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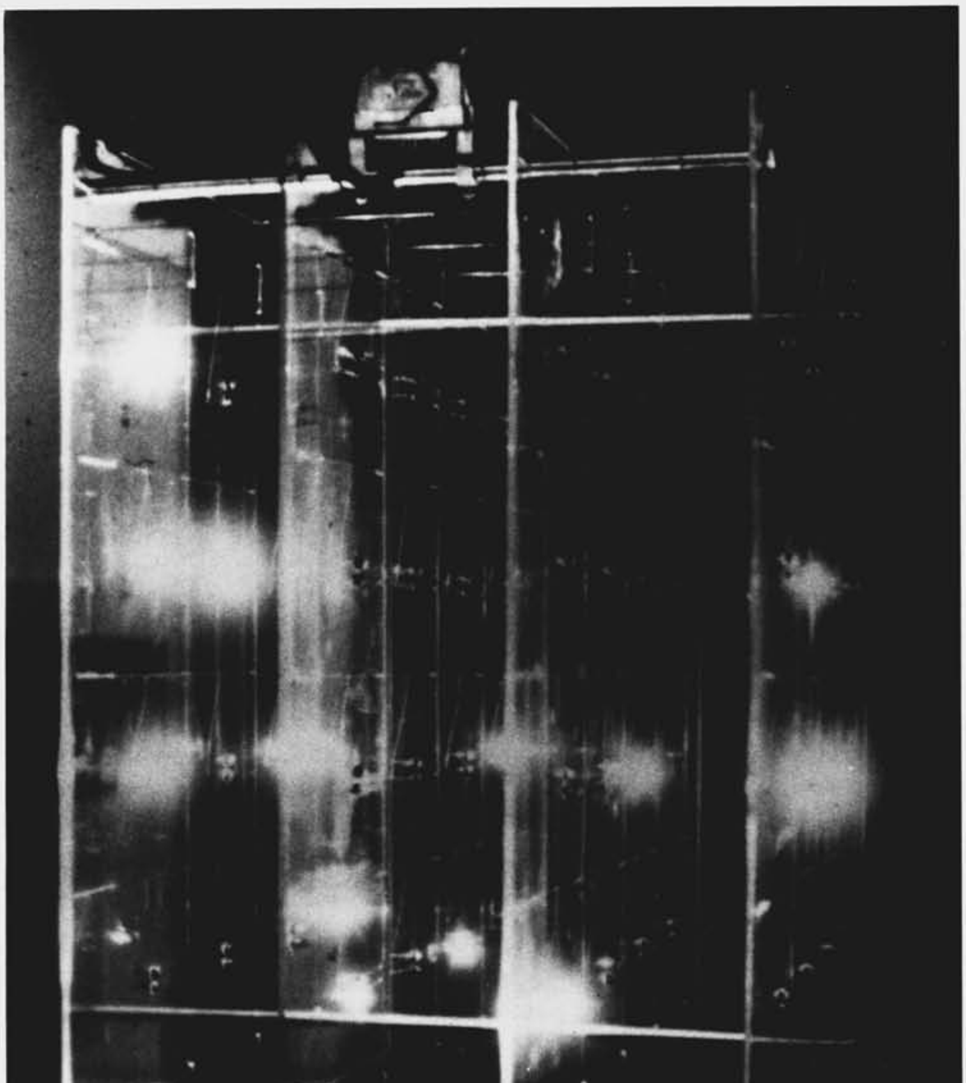
COMPUTER ARTS SOCIETY QUARTERLY AUTUMN 1981



NIGEL JOHNSON: RECENT WORKS

PAGE

Number 49 **Editor: Dominic Boreham**

COMPUTER ARTS SOCIETY QUARTERLY

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EDITORIAL

I must apologise to subscribers for the late appearance of this issue of PAGE. Professional commitments unfortunately impinge on the 'spare–time' activity of editing and publishing PAGE. Inevitably, the next issue, No. 50, is now unlikely to appear before February 1982, but this should not distract us from marvelling at the wonderousness of it appearing at all. PAGE 50 will feature the recent International Festival of Electronic Music, Video and Computer Art, held in Brussels. It is hoped that the following PAGE No. 51 will be a special Canadian issue featuring the artists and composers represented in the forthcoming exhibition of Canadian computer-assisted art at Canada House, London. This exhibition is being arranged by Brian Reffin Smith (RCA) for the Canadian High Commission, and is expected to open in March 1982.

News of the missing PAGE 46 has been received from CASUS. Kurt Lauckner assures us that PAGE 46 is now being typeset and layed out. Like us, Kurt has been constrained by shortage of time and money, worsened by the attempt to publish a larger than usual issue. He has two long articles, one by Harold Cohen and one by Frank Smullin, totalling about 30 pages. Hopefully, subscribers will receive this CASUS issue early in 1982.

Cover: Nigel Johnson: Programmed Perspex Cube, 1981

1. Nigel Johnson: First interactive sculpture, 1978

RECENT WORKS
by Nigel Johnson*

Introduction

This article describes the development of my electronic and computer-assisted artworks during the past four years. I shall describe briefly the development of my earlier works and then in some detail my current work and ideas.

My first involvement with micro-electronics as a medium occurred whilst following an art school degree course in sculpture. I was searching for a suitable means of communicating and expressing my ideas, in particular a number of concerns central to direct communication and interaction between art object and viewer. I was looking for a method of transforming something that was ostensibly inanimate and static, into an interactive, responsive system involving the viewer directly. I wanted to make the viewer a participant, partly responsible for the reactions of the artwork.

Response

The first piece of "electronic" art resulted from my feelings at that time, about figurative work, in that the direction of response between object and viewer was very much a one way occurence. Even though the viewer could move around a three-dimensional object, the relationship between the viewer and the object was not affected by changes in the behaviour of the object.

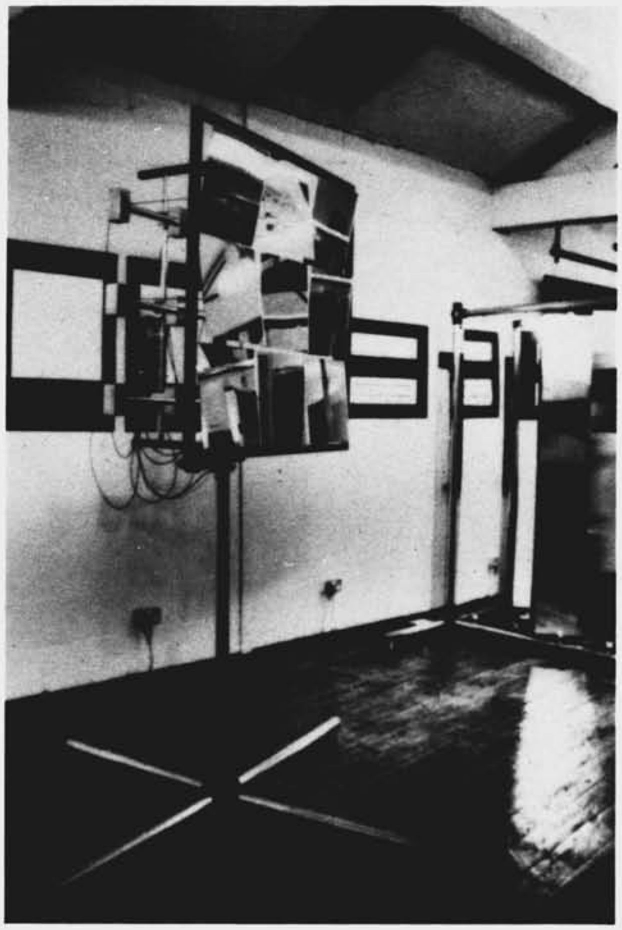
My first piece of electronic/responsive sculpture (illustration 1) was loosely based on the human figure, although constructed intuitively in the way that the constituent components were arranged.

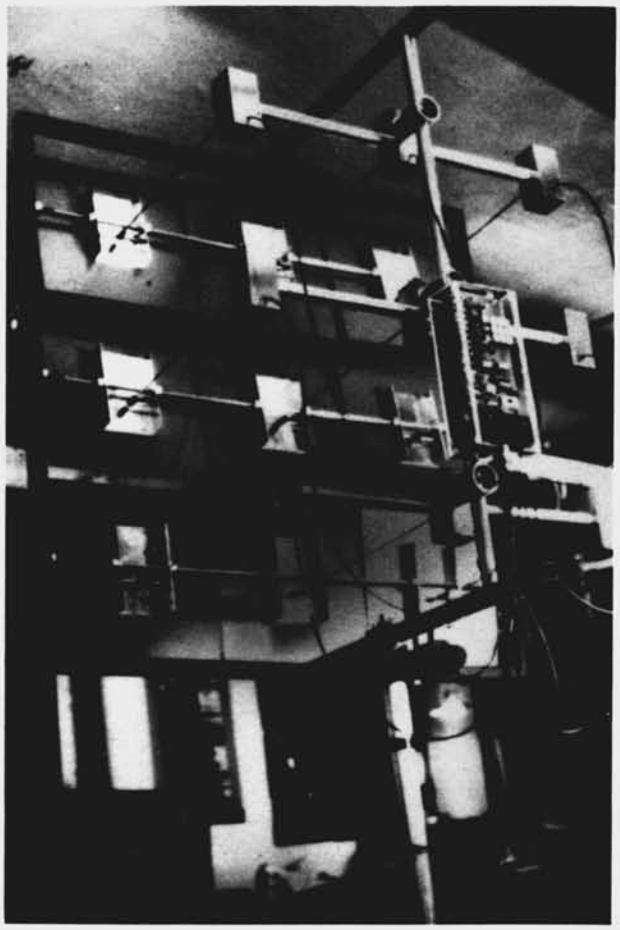
Sensing

The object itself was approximately 6 feet high, standing on a tripod base and capable of rotating through 180 degrees by means of an electric motor. The head section consisted of a parabolic reflector and light-level detection devices, driven by two servo-motors. This gave the object the same degrees of freedom of movement as the head and body of a human figure standing in one position. The piece responded to changes in light levels that occurred when spectators approached and walked around the object. This change in light intensity was converted into sound output, covering a range of frequencies, directly related to these changes. This in turn caused the object to alter its position relative to the viewer and so in turn instigate another type of response in terms of the sound being generated.

I continued with this idea of direct interaction by exploring other forms of transformation of energy, i.e. from light to sound, sound and light into movement and various other combinations of these using a variety of sensing devices. However, it soon became apparent that the responses to given stimuli were always the same, and that a more sophisticated method of dealing with complex situations would be necessary.

* Nigel Johnson – artist living at 7 Coborn Road, London E3 2DA, England





2. Nigel Johnson: Programmed Mirror Sculpture, 1978-79, and rear view showing control gear

Response Reversal

The next major piece of work was in fact a reversal of the viewer-object relationship and my first piece incorporating memory devices to operate the structure. This work was really an attempt to manipulate a reflected image rather than the object's behaviour being conditioned by the spectator's actions. The pre-programmed circuitry was used to control complex sequences of manoeuvres that the structure had to perform.

