Computer - Muse or Amenuensis ?

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Abstract

Most computer systems were, until recently, only graphic recording and output devices (electronic amanuensis) and though possibly useful, not significantly changing the role of art or the artist. The increasing interest in using machine intelligence as part of the creative activity has stimulated new developments in which at the very least the machine can be seen as a catalyst (electronic muse). Nevertheless, artists have hung tenaciously to their traditional roles and critics to their traditional criteria for evaluation. But the logical extension of the use of machine intelligence might more challengingly suggest a change in the nature of creativity and a change in the roles of the relationship of the artists creativity to that of the machine. It is the contention of the author of this paper that the use of such techniques as evolutionary and learning programs will inevitably raise fundamental questions about the role of the artist and the role of aesthetic judgement. It may force a division between evaluating the creative act at a conceptual level (the role of the artist ?) and the act of creativity at the level of an individual evolved manifestation (the computer's role ?).

Nature

Nature is arguably the oldest muse. The nature of this inspiration has oscillated between that of the forms of nature and that of the underlying structures. More recently with the increasing interest in genetics and evolution the interest has switched to nature as an information system. How are the instructions for order, beauty, variety and behaviour coded in DNA, how do they evolve, how do they learn? We are struck at once by how the extreme complexity and variety of nature can be coded in something as simple as the sequencing of the four nucleotides in DNA. We are staggered at the incredible complexity of contemporary living forms with billions of cells as evolved from single cell life forms and possible even from mineral replicators. We are humbled to consider that all living forms whether animal or vegetable consist of the same DNA nucleotides and that for example a human being and spinach contain roughly one-third of their sequence in common. And finally we are faced with the enormous problem that evolution has taken place over billions of years.

The role of the computer

There are many who have been tempted into speculation and work in the field of either metaphor or actual emulation of the principles of genetics or evolution in art and design.[1] Inevitably some of this work does not seem as interesting or as promising as the theory and ideas would suggest and I believe the reason for this is that the inspiration has still not been at a sufficiently fundamental level in considering how such work should act.

It is contention of this paper that it is not possible to design (as opposed to evolve) a computer program of sufficient complexity to produce anything approaching the billions of instructions in DNA. There are some very interesting programs which do indeed directly demonstrate the evolutionary process such as Richard Dawkins' Biomorph program.[2] This allows one to selectively bred and develop new generations of species. This can be done in two different ways. First by generating random mutations on a particular species displayed and then selecting one for further breeding (unnatural selection ?) The second possibility is to tamper with the string of chromosomes available and therefore directly affect the evolutionary process (genetic engineering ?). This program by Dawkins is a great inspiration and fascinating in its own right. It was not however intended as an art or design program and if it were to be considered as such then many further characteristics would be required. In order for the computer program itself to have some sufficient complexity the program itself must evolve from a simple program into a highly complex one. Second, we have to find some simulation or some substitution for the nature of the environment within which selection will occur rather than the arbitrary intervention of some other agent described above as unnatural selection. Some answers to the question of how nature itself decided on environmentally satisfactory solutions are emerging from chaos theory where very clear states such as dying out, becoming permanently periodic, chaotic, or having localised order are characteristic states which are in a sense solutions to particularly kinds of imposed natural problems.

Even popular television programs have been dedicated to explaining that the new science of fractals and chaos theory and every child is now aware of the Mandelbrot set.[3] Nevertheless both the general implications of this and the specific implications in terms of this paper are very far from clear. At the very least it suggests a way of working in which the artist is acting as the initial catalyst by establishing initial rules and some positive feedback system which generates growth. The artist must also have indicated some general way in which the interaction with the environment is going to occur. The most interesting way of working from this point on is to then hand over control completely to the computer and allow the billions of years of evolution to be substituted by the computers patient endless repetition of billions of cycles until some form of environmental outcome is achieved. This means that the computer has not acted as muse or a amanuensis to the artist but the artist has acted as catalyst to the computer. Similarly, it may not be satisfactory to control and select outcomes in traditional aesthetical or formal of other criteria but that perhaps, in the sense of the Dice Man, it is necessary for the artist to take the pledge and accept the outcome without reservation.[4] But this is not to suggest for one moment that the outcome is random. It is far from random because it has been controlled by the evolving forces and logic of the program itself. Random mutations may occur but any particular result is in not way random but as indeed chaos theory shows it has a very clear specific order of itself - "One man's chaos is another man's order".

