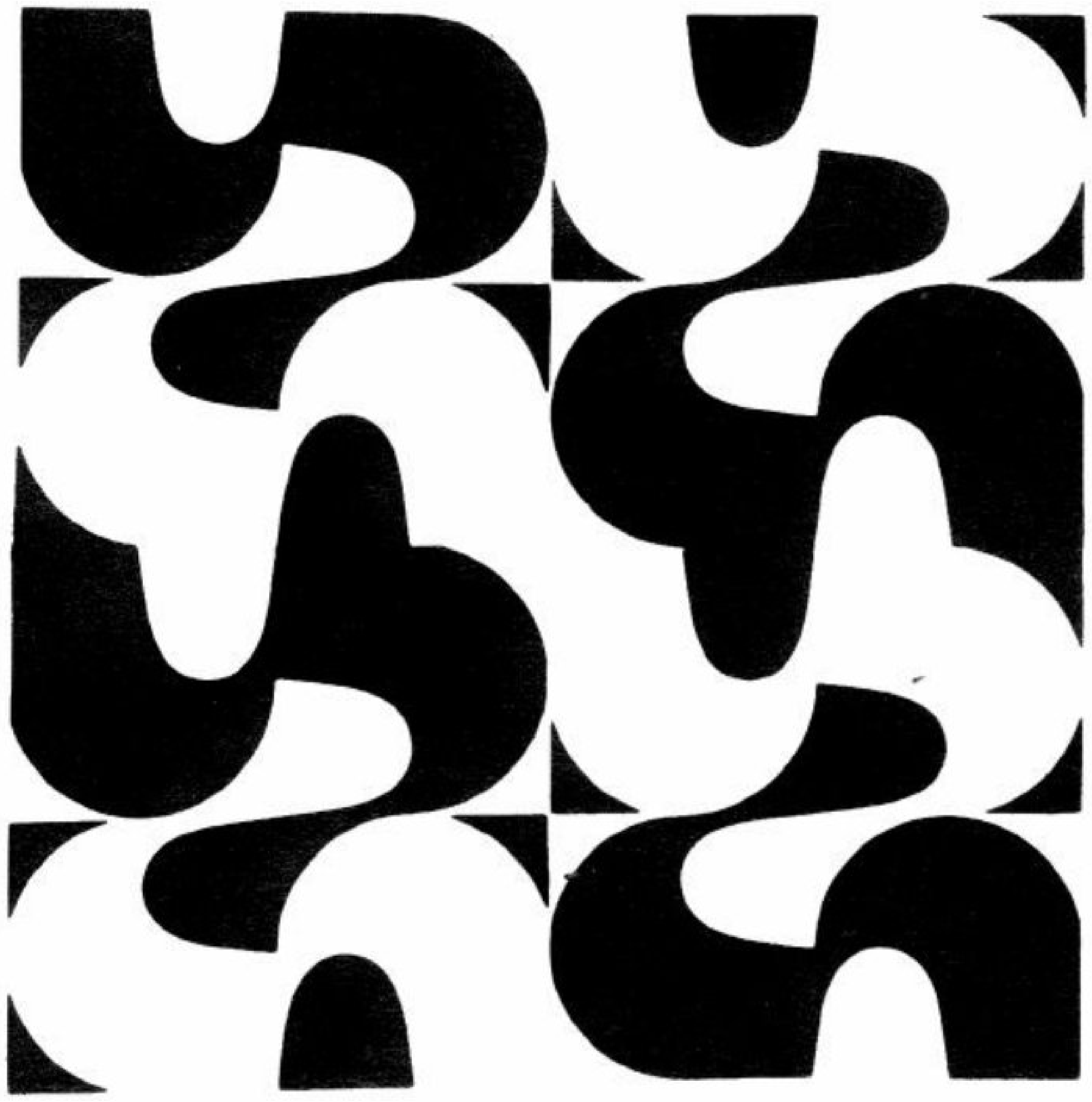