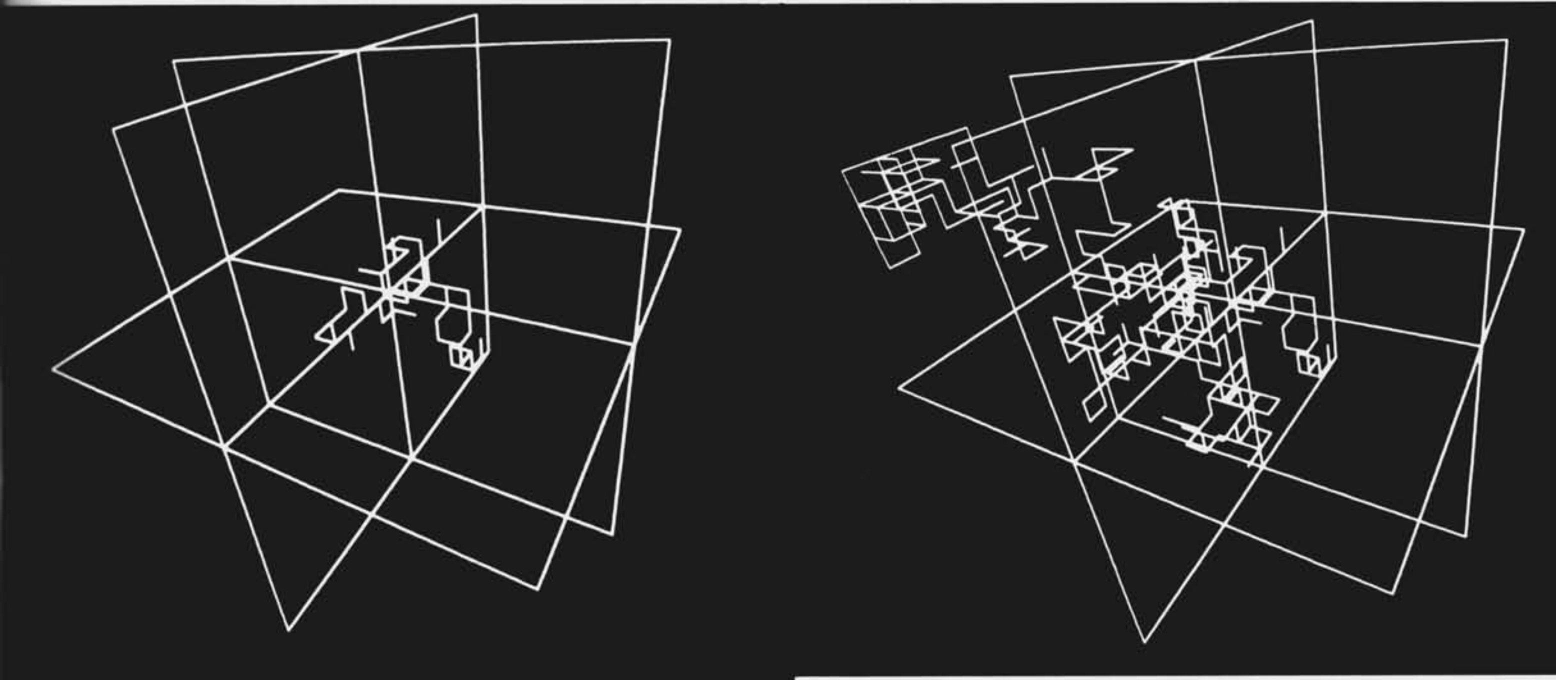
In this case the "image" area was a vertical plane split into nine sections in a 3×3 format (illustration 2) Each section comprised a 1 foot square perspex mirror, independently controlled by a servo-motor. Each mirror was capable of moving by 10 degrees about a horizontal axis. Even though this was quite a small angle, the reflection in relation to the observer was equivalent to looking from floor to ceiling as the mirror moved from one extreme to the other. The operation took 10 seconds to perform and so produced an almost imperceptable and subtle change in the reflected image.

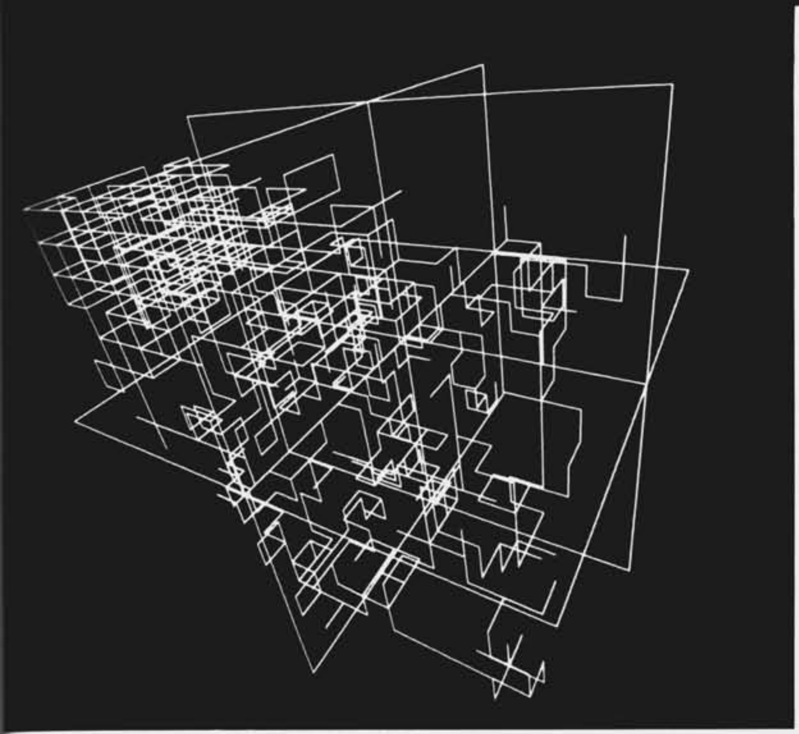
Programming

The mirrors were programmed so that they performed all the possible permutations that the nine mirrors could run through. Further, these combinations were split into groups of nine movements and after each movement the complete top section of the structure rotated by 10 degrees. A further sequence of nine movements would occur and the top section would again revolve by 10 degrees and so on until the structure had completed one revolution at 10 degree intervals.

Once the structure had completed a cycle in one direction it reversed and continued in the opposite direction. With this type of movement, the reflected images over a period of time were in fact panoramic, but as one revolution of the mirror plane took nearly one hour to complete, the effect was only apparent on a speeded up film of the sculpture. One of the interesting results of this piece of work was that when it was exhibited inside, the effect was quite disorientating, probably because of the difficulty in establishing a fixed point of reference whilst looking directly at the mirrors. And yet this effect was not so apparent when shown in a large open space.

Shortly after producing this work, my attention turned to situations in which it would be possible to





3. Nigel Johnson: Sequence from the program *Walk II*, 1979

exercise a greater control over the interactive elements of the work, and also to extend the methods of interaction. It was at this time that I had access to a mini-computer and it was possible to investigate further these ideas.

I wrote a number of programs that traced the movement of a hypothetical living cell in an ideal situation within a changing environment. The programs were written in Fortran IV on a Data General mini-computer at the Slade School of Fine Art, London. The programs utilised a graphics package similar to Gino-F and the images were generated on a Tektronix Display Unit.

The programs themselves were similar in concept to John Conway's (1970) *Life Game*, but did not adhere to the same rigid mathematical rules. In fact I was initially concerned with the path described by a single element and it was not until later that I developed programs involving groups of elements or cells.

Walk I, II, III.

The programs *Walk I* – *Walk III* were all similar in concept but each one differed with regard to the interactive "coefficients" assigned to each environment. The version described here refers to the program *Walk II.*

The program initially describes a cubic environment within which the cell or line is allowed to move (Illustration 3). In *Walk II* the volume in 50×50×50 units, described about an origin along the X, Y and Z axis. The environment could be viewed from any angle at a given viewpoint but in the present illustrations it was rotated 20 degrees about the X and Y axis for reasons of clarity. The cube was divided equally into eight sectors and it was within these areas that the interaction coefficient changed from sector to sector. The only restriction placed on the line was that it was not allowed to retrace its immediately preceding direction of movement. It was however, capable of "scanning" its immediate vicinity by three units in any direction. Areas that were deemed to be favourable or hostile to the line were set up initially, quite arbitrarily, with an equal percentage of each type.

Objective

The objective of the program was for the line to negotiate the "dangerous" areas within a pre-determined number of moves, initially decided by the operator. The starting point of the line was always the origin 0,0,0, the centre of the environment. Once initiated, the program would run its course until the line was no longer able to negotiate its way around the volume, becoming trapped, or if the line was unsuccessful in reaching a safe area, until a pre-determined number of moves had elapsed. Illustration (3) shows successive stages during a run of the program.

Development

In the next stage of development I was concerned with the relationship between groups of interacting lines or cells. By assigning differing interactive coefficients, "species" of the same group could be formed.

I wrote a number of programs for my own Acorn Atom, 6502 micro-processor based system (Zaks, 1979, 1980) and used the highest resolution graphics mode to observe the results. Consider the competition between two species in an isolated environment (for example cats and mice) Such species interact, usually to the greater benefit of one of the species. The system should eventually stabilise either with a constant number of each species or with one having been eliminated. By using a combination of the method described by J. R. Merrill (1976) and an adaptation of a program by J. D. Lee (1978) I was able to simulate a type of predator-prey relationship between colonies of a similar species.

Observation and Plotting

These simulations were two-dimensional in contrast to the programs *Walk I–Walk III*. This was because these versions were written partly in Basic, partly in assembly, and so they were not fast enough to provide the data for the point plotting routine. I used the Lotka-Volterra equation:

$(dNi/dt)=(RiNi/Ki)(Ki-Ni-JiNm)$

where $m=2$ if $i=1$ or $m=1$ if $i=2$

Ni=the number of species i at time t

Ri= the birth rate per individual per unit time

Ki= the maximum number of species i that the isolated environment can support.