Examples

Some examples of projects by the author which explore these concepts.

Aesthetic rules

In this experiment conducted initially in l975 the intention was to experiment with aesthetic rules, first deterministically and then in a learning program.[5] The proportional rules of the drawing of the Tuscan column were taken from James Gibbs, Rules of Drawing, written in l732.[6] James Gibbs described these rules as being "a more exact and easy manner than has been heretofore practised, by which all fractions, in dividing the principal members and their parts are avoided", and as a simple example the beginning of the instructions for the Tuscan order read as follows - "Take any height proposed for this order upon a straight line, and divide it into five equal parts; one of those parts should be the height of the pedestal, according to the outer of the division of the scale on the left hand. Then divide the other four parts above into five parts according to the inner division of that scale; the other fifth part shall be the height of the entablature, and the other four parts betwixt the pedestal and the entablature shall be the height of the column, including its base and capital; and this height being divided into seven parts, one shall be the diameter or thickness of the columns". These instructions were initially translated simple into Fortran so that for example those instructions become -

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IMod1  =    Iheight/5
IPed   =    IMod1
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and so forth.

These instructions then predictably produce a deterministic reproduction of the proportions of the original columns. So far this is only of interest in as much as an explicit proportional information was unusual in computer based design programs at that date (and still is not particularly common). But the intention was that the machine should evolve these proportional or other proportional rules for itself and so the next step was to replace each of the fixed ratios given by James Gibbs such as a fourth/fifth ratio of pedestal to base and substitute a random number driven variable. This random number generator was controlled separately for each variable so that the Gaussian distribution at each point could be varied. The intention was that initially the program would produce entirely random columns with wildly differing proportions between the parts and that these would be evaluated by the 'teacher' and on the basis of this evaluation the computer would gradually learn to adjust the Gaussian distribution of the random numbers for each variable until it 'evolved' either a column to match James Gibbs' rules or one to suit the particular aesthetic preferences by the person to whom is being taught. In the event it failed totally and if anything the columns got worse and worse. Since that date I am pleased to report that understanding of nature of learning programs and how to apply these successfully in real life application has greatly improved and that a recent re-run of this program with a more sophisticated learning technique not relying on an external agency is producing very much more interesting and satisfactory results.[7]

Self replicating physical automata

In this example constructed in 1979 each cell of the working model was constructed using simple electronics in such a way that the light emitting diodes were used to display the next growth state of the structure.[8] This first model was deterministic in the sense that the imbedded rules were those for one of Stanislaw Ulam's automata.[9] Therefore the outcome was predictable but the implications of the potential of having sufficient intelligence in each cell of the model is such that it was able to itself to determine what was going to fit adjacently to it, gave a new meaning to the concept of a self replicating automata. What this actually represents is a piece of intelligent structure which is able to reproduce its own rules for growth and continuation. We thus have a structure which is capable of controlling its own growth and development, but the rules are fixed and the next step is therefore to try to develop systems where the rules and their complexity can also evolve.

The generator project

In the generator project for which the author of this paper was consultant to the architect Cedric Price the intention was to develop a computer program for controlling a flexible building to be located in Florida. The intention was that the changing needs the computer program would suggest variable configurations in the building arrangement. Furthermore overall control of the site was to be maintained by embedding electronic components into every part of the building fabric so that in a sense the building became literally 'intelligent'. It was at least intelligent in the sense that it knew where every part of its structure was, had some information being fed back on how it was being used and in response to changing needs was able to suggest changing configurations which was fed to a crane driver who was permanently on the site to move components. The architect was concerned that as people were not used to having control over such a flexible environment they might not make sufficient demands upon the building to test its real potential. We were also concerned that with the power of the microprocessors we were proposing imbedding in the building fabric there was a vast excess of computational power over that needed for the structure to control its own configuration. We therefore suggested that rather than having the rules for controlling the building being deterministic they should also work on a learning program so that the building would gradually learn to adapt the best strategy for adapting itself in response to changing needs and measuring its performance in terms of the way in which the building was then used. The problem of how to produce random variations in the form of a building was overcome by introducing a concept of 'boredom' such that when no change had occurred to the building due to changing in external program for some time then the building itself would become bored and make whimsical and arbitrary suggestions to the change of its form and then discover what response this evoked from those using the building.