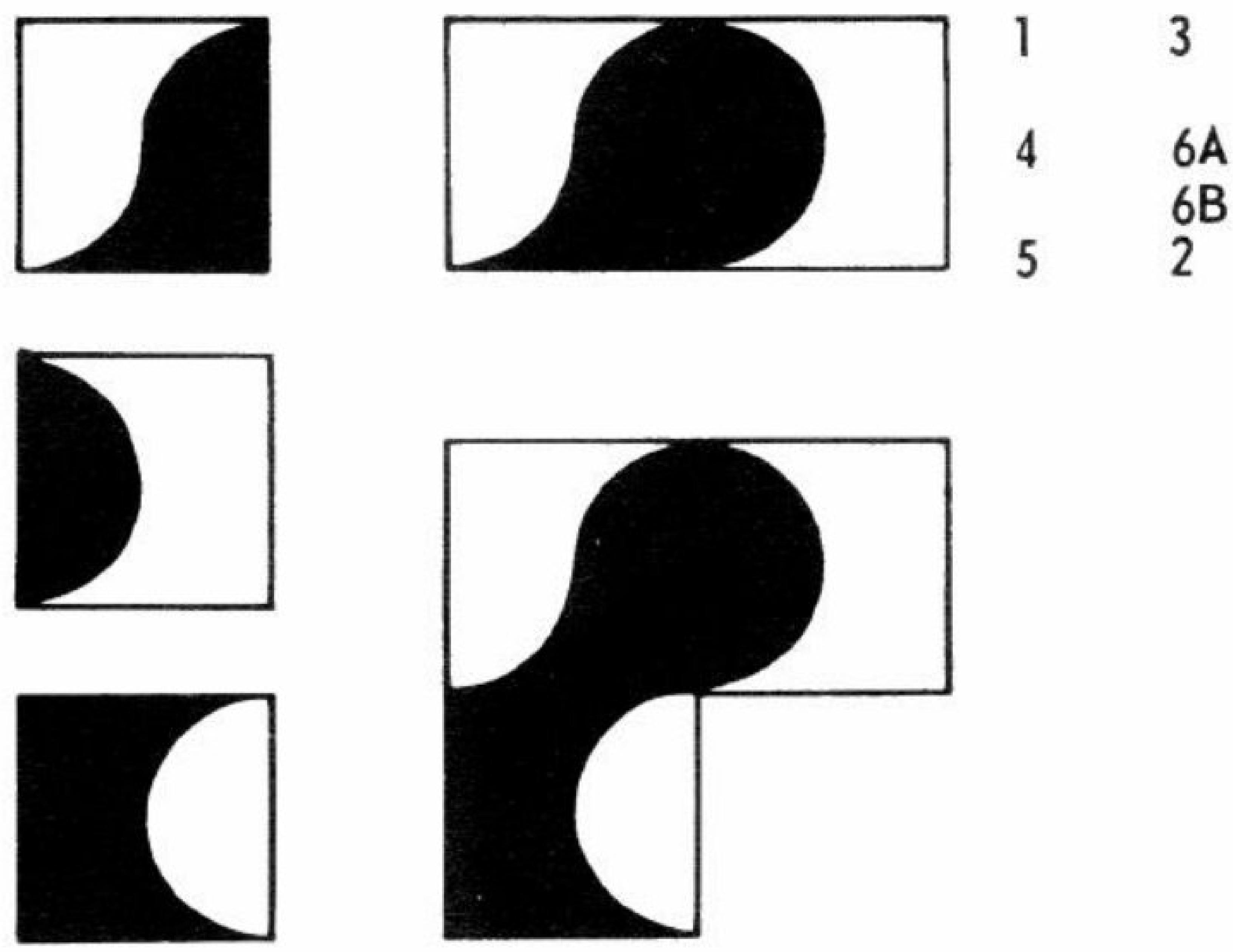