Ji= the interaction coefficient which is positive if the species is preyed upon; negative if there are beneficial effects

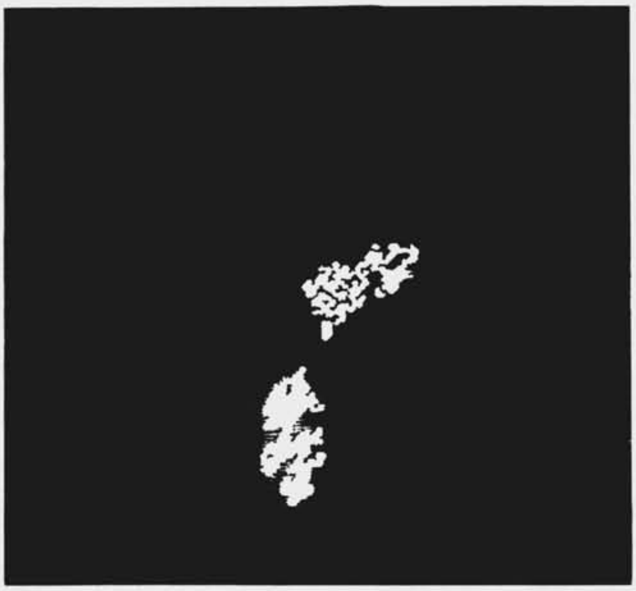
By a method of differentiation the equation was used to calculate these variables and then the data was stored for later plotting.The complete system could then be "observed" for a specific number of time units and the results displayed on the VDU.

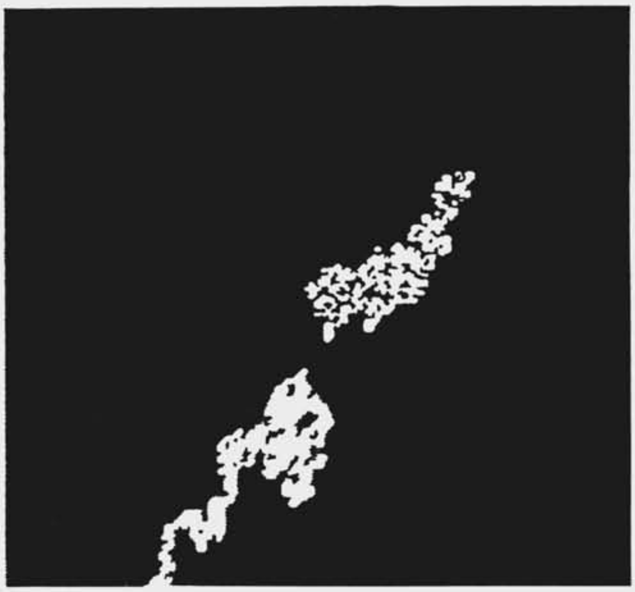
The highest graphics mode on the Acorn Atom gives a resolution of 256×192 in black and white, which was quite adequate for these programs, with the versatile Plot, Draw, and Move routines. Once the average numbers of each species had been calculated at specific time intervals, the data could then be passed over to the point plotting routine. Again the initial starting points of each colony were arbitrary but allowed each colony sufficient space to expand and contract as necessary. By calculating the differences in the number of each species at successive time intervals, the correct number of each could be added to or subtracted from the existing colonies. Using a very simple vector plotting method it was possible to determine the state of any point on the screen, and so each colony was able to test for the position of the other before making any move. Illustration (4) shows the development of one program *Eco. II* and the organic appearance of the colonies at the half way stage of one run.

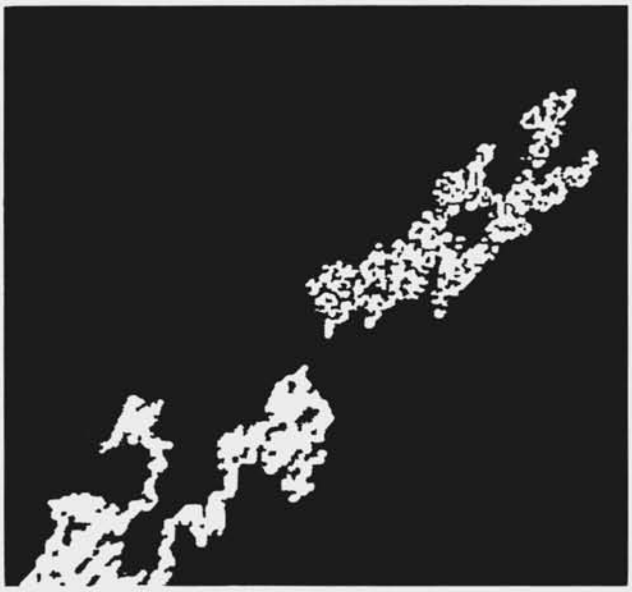
I am currently working on some three dimensional, assembly language versions of these programs (Leventhal, 1980) and extending the predator-prey types of "ecological" systems.

A real 3D Model

One of my most recent pieces of work contained a combination of the previous concepts, projected this







4. Nigel Johnson: Three stages from the program *Eco. II*, 1980-81

time into real space rather than its simulation. I felt that it was quite important to break away from the previous "flat imaging", which though playing an important role in the development of ideas, appears unavoidably flat and internal to the machine from the spectator's point of view.

The work shown in illustration (5) (see front cover) was initially built as a small scale working model. I had envisaged a large scale version similar to the model through which it would be possible to walk and to interact with directly. However, even at the scale of the model it was possible to see through and walk around the piece in its entirety whilst the programs were running and to obtain some sense of its spatial qualities.

The environment in this case was an extension of the simulated environment as used in the *Walk II* program, except that the volume was divided into a lesser number of units. A 4×4 grid structure was used, giving a volume of 64 cubic units.

The structure itself was constructed from four sheets of clear perspex, separated by a gap of 4 inches between each plane. Each plane of perspex was sub-divided into 16 units (4×4), each unit measuring 4 inches by 4 inches. About the centre of each unit two miniature wire-ended filament bulbs were inserted into drilled holes in the perspex. The lower bulb in each unit was painted with a transluscent lacquer in order to distinguish one of two possible "conditions" within each unit; i.e., either a green or a white illuminated bulb.

Multiplex and Memory

In order to control all 128 bulbs, I decided to multiplex the system such that all the bulbs could be controlled by 8 data lines from the computer port rather than having 128 individual lines and switching

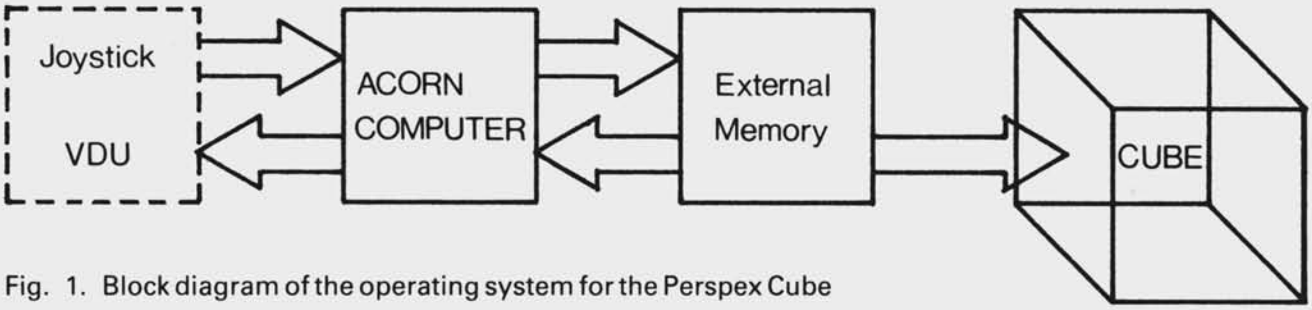


Fig. 1. Block diagram of the operating system for the Perspex Cube

circuits (de Jong, 1980). So that the computer was not engaged in performing all the calculations and having to update the display at the same time, I built an external memory store and driving circuitry to keep the display constantly refreshed. Figure (1) shows the basic layout of the system. Once one set of data had been calculated for a particular move within the cube, the data was stored in the external memory which kept the display updated whilst the next set of data was being calculated.

Concepts and Rules

The concepts behind this work paralleled the ideas contained in the program *Eco. II*, in that it was possible to observe the interplay between two hypothetical living organisms with certain conditions or laws dictating their movements. On initiation the program would set up the starting positions of the organism by illuminating four green and four white bulbs. In other words each organism occupied four units in the environment, with one bulb representing the head and the other three bulbs the body and tail section. This made their progress easy to follow as they snaked their way around the cube. The rules governing the movement of the organisms were as follows:

1 Each was allowed to move in any direction, left, right, up, down or diagonally one cell at a time
2 Each was allowed to "scan" the envoronment by up to four cells in any direction from the current head position
3 The organism was not allowed to retrace its preceding path
4 One organism was not allowed to occupy the same cell as the other at the same instant in time

The preference of one particular move over another, as the organisms scanned their environment, was decided on a points system. The highest positive number indicated the most advantageous move, whilst a negative number indicated the reverse. The final goal of the program was for each of the organisms to out-manoeuvre the other such that it was trapped and unable to move.

When the piece was first exhibited, the programs were Basic versions but I have since completed a real-time assembly language version. It had also been my intention at some date to include direct spectator participation by means of a joystick control as indicated in the block diagram (Fig. 1). This would enable the participant to control the direction of movement of one of the organisms whilst competing against the other. Information about the environment would then be displayed on the VDU.