The reptile system

This is a structural system consisting of two folded structural plate systems which have the characteristic of fitting together into a very rich and varied form allowing complex shapes to be built and to form straight line edges and openings without cutting components. Again for this project there was a simple deterministic computer program written such that components could be arranged in particular ways and the structure would then be drawn and structural calculations performed. There was also a significant development of a learning program for this project. The computer system worked by being 'seeded' with a minimum configuration of the two structural units in all their possible orientations in space such as closure was ensured. This seed then went through a series of operations of growing it, stretching it, developing it so that automatically large structural envelopes would be developed. Again the capability was built into the program for a very large number of iterations in an attempt to produce a particular configuration of the units in response to a particular problem. The designer conceives of the initial rules for achieving the conjunctions of the special units and is also able to derive more than one seed and the selection of a particular seed for a particular seed influences the complexity of the overall form. This is a direct analogous to having different varieties of the same plant seeds. In this case the question of external control to determine whether or not a configuration was successful were entirely by practical considerations such as it had to find a method of actually reaching the required boundaries of the structure and then some attempt at optimization was made such that it could attempt to find a solution to the structure which employed the minimum number of structural units. It was also for experimental purposes possible to reverse some of these criteria so that it tried to form the required enclosure with the maximum continuous structural surface which of course led to extraordinary complex wrinkled and crumpled surfaces. [11,12]

The universal constructor

The universal constructor is the most recent experiment and so named both in deference to Von Neumann and also because it was also a test bed of universal application. It consists of a number of cells which can be deployed in three-dimensional space. Each cell has 'intelligence' in the form of a fairly complex integrated circuit which enables it to display its own identity, to pass messages, to go into various states. Various configurations of the units and the landscapes on which they sit can be suggested and the experiment takes the form of proposing rules which are then programmed into the logic of the individual units which in turn will form some kind of overall configuration in response to a particular environmental problem. The particular purpose of this model was to experiment with direct interaction with the environment and the environment in this case was to be an active participator. So in a particular application the participator would configure the environment in some manner and then see how the computer system would respond and arrange structure in response to that environment. Again the intention being that the system would gain experience of dealing with both participators in general and specific participators in particular and try to evolve more complex rules for dealing with particular situations. [13,14]

See colour plate for illustration of the Universal Constructor in Use. Figs. 1 and 2 show the light emitting diodes passing messages between units and up stacks of units. Figs. 3 and 4 show an application where the changing light visit patterns represent changing positions in the Laban dance notation. In this particular application the participator instals a set of obstacles or a set for the dancers to respond to and the system then creates a dance response appropriate to that environment. Fig. 5 project by Faiza Mohd. Isa.

Conclusion

The initial question was

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and the answer is no because it was not intended to be an either/or question, but to imply that computers are now moving significantly beyond being either amanuensis or a muse and into new areas requiring a fundamental rethink of roles and aesthetic judgement.

Notes and References

1. For a review of biological analogies in design see: Steadman, Philip. The Evolution of Designs - Biological analogy in architecture and the applied arts, Cambridge University Press, 1979.

2. Dawkins, Richard. The Blind Watchmaker, Longman, 1986.

3. Pickover, Clifford A. Computers, Pattern, Chaos, and Beauty. Sutton 1990.

4. Rhinehart, Luke. The Dice Man, Granada, 1972.

5. Project conducted by the author and a group of students at the Architectural Association 1975, and completed by John Guze.