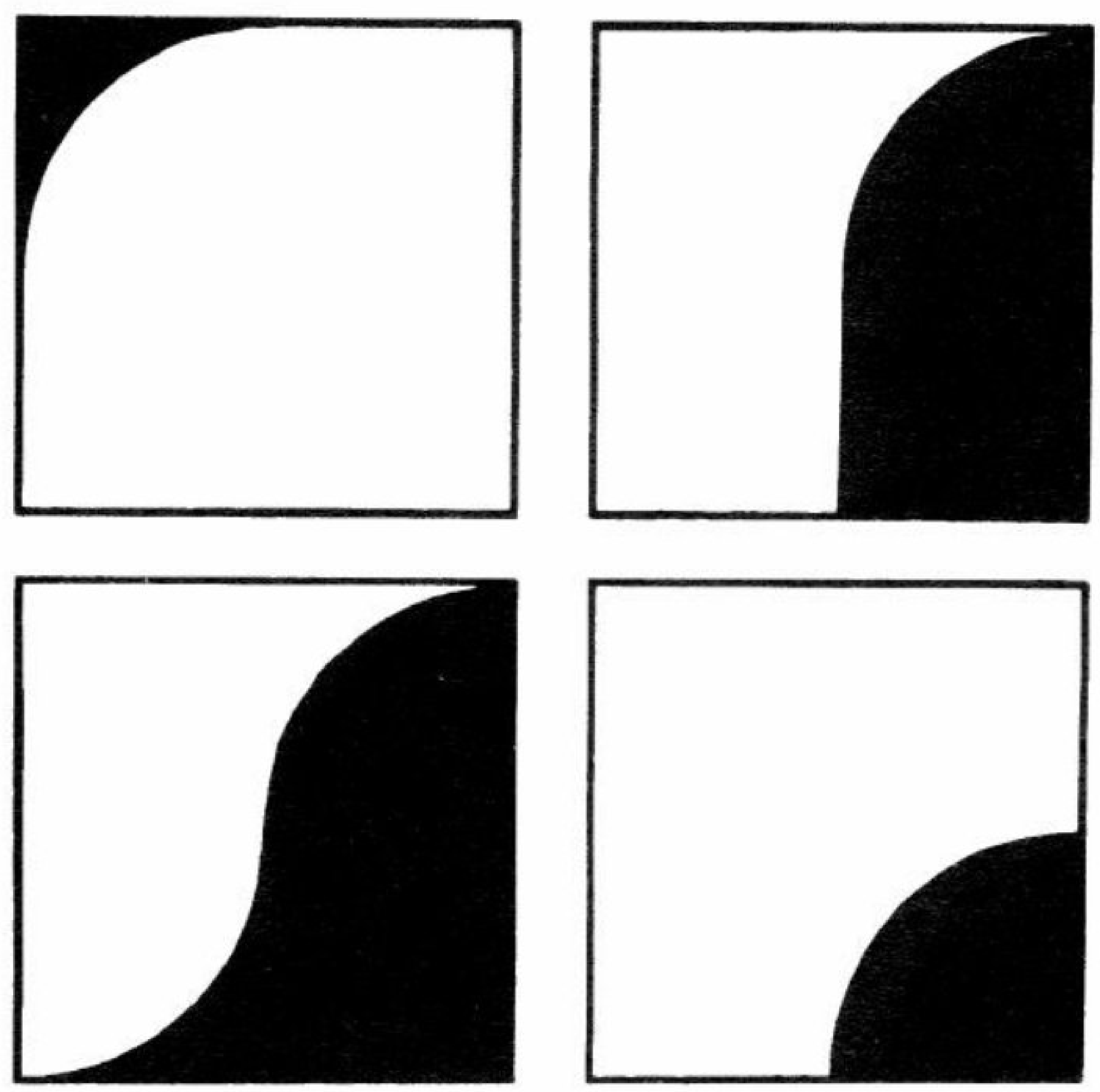












BARBADILLO