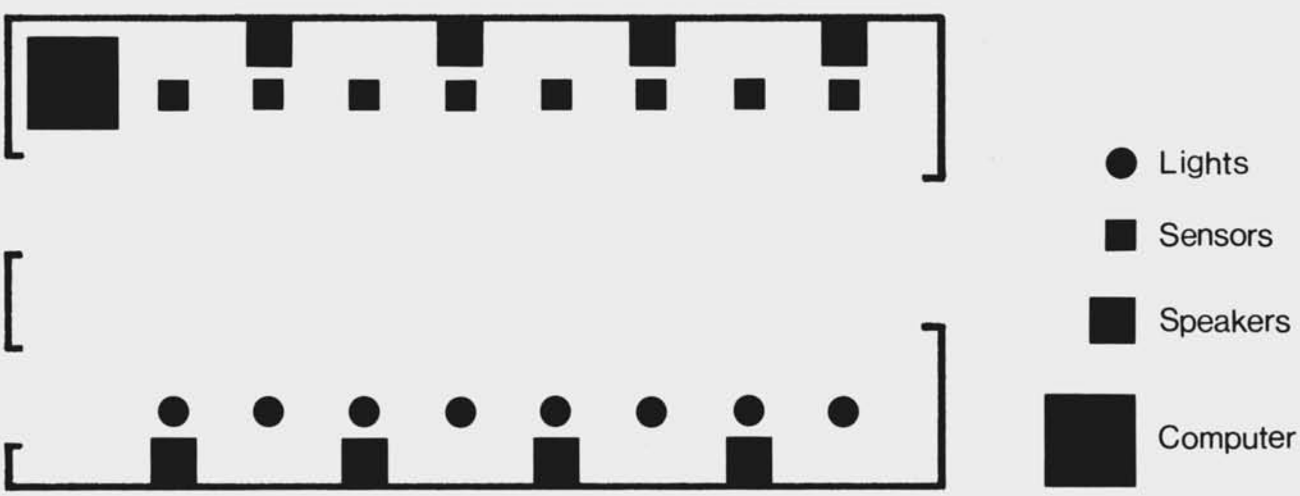
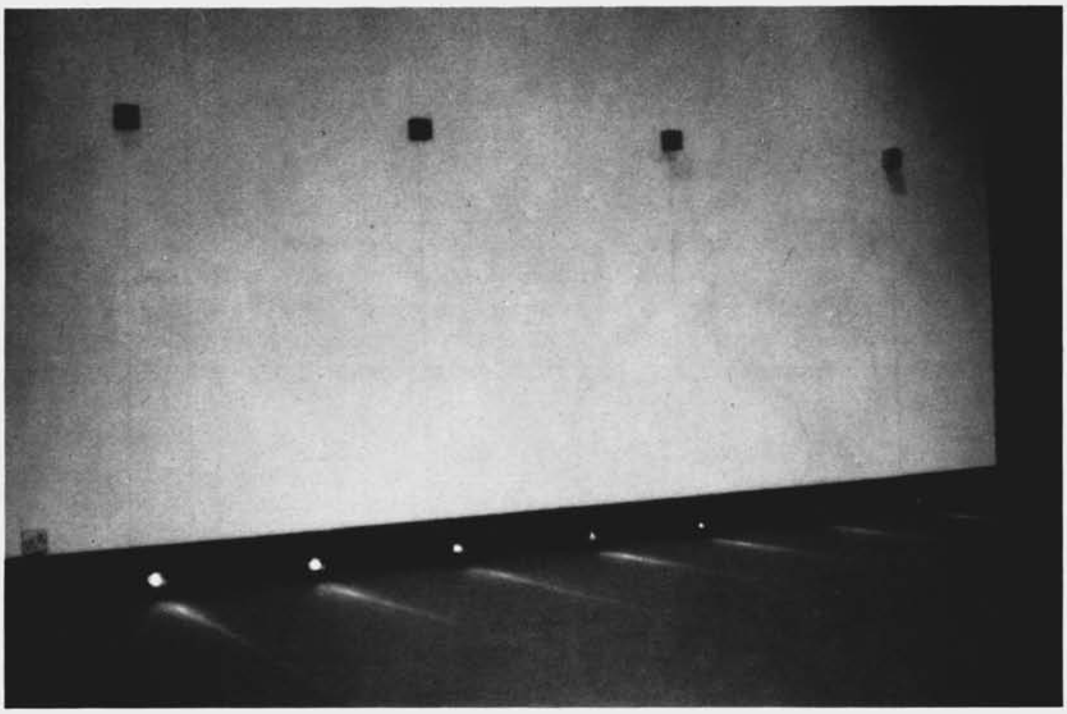


Fig. 2. Layout of the installation showing the positions of sensors, speakers and lights



6. Nigel Johnson: Interactive Sound Installation, showing one wall, 1981

Sound Installation

One other recent piece of work involved an investigation of some earlier concepts particularly relating to movement. The idea of "transformation in time" would be a more precise term, as it comprehends the idea of movement, but also includes events in time where something different from movement is perceived. For example a change in sound frequencies or light levels. In my installation sound was used as a form of feedback in which the formation of the sound was structured quite precisely by the movements of people travelling through a room. Fig. (2) shows the basic layout of the room.

Sound Generation

I utilised the General Instruments 8912 Programmable Sound Generator which was designed to produce a variety of complex sounds under software control. By using a register stack (memory locations containing data, structured in chronological order) the processor can load values into the sound generation circuit and then carry on with other tasks whilst the sound is being generated.

There are three tone generators and a noise generator, contained in the device and these three tones can be fed to three seperate outputs. Noise can be added to any or all of these tones, or output instead of the tones. The amplitudes of the tones can be set to one of sixteen values, or they can be set for various options of fast or slow attack and decay, single shot or repeat, so allowing a wide variety of sounds with logarithmic outputs. (For a comprehensive guide to digital sound synthesis and applications see Chamberlin, 1980).

The registers can be set to any value in the range 1 to 4095 decimal, and the sound generator itself is governed relative to an external clock of 1 to 2 MHz. As the clock is divided by sixteen before being fed to any of the tone generators, the output frequency can be determined by the formula:

$$\frac{f = F\,\text{clock}}{16 \times R}$$

where F=2 MHz and R lies between 1 and 4095 decimal.

Obviously some of the frequencies capable of being produced were outside the human audible range and so a selection of frequencies were used which fell within acceptable limits for the purpose of this installation. For a pure sine wave, the human ear is generally regarded as being capable of hearing frequencies between 20Hz and 20KHz. The 20KHz upper level is usually a bit optimistic, however, with 15KHz to 18KHz being more common for young people. The lower limit of 20Hz is somewhat arbitary since such low frequencies, if they are loud enough, make their presence felt through vibration.

Sensing

The sensory input to the system was kept to a minimum, consisting of 8 photo-transistors arranged at ground level, and activated by 8 lights similarly placed along the opposite wall (illustration 6). This

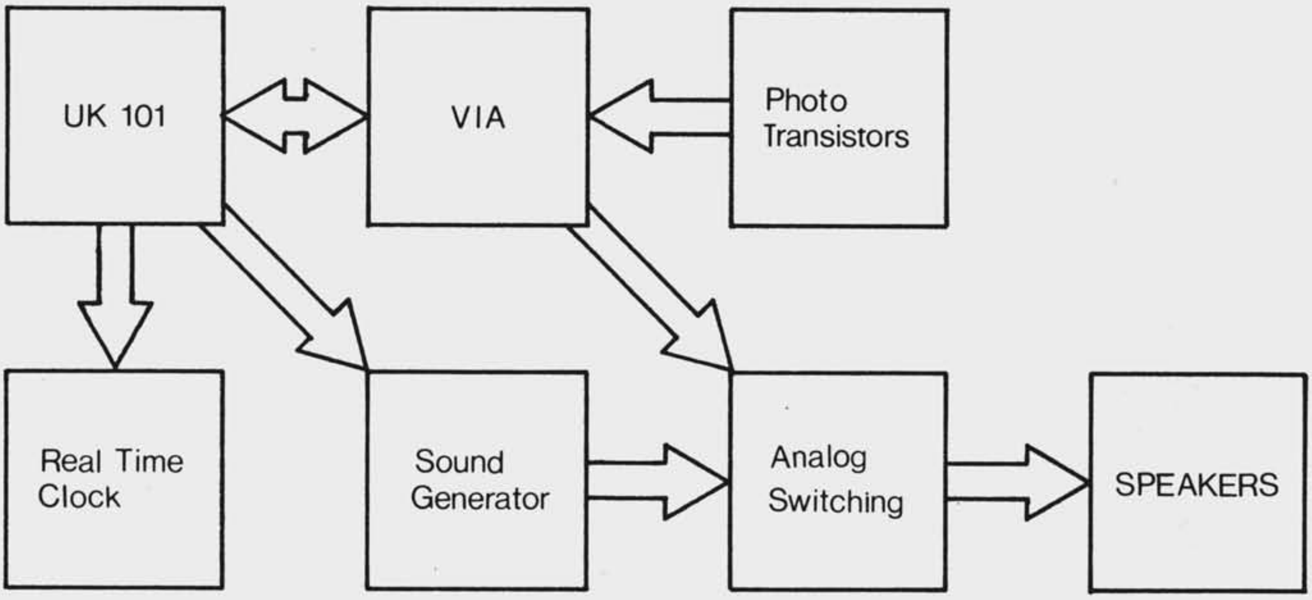


Fig. 3. Block diagram of the Interactive Sound Installation operating system

arrangement indicated on and off states, i.e. binary 1 or 0, whenever the light beam activating the photo-transistors was interrupted. The outputs from the sensors were connected to the input/output device of the Uk101 microcomputer (Fig. 3), which in this case was a 6522 VIA (Versatile Interface Adaptor). One of the functions of this device is that of allowing the micro to communicate with the outside world via two 8-bit input/output ports, such that each of the 16 lines can be configured to be either input or output.

Sound Movement

To complement the movements of human participants I decided that the spatial location of the generated sound should be variable. To achieve this I used a number of solid state bilateral switching devices, which consisted of independant electronic switches, each capable of passing signals, either analogue or digital, in either direction. Using this method it was possible to create mono, stereo or "octophonic" effects.

The System

All the operations were governed by a software real-time clock capable of measuring events down to one fiftieth of a second. By reference to this clock any inputs via the sensors could be timed precisely. The main points of the algorithm were:

1 Check to see if any sensors are active. If not, re-check.
2 On interruption, find out which sensors have been activated and store their positions in memory.
3 Look at the clock and store Time 1
4 Re-check whether the sensor is still active. If so, keep checking.
5 Once deactivated, look at the clock and store Time 2.
6 Subtract T2 from T1 and calculate the velocity over the given distance.
7 Jump to main program.
8 Select the frequency range.
9 Use the velocity as a "seed" for selection of the number of tones and the rate at which the sounds are to be generated.
10 Select the amplitude values.
11 Select the corresponding speakers and output the sound.
12 Continue.

Briefly, the program used the velocity of the participants as a "seed" so that all the selection procedures were based upon these values and used to determine the range of frequencies to be output. Because it was possible to time events to such fine limits, the quality of the sounds varied quite perceptably with each individual that moved within the installation (illustration 7). Other factors were also taken into account such as the time taken between a number of sensors, so that it was possible to a certain extent to predict the position of the participant. The sound itself was switched from speaker to speaker, depending on where the person was in the room, and the effect of the sound moving up and down the room, or diagonally from wall to wall was very strong indeed. It was interesting to note the varying reactions of people to this piece of work. Because the installation was set up in the foyer of a building, which happened to be the main entrance, contact with the work was practically unavoidable. Peoples' reactions in the main developed through initial curiosity, then play and discovery of the relationships between their actions and the sounds heard.

Afterword

I wish to express my thanks to a colleague, Tony Jenkins for his great interest and many hours of help in realising some of the work over the past year.

Currently I am working on some new projects, with the hopeful intention of placing the work in an architectural and public context. I would be glad to hear from anyone with technical expertise interested in future collaboration, and from anyone interested in sponsoring or commissioning work.

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Biography

1957 Born in Todmorden, West Yorkshire
1975 Foundation Course, Perceval Whitely, Halifax
1976 – 79 Liverpool Polytechnic
1979 B.A. (1st Class Hons.)
1979 – 81 Slade School of Fine Art
1981 H.D.F.A. (Lond)

Exhibitions

1977 Piece Hall Halifax
1978 Liverpool Polytechnic
1979 Liverpool Academy
1980 Fort Motte State Museum U.S.A.
1981 Young Contemporaries I.C.A. London
1981 Bartlett Foyer University College London
1981 International Festival of Electronic Music, Video and Computer Art, Brussels

Contact Address:
Nigel M. Johnson, 7 Coborn Road, Bow,
London E3 2DA, England.
Tel. 01 981 5239

7. Nigel Johnson: Interactive Sound Installation

CREATIVE COMPUTERS
by F. W. M. Stentiford*

Abstract

This article discusses two fundamentally different approaches to the design of a creative machine. Such a machine might be capable of producing works of art or making original observations about the world around us.