6. Gibbs, James. Rules for Drawing, London 1732, republished Gregg International 1968.

7. Experiment, John and Julia Frazer 1990, publication pending.

8. Frazer J H, J M & P A. Intelligent Physical Three-Dimensional Modelling Systems. Proceedings of Computer Graphics 80, Online Conferences 1980.

9. Ulam, Stanislaw. On Some Mathematical Problems connected with patterns of Growth of Figures. Proc Symp Applied Math V14 1962.

10 This project is variously published and discussed, see for example:

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'World's First Intelligent Building' *RIBA Journal*, Jan 1982.
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11 Frazer J H & Connor J M. A Conceptual Seeding Technique for Architectural Design Proceedings of PArC, Berlin 1979.

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"Hypothetico-deductive model for design" F Guerra, Architectural Design, April 1974.
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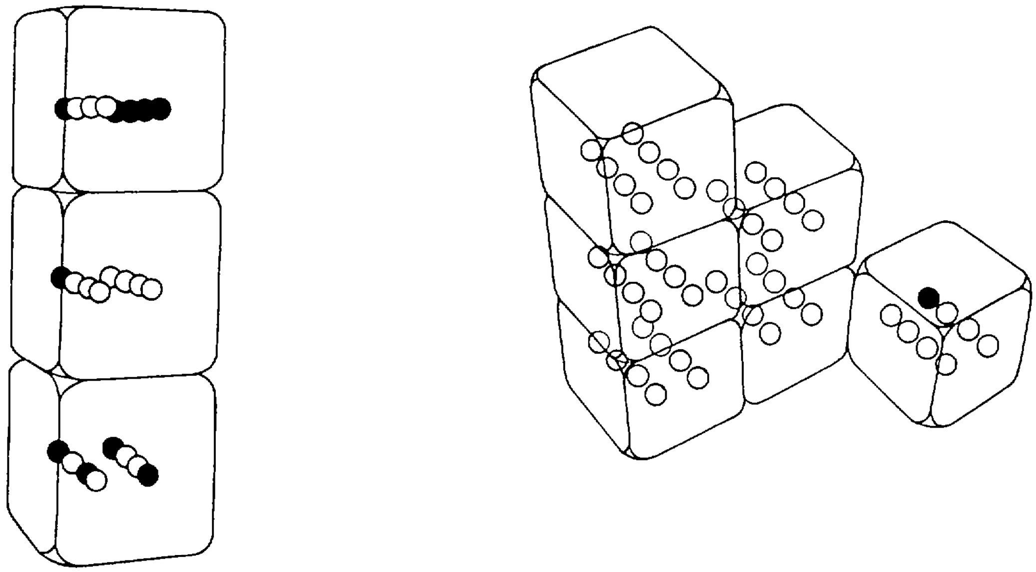

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fig 1 Light emitting diodes passing messages between units