The first approach relies on a mathematical formalism to produce results. In this case a computer might be programmed to follow the steps dictated by a rigorous mathematical logical system to produce "theorems". Each theorem here would correspond to a required result, that is, a picture or an original observation, for instance.

Some objections are made to such a formal approach and an alternative method is proposed which does not suffer from the same difficulties.

The Formal Approach

Any formal approach requires a set of axioms plus rules of inference to generate the desired results. In the search for prime numbers, for example, the axioms of number theory can be programmed on a computer in various ways, and not surprisingly the required numbers are output. However, if the computer is to produce a work of art, it is not immediately apparent what sort of mathematical structure would be suitable!

Objection 1 : The Smart Observer

For the purposes of discussion let it be assumed that a supposedly creative computer, working according to rigorous and deterministic logical operations has been constructed and is before us. One might envisage the computer producing a work of art on a plotter every few minutes for us all to see and appreciate.

Most observers, we notice, are enjoying the show, but some are not. It turns out that some individuals are unhappy with the outputs because they are all too "similar." To them the pictures are all clearly being generated from an unchanging set of production rules programmed into the computer, and apart from the very first picture the gallery is very boring. One individual finds that it is appropriate to congratulate the programmer for his original and ingenious program which produces one (the first) highly creative piece of art. It might be concluded that those happy admirers who are not able to see the commonality between the pictures are merely reacting to their surprise rather than to their observation of any intrinsic spark of originality in each output (Turing, 1950).

To take a simplistic example, our computer might have plotted as its first picture an attractive arrangement of geometric shapes and then algorithmically shifted the shapes around to produce an unending series of similar patterns. Most people would have spotted that very little in the way of originality is added after the first effort. More complex examples would not be quite so easy to unravel, but in principle the true originality of the successive computer outputs could always be challenged by someone who managed to understand how the algorithm generated them. Such a smart person would never attribute creativity to the computer and its program, but rather to the program writer.

Objection 2 : Surprising Results Are not Necessarily Original

There are many examples of computer programs which yield results which have surprised their originators. Almost every computer operating system in the world produces a fair crop of surprises every day! However, this is not to say that such results are original in a sense which is independent of the program which generated them. In these cases the program is merely an alternative representation of the "surprising results" and the **running** of the program in effect translates one representation into another. The program writer is surprised only because he has not done sufficient calculation to decide what to expect before actually executing the program (Turing, 1950).

Objection 3 : The Onion Peeling Experiment

A computer program which simulates the operation of a rigorous mathematical system consists of a set of procedures which generate successive statements in the system. In considering the functions carried out by our creative computer we find certain programmed procedures which we can definitely dismiss as

*F.W.M. Stentiford works for British Telecom. Contact address: Sheepstor, Boyton, Woodbridge, Suffolk IP12 3LH

not being concerned with the act of creation. These might include input/output tasks or housekeeping for data storage and can be stripped off like the skin of an onion. But in what remains we find a further skin to be removed as it is surely possible to identify each procedure in the computer system with some routine non – creative operation. If we arrive at a large and complex procedure at the "centre", it should always be possible to break it down so as to correspond to the mathematical operations which the software is intended to simulate. Many people would not feel that any creativity is required to move from one step to the next according to a set of mathematically defined rules.

This argument although rather shallow nevertheless questions whether any real creativity could be attributed to a mathematically programmed computer.

Objection 4 : The Lack of Evidence for a Logically Operating Brain

It has often been suggested that the brain itself provides evidence for the existence of a creative machine. However it has not been established that the brain actually *is* a logically operating and deterministic machine. Current knowledge on the functioning of the brain is very sketchy (Hubel & Wiesel, 1974) and could hardly be used to justify that the brain works in a rigorous mathematical framework. Indeed there are plenty of instances when our own brains appear to behave very illogically even when we are attempting to play a good game of chess. It is possible, therefore, that no formalism has yet been found to describe the operation of the brain because there isn't any!

Objection 5 : Gödel's Theorem

Returning to our creative computer we now find that it is producing architectural designs for buildings. The audience is again frustrated because the buildings all appear very square and uninteresting. One of our smart observers notices that the programmer must have instructed the machine to use rectangular bricks of various sizes and to only place them on top of each other so that corners touched other corners. Presumably it was felt that this might give the building maximum stability. Everyone then immediately appreciated why the computer seemed unable to produce a single design with an arch in it. It was simply because the "stability" heuristic precluded arches from the computer search.

In general a computer program, which has as its task the selection of the best of a number of choices, conducts a search. The choices might be the different ways of placing bricks on each other or the routes the travelling salesman might take between a number of towns. If the number of choices is small, exhaustive enumeration will always guarantee the best solution. More sophisticated techniques such as branch-and-bound, and alpha – beta pruning, can be used to improve the efficiency. However, all techniques run into trouble when the universe of search gets large, and practical steps have to be taken to reduce the processing time. The programmer almost always uses his intuitive understanding of the problem to construct heuristics which will remove large chunks of the search space without, in his belief, impairing the results. Such heuristics might include the stability heuristic described above, or the rule that the control of the central squares in a game of chess is more important than possession of the edge squares. Heuristics can give no guarantees that satisfactory results will be forthcoming; indeed they may preclude the best results as in the simple example above.

Logic based computer programs have been compared with the production of theorems from axioms and rules of inference (Nagel & Newman, 1959; Lucas, 1970). Here, if the logical system is consistent and not tautological, Gödel's theorem holds. Basically Gödel showed that not all theorems can be proved; i.e., there are true statements which can never be verified within the system. For example, the conjecture that every even number is the sum of two primes has not been disproved by a contradiction, but neither has it been proved to be true for all cases. Possibly it may be one of Gödel's true but unprovable statements. It follows that a computer which emulated a logical system in a search for results would be barred from a class of solutions by the search algorithm itself.

These arguments tend to imply that searches which are governed by a set of rules or heuristics can be severely hampered in their operation because large and fruitful areas of the search space may be unwittingly excluded.

Objection 6 : Scientific Opinion Favours an A-logical Act of Creation

Many scientists when asked how they feel an original discovery is made do not suggest that it is achieved by reasoning in strictly rational and precise terms (Courant, 1958; Hadamard, 1949; Hempel, 1966; Koestler, 1971; Medawar, 1967; Meltzer, 1970; Miller, 1971; Rosser, 1953; Wertheimer, 1959). Instead it is thought that new ideas arise through a process of trial and error and intuition.

> "There is no such thing as a logical method of having new ideas, or a logical reconstruction of this process. My view may be expressed by saying that every discovery contains 'an irrational element,' or 'a creative intuition', in Bergson's sense." (Popper, 1959)

These opinions do nothing to help the formalist to build his creative computer.

The Evolutionary Approach

An alternative approach to the problem of creativity is now proposed. Four of the objections are shown not to apply and the other two are already in fact in support.

Results returned by procedures with a *random element* are certainly original because there is no "smart observer" who could say that the random number source (hardware or software) actually "contained" the solutions (objection 1). By the same token the running of a program with a random element could not be considered as a translation of representations because the random numbers are simply not defined (when derived from a noisy diode, for example) before the program is run (objection 2). An onion peeling experiment clearly would reveal the source of originality as being the random number generator, what else?

Random search procedures fall outside any logical framework because each step is not properly related to earlier steps in the process. This means that Gödel's theorem does not apply, solutions are not precluded by heuristics, and searches should therefore have more scope to find the best results (objection 5). As an example we might consider our architectural design system again. For simplicity let us work in 2 dimensions with a large tray of rectangular bricks (*Lego* pieces). We are looking for configurations that will support themselves under gravity so we give the tray a good shake and allow the pieces to slide to the bottom. Pieces which are structurally unimportant can be easily identified and removed leaving what is probably a highly creative piece of art! Arches are no problem. The resulting structures can be subjected to additional stresses such as extra weights and rejected upon collapse. Clearly all this can be simulated in a computer with thousands of configurations being tested every second. Such a search is not governed by a set of rules which dictates which brick positions shall be tested next and hence is able to select structures from the entire universe of possibilities without restriction.

A totally random search consists of a series of "stabs in the dark", each followed by an evaluation against some criterion. If the stab measures up it is retained and the process continues. These ideas carry over onto our tray of *Lego* pieces by allowing the investigator to fix any interesting structures to the tray and to continue the random search with the remainder.

In many problems such an approach can be as inefficient as an exhaustive search. However in the problem of discovering new structures (eg works of art, or patterns in the real world) the random search can be confined to part of the structure at a time with the evaluation criterion depending on the performance of the total structure. When this is done the search process moves through a series of steadily improving structures each differing from the last by a small random change. This is Darwinian evolution, indisputably a highly creative business.

It is interesting to note in passing that an alternative theory of evolution was proposed by Lamarck who believed in the inheritance of acquired characteristics. This could be interpreted here as requiring the steps of evolution not to be random mutations but to be changes which are heuristically guided by the parents' experiences. For instance, Lamarck would say that giraffes have long necks because parent giraffes stretched their necks a lot to get food. Stretching probably affected the neck bones during the giraffes' lifetimes and this feature was then passed to the offspring. There is no reason why under certain circumstances there should not be a selective advantage for such guided evolution. However, if Lamarckian evolution were to predominate, according to the arguments here (objection 5) species would not achieve so much adapatability because their "search space" for new variations would be substantially reduced by the guidance rules. This would mean that in the long term species which practised Lamarckian evolution would be at a (meta –) selective disadvantage to those practising Darwinian evolution and die out.

Discussion

Six objections to the formalists' approach to creative computing have been described. It has been argued that the evolutionary search is not affected by these objections and is essentially a creative process. To demand that we formally prove that evolution is creative is to ask that we place evolution in a formal framework, which is not possible almost by definition. The positive justification for these views is therefore only to be found by experiment. Some actual results might form the subject of a future article.

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EDITOR'S NOTE

Although I find much to argue about in Fred Stentiford's article, I am glad that he has re-opened the debate on machine creativity. I know that Mr. Stentiford is interested, as I am, in receiving comment and constructive criticism of these ideas. Further contributions on the subject of machine creativity are therefore invited, bearing in mind the following observations.

Firstly, criticism and discussion should be firmly based on what has already been done (a) practically, in the way of tested algorithms; (b) theoretically, in terms of argument, and models of natural and artificial creativity. Secondly, the presentation of a system which actually produces some hard copy is considerably more interesting than mere speculation.

Those interested in some further reading around the subject could take a look through past issues of PAGE, and the books listed below.

Finally, to name some names, I would be very glad to hear from Michael Thompson, James Gips, George Stiny, and Harold Cohen.

D.B.

Boden, M.A. (1977) *Artificial Intelligence and Natural Man*. Harvester
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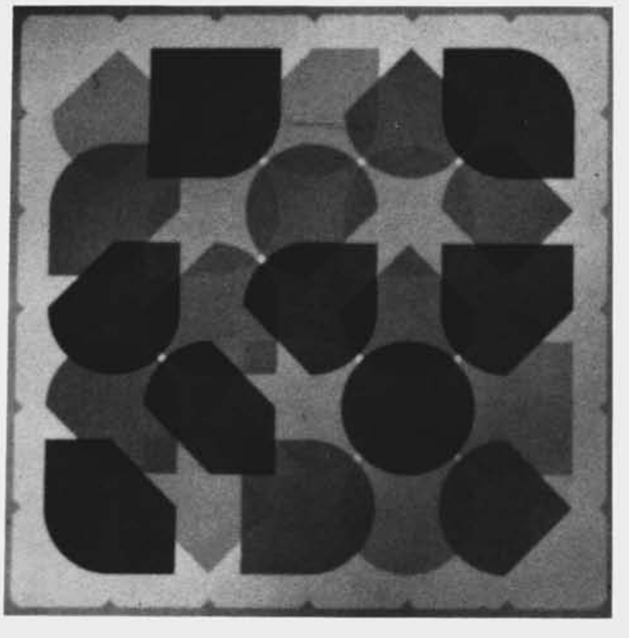
Paul Brown, MODULUS (8) Series, 1978–79



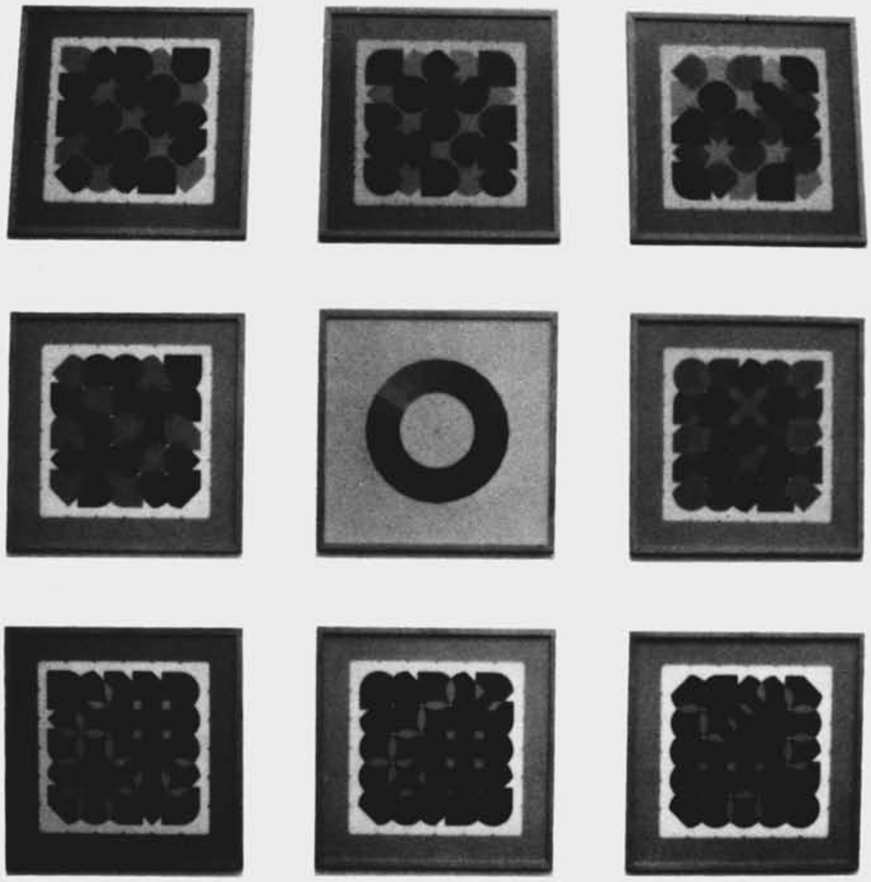
THE MODULUS(8) SERIES by Paul Brown*

8 paintings and 1 reference chart
Liquitex Modular Colour on hardboard

The *MODULUS(8) Series* of paintings evolved from the proposition that changing the colours of an otherwise consistent set of forms will effect the way that these forms are perceived. This is, of course, nothing new; I wished only to design an ordered exploration that would demonstrate this proposition in a tangible non-verbal format.

Several paintings I had made previously showed that well ordered forms could appear random (confused) even when distinguished by ordered colour. This could be explained by the degree of variation in the basic formal arrangement. Triangular lattices containing six-fold vertices were more likely to appear

*Artist and Consultant in Computer Graphics, living at 9 Nansen Road, London SW11, England.



Paul Brown,
MODULUS (8) Series, 1978–79

disordered than square lattices which contain only four-fold vertices. In the *MODULUS(8) Series* I restricted my attention to simple formal elements in order to concentrate on the effects of colour.

Fig. 1 may be seen as three independant forms, two circles and a rectangle, each overlayed by the others to form three sub-areas. If we colour the areas in fig. 1 using the arrangement of a regular colour circle (fig. 2) so that colour 1 goes in area 1; 2 in 2; etc. this impression is strengthened – that is to say that both the formal elements and the colour give the same information. If, however, we rotate the colour circle through 60 deg. and now fill the areas in fig. 1 so that colour 2 goes in area 1; 3 in 2; ...; 1 in 6 – the impression of independence and conjunction is destroyed. The brain rejects the formal complexity necessary to make the assumption that the areas coloured red, green or blue are the result of conjunction. The image is now more likely to be perceived as six independant areas with no conjunction. If the colour circle is rotated by 120 deg. we find, as far as information is concerned, nothing is changed - only a simple transposition has taken place.

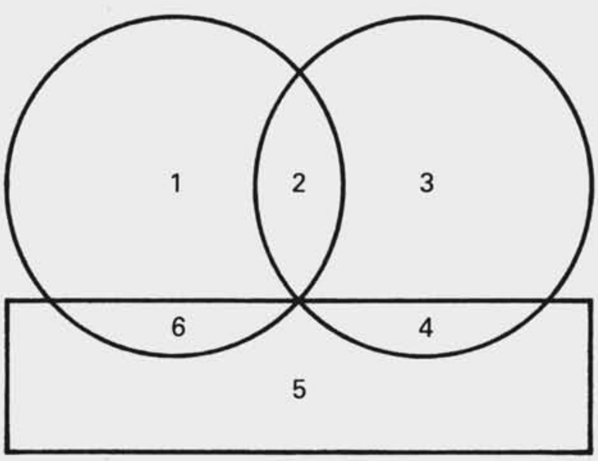


Fig. 1

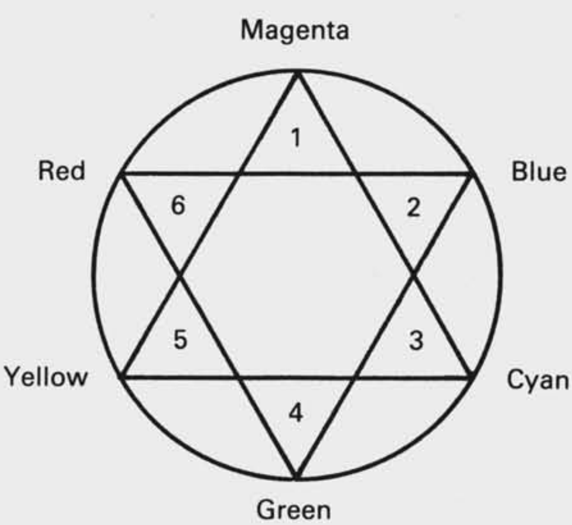


Fig. 2

The *MODULUS(8) Series* explores this rotational movement about a regular colour circle using 15 deg. increments. Since the eighth increment would complete a 120 deg. movement the whole proposition is illustrated in eight images – the ninth would be the transposition of the first. This gives rise to the title of the piece (modulus is the name of a mathematical function – remaindering – which converts large or infinite sets into smaller or finite ones). Thus these eight images explore the whole 360 deg. rotation of the colour circle.

The work was modelled using the NOVA 2 Computer System at the Slade School of Fine Art, University College London and realised using the Modular range of colours made by Liquitex, using the Munsell classifications.

Most of my work since 1974 has involved computers or digital electronics, which have assisted a great deal, mainly in the reduction of time-consuming calculation or the production of high resolution artwork. My more recent work – in three-dimensional topologies – would be inconceivable without this kind of assistance. However I must stress that I do not consider this technology to be a necessary aspect of the finished work.

I have had to learn to use limited symbolic languages to express the ideas that interest me. These languages have influenced my ideas and interests. This is the area where the technology has made a significant contribution to my work. This is not to say that I am now more likely to be interested in ideas which I know can be most easily solved by these languages. Rather, my whole approach to problem-solving has been given a new dimension and perspective which allows me to see aspects that might previously have been overlooked or appeared insignificant.

Biography

1947	Born in Halifax, Yorkshire
1966–68	Manchester College of Art and Design
1974–77	Liverpool Polytechnic, Sculpture School
1977	B.A. (1st Class Hons.)
1977–79	Slade School of Fine Art, University College, London
1979	H.D.F.A. (Lond.)

Paul Brown has worked in lightshows, multi-media theatre, as a photographic technician, as an art therapist, in the community arts and as a computer software consultant. He is Exhibitions Officer of the Computer Arts Society, and a council member of the Research Into Lost Knowledge Organisation (RILKO).

Exhibitions

1967	Northern Young Contemporaries, Whitworth Gallery, Manchester
1974	The Video Show, Serpentine Gallery, London
1977–79	RILKO Artists, Acme Gallery, London and UK tour
1978	8eme Festival de Musique Experimentale, Bourges, France
1979	Children's Computing Funfair, BCS '79, London
1979	Modulus (8), Bartlett Foyer, University College, London
1979	Festival for Mind, Body and Spirit, Olympia, London
1980	Computer Graphics '80, Metropole, Brighton
1980	Venice Biennale, Venice, Italy
1981	Memoria nella Informatica, Milan, Italy
1981	International Festival of Electronic Music, Video and Computer Art, Palais des Beaux Arts, Brussels

1976	Designed and made the *North West Export Award* - a cybernetic trophy - for the Confederation of British Industry
1977	Produced and directed *The Earth Probe,* a computer-assisted documentary film. (16mm, col., sound)

Bibliography

1974	*Art and Artists,* May
1976	*Arts Review,* October
1978	*Computer Bulletin,* Spring and Autumn
1979	BBC TV *Why Don't You . . .,* January
1979	*Independant Cinema,* 1:1
1979	*Observer Colour Supplement,* May
1980	*Computer Aided Design,* Vol. 12, No. 1, January

Collections

Work is represented in the collections of the Confederation of British Industry, the British Computer Society and private collections in the UK and Europe.