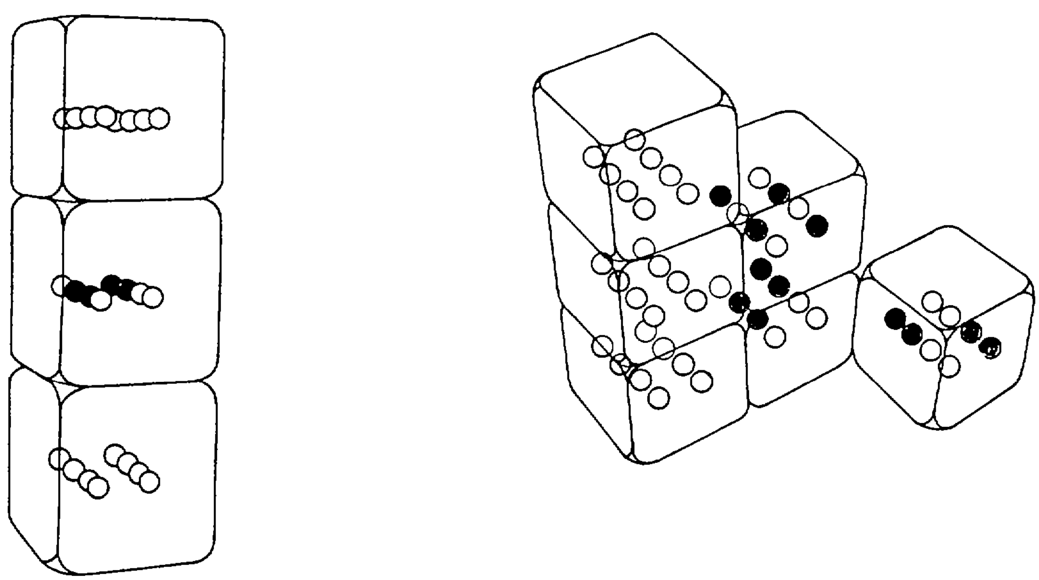

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fig 2 Light emitting diodes passing messages between units

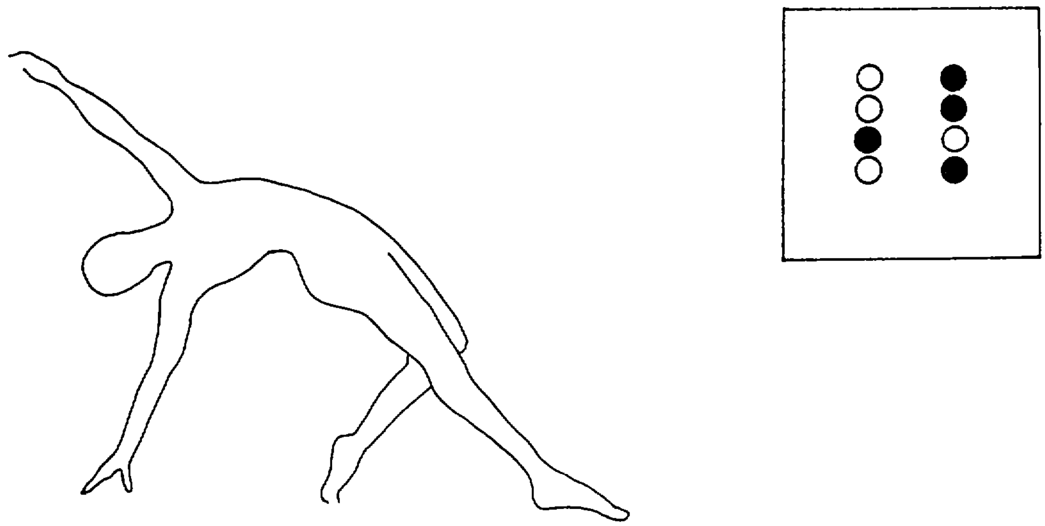

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fig 3 Light emitting diode representing dance position in the Laban notation

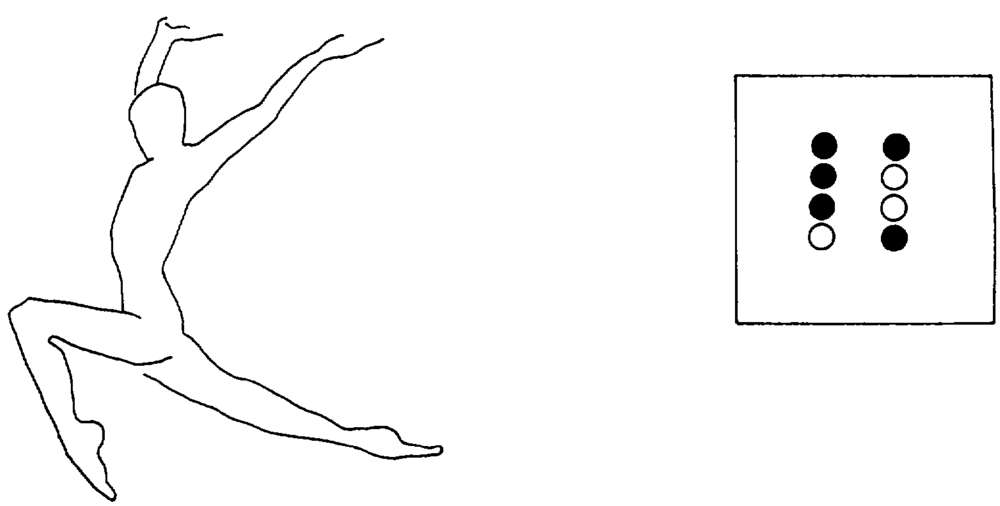

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fig 4 Light emitting diode representing dance position in the Laban notation