ANNOUNCEMENTS

A NEW MIDLANDS BRANCH OF THE CAS

The first meeting of the newly formed CAS (Midlands) Branch was held at Leicester Polytechnic on 7 October 1981. The Branch has been formed to enable locally-based Members to organise specific projects. The following Members were elected to the Branch committee:

Chairman: Dr. Ernest Edmonds
Secretary: Dr. Stephen Scrivener
Exhibitions Organiser: Colin Jones
ADVISORY PANEL:
2D Fine Art: Dominic Boreham
3D Fine Art: Susan Tebby
Computing: André Schappo

It should be noted that this committee is a purely local structure, established for the convenience and efficiency of managing the internal affairs of the Midlands Branch. It does not have any official standing within the BCS and it is not represented on the BCS Specialist Groups Board. *It is not equipped to deal with enquiries about CAS in general, or to handle subscriptions, both of which should continue to be addressed to John Lansdown at Russell Square.*

Among the project proposals tabled at the meeting was the proposal to organise a one-day Conference on Computing in Architecture, to be held at Leicester Polytechnic. The Conference would be timed to coincide with a touring exhibition entitled: *Architect and Computer*, arranged by the Goethe Institute, to open at the Kimberlin Exhibition Hall, Leicester Polytechnic, in March 1982.

S T O P P R E S S

CONFERENCE: ARCHITECT AND COMPUTER

LEICESTER POLYTECHNIC . 8 MARCH 1982

CAS(Midlands) in conjunction with Leicester Polytechnic have arranged a one day conference (see above). The conference is primarily intended to introduce the architect to the potential of the computer as an aid in the design of buildings. Past and present research will be reviewed, and future trends in CAAD examined. Emphasis will be placed on current usage of computers in practice and in commercial applications.

The invited speakers are all acknowledged authorities in CAAD.

Chairman: Neil Bowman, Leicester Polytechnic
Speakers: Alan Bridges, ABACUS, Strathclyde
Rob Howard, CICA, Cambridge
Aart Bijl, EdCAAD, Edinburgh
Richard D'Arcy, D'Arcy Race Partnership
Dr.Brian Lawson, University of Sheffield

Papers produced by speakers will be published subsequently in PAGE.

Delegate Fee: £30 includes coffee, lunch and tea, and a copy of the published conference papers.

Details from: Diane Fox-Kirk, Short Course/Conference Organiser, Industrial Liaison Centre, Leicester Polytechnic, PO Box 143, Leicester LE1 9BH Telephone (0533) 549972

FRANK J. MALINA (1912 – 1981)

Frank J. Malina, father of America's first high altitude sounding rocket and a pioneer of the use of light and motion in art, died on November 9, 1981 at his home in Boulogne-sur-Seine on the outskirts of Paris. He was 69 years old.

Born in 1912 in Brenham, Texas, Malina obtained his B.S. in mechanical engineering from Texas A & M in 1934. He became interested in rocket engineering in the 1930s, when rocketry and space travel were scoffed at as technically impossible. He wrote a doctoral thesis on rocket propulsion and rocket flight for the California Institute of Technology in 1937, and in 1944 was co-founder with the noted Theodore von Karman of the Institute's now famous Jet Propulsion Laboratory. In 1945 he proved the sceptics wrong, conceiving and then directing the design, construction and launching into the outer atmosphere of the WAC Corporal, the United States' first successful high altitude sounding rocket. The rocket used a liquid propellant. This led to the creation, by Malina and five other colleagues, of America's first rocket company, Aerojet Corporation. A firm believer in international cooperation in science he joined UNESCO in 1947, remaining until 1953 as head of UNESCO's division of scientific research. Until his death he was an active member of the International Astronautics Federation as well as the International Academy of Astronautics, both of which he was instrumental in creating. He outlined a plan for a manned laboratory on the moon called the 'Lunar International Laboratory" where astronauts, scientists and technicians from different countries could work together, for peaceful purposes in space. He is the author of a history of rocket propulsion which he wrote for Princeton University and of many papers and studies on rocket propulsion into space. In 1939 he was awarded the French Prix d'Astronautique R.E.P.-Hirsch, the C.M. Hickman Award of the American Rocket Society in 1948, and the Order of Merit from the French Society for the Encouragement of Research and Invention in 1962.

But science and astronautics were not Frank Malina's only interest. For much of his lifetime he attached equal importance to his art work. One of the first pioneers of kinetic art, his "electro-paintings" and "electric mobiles" using flashing lights were exhibited in Paris as early as 1955. A year later he evolved his "lumidyne" paintings using electric light shining through painted moving and static elements, sometimes with the addition of a diffusing screen, for which he is internationally known. He was awarded the Yvonne Valensi Prize in 1958 and the Signature Prize in 1970 for his kinetic paintings. His works have been exhibited in Paris, Brussels, Mexico City, Zurich, Amsterdam, Tel Aviv, Washington D.C., New York, London, Rome, Prague, Zagreb, etc., and are on permanent display in Paris in the Musée d'Art National, the Centre National d'Art Contemporain, and the Musée de la Ville de Paris; and in museums in Lyon, France; Krefeld, German Fed. Rep.; Smithsonian Institution, Washington, D.C., UNESCO, Paris; National Gallery, Prague; Palace of Arts and Science, San Francisco. A kinetic mural measuring 2.5 by 3 metres stands in the Pergamon Press Building in Oxford, England.

In 1967 Malina launched the international journal of contemporary visual arts, *Leonardo*, of which he was the chief editor until his death. This quarterly review in which artists themselves write on their work, provides a bridge between developments in art and science which Frank Malina sought to promote during his life. He is survived by his widow and two sons.

R.F.M.

COMPUTERS IN INDUSTRIAL (PRODUCT) DESIGN

Computers in Design Group – Sheffield City Polytechnic

The Computers in Design Group is made up of staff from the Departments of Design, Mechnical Engineering and Computer Studies. The current project of the group is to

- investigate the use of computers in product design practices
- investigate possible micro computer use by designers
- propose and develop appropriate products and procedures

The group has circulated a questionnaire to over 1,000 designers via *Designer Magazine* and is currently analysing the replies.

If any product designers would like to either help in our investigation or to receive copies of our reports they should contact:

Brian Webb
Department of Design
Sheffield City Polytechnic
Psalter Lane
Sheffield S11 8UZ

G Cockerham, T Coward, D Simpson, B Webb

LETTERS

Dear Dominic

I am very sorry to have to inform you that due to work overload I am resigning as member of the Computer Arts Society, effective 31 December 1981, and giving up the Swiss Branch of CAS.

Best wishes

Herbert Bruderer

I.N.I.V.
Thaler Straße 8
CH-9400 Rorschach SG
Switzerland

Dear Sir,

I have quite incidentally had a chance to look at PAGE 44 featuring the Chris French paper, and it has made me so interested as to subscribe to PAGE and apply for CAS membership. I have also ordered 1980 issues of PAGE, and found there a quite amusing (although no less important) discussion in PAGE 45 on Chris French's article.

To be precise, I have been impressed firstly by the technical content of the paper, mostly its impossible figures theme, being for some time both an admirer and a creator of impossible art. I have found in French's confused-depth ball spirals things new and appealing to me. The paper itself is well written and shows serious intellectual order, rarely seen in writings on art, and signifies the author's intellectually wide horizons, rarely seen among our over-specialized scientists. That "puerile drivel", as called by Alan Sutcliffe, was mostly lost for me in the first reading, this being hardly surprising if one takes into account I'm not a native speaker of English and my "continental English" self-taught knowledge is based mostly on very serious computer science and art books, with the aid of some ballically (?) innocent fiction like Alice's Adventures or Tolkien's fantasy. Only after reading your letters exchange I have plunged into the text once more (with considerable help of my OALDCE dictionary) to taste some, but still not all, I suspect, of its flavour. And as a result I generally take Chris French's side (maybe, with only this objection: why he spoiled so brutally the fine bottom of the Queen of Clubs?).

It might be interesting to note some significant linguistic differences here. In Polish, there is a little obscene phrase parallel to "What a load of balls!". It is "Ale jaja!"; almost literally "What eggs!", and semantically "What balls!". But it has interestingly different meaning to the English counterpart. It is exclaimed when referring to something (somewhat scandalously) extraordinary, uncommonly exciting or confused. Is it not causing a bit of thought that in the country so sarcastically (although I think, with too much exaggeration) described by Chris French in his first paragraph, the "Balls!" are associated with unfulfillment and worthlessness, contrary to their natural (driving and active) meaning in the language of a nation considered to be still full of cavalier fantasy?

Considering your postscript, I agree with you that it is unfortunately a common disease of our times – to tolerate empty drivel too often sold for deep thought or art. I think it is mostly due to the general confusion of values and fall of universal standards; a phenomenon characteristic to transitive periods of rapid change. In such a situation many lose their orientation and become afraid to criticize anything ("maybe it's deeply valuable if I couldn't make immediate sense of it"). Emptiness often looks to many quite like deep space. It is much safer to hold somebody's tongue or only catch hold of some "obvious" feature like obscene references or irreverent style. The remedy seems to be, as of old: more balls, boys! (in Polish sense, of course!). One will then deserve another Polish phrase of (still somewhat obscene) recognition: "chlop z jajami": "a man with balls".

What I wish all of you wholeheartedly.

Yours sincerely

Dr. Zenon Kulpa

P.S. I hope my letter will not look offensive? At least, I have not meant it to be such.

Address for correspondence: Institute of Biocybernetics and Biomedical Engineering
ul. KRN 55, 00-818 Warsaw
Poland

(Those who appreciate Chris French's idiosyncratic humour may like to track down an earlier example which appeared in the *New Scientist* for 7 August 1975, pp. 317–319. Entitled: "Computerised Mumbo-Jumbo", it presents Dr. French's then early research into updating superstitious practices. The main part of the paper deals with a new digital version of the traditional wax-image-and-pins routine, by which one can get rid of one's colleagues through simulating their "disappearance". – Editor)

BOOKS

TAPE MUSIC COMPOSITION
by David Keane

Oxford University Press ISBN 0-19-311919-6 Pb. £5.95

David Keane is professor of music at Queen's University, Kingston, Ontario, and an established composer of electronic music. In this modest book of 157 pages, he introduces the composer to the skills and technical knowledge required for composing tape music. This last phrase is to be understood quite literally. The book deals with the *classical* electronic music studio, i.e., a studio dependent upon editing and tape recorder manipulation as the primary means of production. Keane is quite clear about his approach and about the applications of his book. ". . . . I believe that the economy, simplicity, portability, versatility, and ready availability of the tape recorder makes it likely to remain the single most valuable tool for the exploration of music for many decades to come." He does not deal with voltage control, except briefly in chapter 8, "Composition with synthesizers", nor with computer generation. Of the latter: "because soon the medium will have so evolved that its use will not be based upon analog-electronic-music studio thinking."