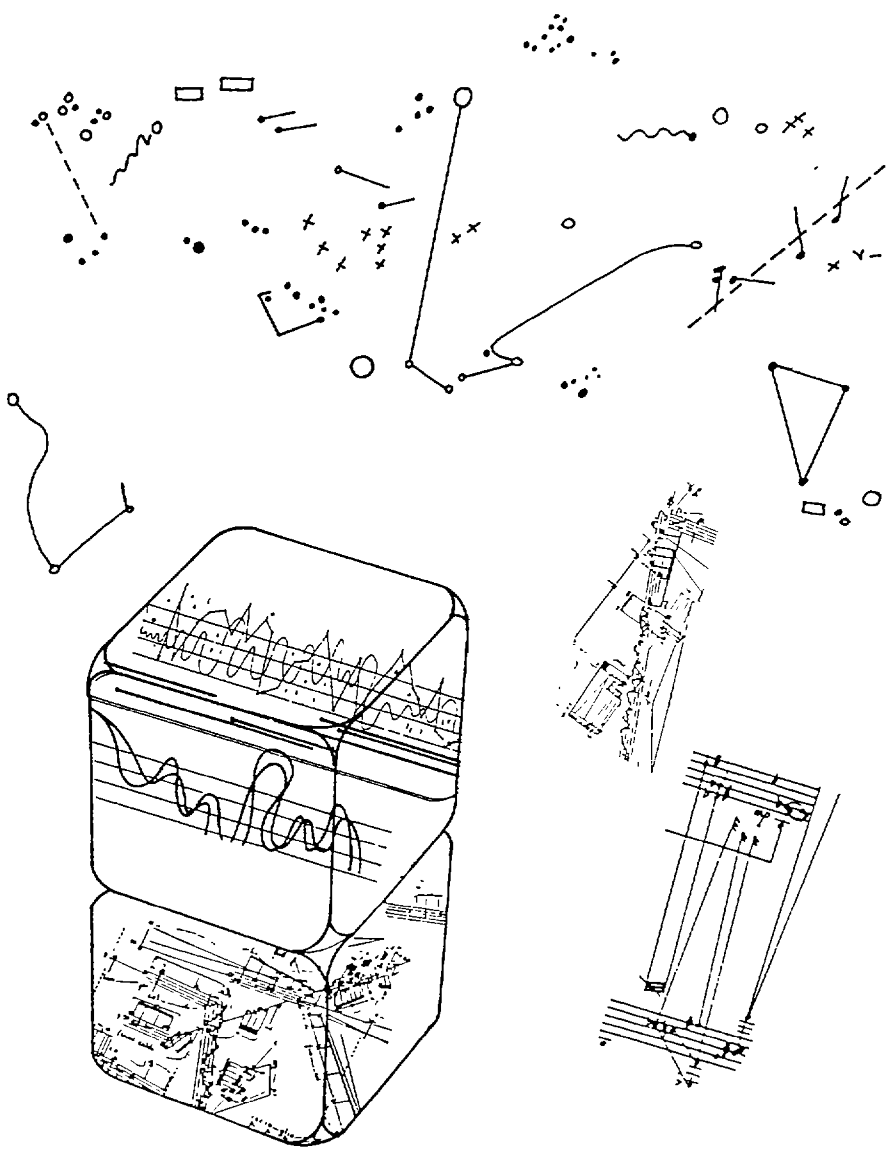

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fig 5 Project by Faiza Mohd. Isa.
Complete dance and music system