As an introduction to the craftsmanship of using tape recorders for composition, Keane begins with absolute basics. He explains in simple terms the technology, how and why it does what it does, and how to use it. Although he assumes no previous expertise, he does not treat the reader as a simpleton, giving sufficient technical information to enable intelligent understanding of the medium to develop. Above all, he is not afraid, as so many are, to give advice. Firstly he gives one the benefit of his experience in using the technology, secondly and more importantly, he lays great emphasis on how to use various sounds or treatments to their best effect within an intelligently structured and well considered composition.

Chapter 1 : Principles of tape recorders, and Chapter 2 : Principles of tape recording, deal with the basic equipment: tape heads, transport, electronics, tape, reels, microphones, VU-meters, microphone placement, and noise. Chapter 3 : Composition using basic recording techniques, opens with some observations on compositional structure and goes on to consider duration, loudness, pitch, timbre, texture, and tempo, finishing with basic tape/machine manipulation.

Chapter 4 : Composition using basic tape editing techniques, gives some useful advice on splicing and editing. Chapter 5 : Composition using two tape recorders, introduces some basic techniques that are possible with two machines, including mixing, cross fading and speed variation, and treatments such as echo, reverberation and multiplication. The chapter ends with a section on tape loops, although diagrams of tape loop guide systems are to be found in Appendix D, at the back of the book. Chapter 6 is devoted to mixers and the treatments possible with them, whilst Chapter 7 is concerned with other treatment devices: filtering, white noise, reverberation, and variable speed control.

Chapter 9 : Basic aesthetic considerations, reviews the compositional process in terms of performing, listening and forming objectives. Other topics include complexity and randomness, time, and structural considerations. Chapter 10 : Setting up an electronic music studio, makes some very general remarks about equipment, accommodation, and studio layout and operation. Unfortunately this chapter is superfluous, since it does little more than skim over considerations that the reader will already have absorbed from the preceding chapters. The 'little more' consists mainly of some rather obvious remarks about accessability and layout, more common sense than expert advice. However, this is a small criticism for a book which is an excellent buy for the novice with serious intentions. The book concludes with five appendices, a bibliography and an index. The bibliography lists 32 books, each of which David Keane summarizes in four or five lines.

Dominic Boreham

MUSICAL APPLICATIONS OF MICROPROCESSORS
by Hal Chamberlin

Hayden Book Company, distributed by John Wiley. 661pp. $24.95 £19.45

Hal Chamberlin's book on Musical Applications of Microprocessors provides an excellent and comprehensive insight into the theoretical and practical use of microprocessors in digital sound and music synthesis. The book will appeal not only to general readers wishing to aquaint themselves with an overview of the microprocessor sound generation field but would also appeal to the specialist already involved in this area. Important music production techniques utilising microprocessors are discussed, and also techniques are presented that could be applied to the new 16-bit microprocessor. The book is

divided into three main sections:
Section I covering the background material
Section II Computer Controlled Analog Synthesis
Section III Digital Synthesis and Sound Modification

Chapters 1 to 5 (Section 1) guide the reader through the basic principles involved in music synthesis, with emphasis on providing a working knowledge of the theoretical and physical properties of sound, so that this understanding will allow intelligent experimentation and facilitate a high degree of control over the sound by using computers. The fundamental parameters of sound are explained with explicit diagrams and tables involving the main 'ingredients' of frequency, musical pitch, amplitude and the shape of the waveform itself.

In Chapter 3 the basic modules of voltage-controlled synthesisers are considered, including Voltage Controlled Oscillators (VCO), Voltage Controlled Amplifiers (VCA), clippers and envelope generators. In Chapter 4, some of the limitations of voltage-controlled equipment and techniques, such as accuracy, the number of simultaneous sounds capable of being produced, and time, are discussed. Chapter 4 continues with the 'representation' of sound in digital form and the conversion of numbers into waveform information, utilising digital to analogue conversion. The computation of sound waveforms is considered using various methods such as 'built-in' functions (sine functions), the Fourier series, look-up tables and hardware 'add-ons'; for example, a multiplier and multiplier-summer circuit. Following this, music programming systems and languages are briefly reviewed, i.e. NOTRAN and MUSIC V, looking at the merits and draw-backs of these two languages. Section I concludes with a brief history of microprocessors, a mention of assemblers and high-level languages and a fairly detailed look at the instruction sets, timing cycles and addressing modes of Intel's 8080 microprocessor, the LS1-II which emulates the PDP-11 and the popular 6502 microprocessor.

The meat of the text is contained in the next two sections, beginning with Computer-Controlled Analog Synthesis in Section II. The application of microprocessors in controlling analogue sound-synthesising equipment is described with emphasis on control rather than simulation of equipment. As such the various types of circuits and equipment that can be controlled, the interfacing techniques that are used to obtain control, and the programming and human interfacing needed to effect control, are considered. Emphasis is placed on the control of analogue synthesising equipment, using digital techniques. Again the basic modules, VCO, VCA and Voltage Controlled Filters are examined, but this time in greater detail, with many practical circuit diagrams and applications. Chapter 7 goes on to consider Digital-to-Analog Convertors (DAC) and Analog-to-Digital Convertors (ADC) and the multiplexing of these devices, (making one convertor appear like several identical, but slower, convertors).

At the end of Chapter 7, three assembler language sub-routines are included that demonstrate successive approximation, analog-to-digital conversion routines for the 8080, 6502 and the LS1-II microprocessors. The remaining four chapters (8 – 11) of this section deal with the interconnection of the synthesis and interface modules into a useful system, and divides them into three fundamental areas:

- Interconnection manually
- Interconnection with computer-controlled switching
- 'Instrument-orientated' organisation

A detailed examination of the techniques used with this organisational philosophy is expanded in Chapter 9, giving circuit diagrams and assembler program listings for a 6502, five octave, velocity-sensitive keyboard. Other manual input devices are included, such as joysticks and graphic digitizers, and finally in this section the application of graphic display devices in music is discussed, with a practical, simple vector display unit that can be built quite cheaply.

As the previous section dealt with control of external equipment, the last section (chapters 12 – 18) considers the simulation of such equipment. Chapter 12 discusses the Digital-to-Analog and Analog-to-Digital conversion of Audio Signals with schematic diagrams of practical-high-quality audio DACs and filters. Chapters 13-15 consider digital generation of processing techniques, direct waveform computation, linear interpolation and look-up tables with several programs written in Basic for the manipulation of the various techniques described. Other program listings in Basic include main routines and sub-routines utilising a Fast Fourier Transform algorithm. Chapter 14 looks at various methods of digital filtering including low-pass, state-variable, and multiple feedback, All-Pass Digital Filter, and digital Notch Filter, again with illustrations, schematic diagrams and Basic sub-routines to demonstrate filtering methods.

The last two chapters (16 – 18) discuss the implementation and use of previously outlined digital sound synthesis modification techniques, divided into two areas of software and hardware. The hardware topics covered include counters, frequency generators, dividers, Fourier series tone generators and a practical hybrid voice module. The final chapter looks at the software and begins with a general look at the suitability of various higher-level languages such as Fortran, Basic, APL and Pascal and then uses the 6502 micro to serve as an example of a low-level programming technique, with the appropriate 6502 assembler language listings.

Altogether, the book is well planned and presented in an effortlessly readable manner. Not every related subject is detailed to the same degree, and some background knowledge of hardware and software would be advantageous. However, enough information is provided to apply the topics and techniques discussed and for the reader to experiment using the information provided. This book is essential reading for anyone interested in microprocessor applications to music generation.

Nigel M. Johnson

GIGO

Magic Cube does time-travel

Rubik, 37, conceived the idea and had a prototype made in 1974, following which he contacted several dozens of putative manufacturers. It took him two years to land a partner in the small Politechnika industrial co-op, and the 'magic cube' appeared at the 1978 Budapest International Fair in 1976. There an agent for Ideal Toy spotted it accidently.

Computing, August 6 1981

"The appropriate response to such an art of self expression is to identify it as belonging to a personality. But art with a style, unlike art with such a personal manner, requires an elaborated internal structure. And the goal of criticism is, in describing the work's composition, to identify its style, and describe its relation to the implied personality of the artist. In so doing, we return to an account of 'order, harmony, and proportion', though of course our order, harmony, and proportion are very far removed from that of classical art. In describing Gold's work within such a framework, I am not suggesting that her painting is 'dry' or consciously cerebral. Rather, as always in criticism, the goal is discursively to describe what we perceive as sensuous relations.

Thus identifying the internal structure of the artwork with an artist's personality may, right now, seem reactionary. Very much contemporary criticism argues that artistic personalities are mere fictions, waiting to be deconstructed. We all really are, or – perhaps – ought, if we are to be authentic, to become disintegrated personalities. One response to this view is that styleless art which comes, as it were, predeconstructed."

David Carrier : "Sharon Gold"

"For a painting to stand up to being savoured and weighed by posterity, it has to be savoured and weighed by its maker. There is no getting away from it, and this is where Rigden scores. He has closed out concern for eloquence and hasty show in favour of an intense particular focus, and a few sedulously pondered relationships. This is the thing that disturbs the prescriber most, the doyen of safe generalisation, safe because empty, the would-be far-outer, and hot-air balloonist. They cannot quite face up to the fact that paintings are made out of painted parts, discrete physically verifiable elements, 'pieces' or 'marks', and that anything particular enough to be felt as a definite influence, to weigh and press against another, has a history. It cannot come from nowhere. All that tough talk about originality is a sure sign you're afraid you haven't got any, or the ability to recognise it when you see it. And the same with content. But you're sure to find favour with the don't knows. They're anybody's. It's funny how a painter nursing the originality grudge can get to sound like one of your so romantic art-hating art-lovers, calling for the ultimate excruciating beyond-art thrill.

If you think Geoff Rigden is a messy painter when he goes all out, that his surfaces are crude, rough or ugly, you should see thick paint when it is wielded by someone trying for a grand-manner cliché effect, and no real feeling to back it up, that is, no feeling that has found its ways to tune with live paint, on real speaking terms with the means – the manufactured 'ambitious'." etc., etc.

Alan Gouk : "Geoff Rigden, painter"

Both the above two quotes were sent in by Richard Bright; they appeared in *Artscribe* No. 30 August 1981. Easy target Richard, *Artscribe* must surely win the GIGO prize for 1981.

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BRITISH COMPUTER SOCIETY SPECIALIST GROUP

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CAS Secretary: John Lansdown, 50/51 Russell Square, London WC1B 4JX, England.
CAS Treasurer: Dr. George Mallen, 50/51 Russell Square, London WC1B 4JX, England.
PAGE Editor: Dominic Boreham, 42 Campion Walk, Leicester LE4 0PD, England. Tel: (0533) 357487.
CAS (Midlands) Secretary: Dr. Stephen Scrivener, 35 Goodes Lane, Syston, Leicester, England.
CASF – French Branch: Bernard Demio, 12 rue Rambuteau, 75003 Paris, France.
CASUS – US Branch and Editor of US editions of PAGE: Kurt Lauckner, Mathematics Department, Eastern Michigan University, Ypsilanti, Michigan, 48197, U.S.A.

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