Beyond Computable Numbers Revisited

Ernest Edmonds[1]

Abstract. This paper reviews the crucial influence that Alan Turing has had on art and, in particular on the development of the Generative Arts and the employment of automata in the making of art. The paper briefly reviews the concept of using automata in art and the extension of the basic idea to include interaction. The paper revisits an earlier argument and homage to Turing and brings it up to date.

1 INTRODUCTION

The most important contribution that Alan Turing made was in his 1937 paper [1], in which he proposed a full account of computation illustrated by what has become known as the Turing Machine. As Jack Copeland put it: this paper "contains his most significant work. Here he pioneered the theory of computation, introducing the famous abstract computing machines soon dubbed 'Turing machines'" [2:6]

Turing's contribution was his most significant to art as it was to our culture and our lives more generally. This abstract machine was shown to be able to compute anything that could be finitely defined, given a particular point of view. This point of view was subsequently taken as the received position and pointed directly to the possibility of constructing real machines. These machines became known as 'computers'. The abstract machine that Turing invented might more correctly be termed an 'automaton', a mathematical model of what we know as a 'computer'.

'Automata' comes from the Greek for 'self-acting'. Automata, then, are machines (sometimes abstract mathematical ones and sometimes physical ones) that perform some set of actions in sequence on their own, normally without human intervention. Automata, as real machines, are sometimes associated with surrealism and this raises the thought "what is the relationship between Turing's ideas and surrealism?" This relationship is curious, but interesting.

Wiszniewski, Coyne and Pierce addressed the issue, contrasting the Turing and surrealist positions: "Alan Turing worked with and invented machines … Though at opposite ends of the philosophical spectrum, aspects of Turing's machines also resonate with the quasi-mechanical devices of the surrealists." [3]. Of-course the surrealists were directly opposed to the rational use of logic that was central to Turing. However, in discussing dreams in *The Manifesto of Surrealism*, Breton said "… when it is subjected to a methodical examination, when … we succeed in recording the content of dreams … we may hope that the mysteries … will give way to the great Mystery" [4]. Breton might have been very surprised, but probably not very pleased, to see that the application of the automata that Turing gave rise to have contributed towards this methodological examination.

2 AUTOMATA AND ART

Crucial to the Turing machine was the concept of computation and the finite definition of processes that could 'calculate' any 'computable' number. These concepts arose out of a long and difficult journey that had taken place in philosophy and the foundations of mathematics in which, for reasons that we will skip in this short paper, even the reliability of arithmetic had been called into question. The history is briefly summarized, with references, in [5].

For art, computation introduced a wholly new possibility: that of defining a making, designing or construction process in a finite way that could lead to an automatic method of making the artwork itself. The possibility of automata making art became a reality. A certain mystery could be removed from aesthetic dreams.

In many ways the idea of automata making art could be seen as an answer to the constructivist dream of replacing 'composition' by 'construction' [6]. In 1921 the constructivists had turned their back on 'composition' and the strong concentration of the arrangements of colour and form that made up the appearance of the final art object. In stead they advocated a constructive approach in which, by one means or another, the artist defined the construction of the work and left the final appearance to be determined by the consequences of that process.

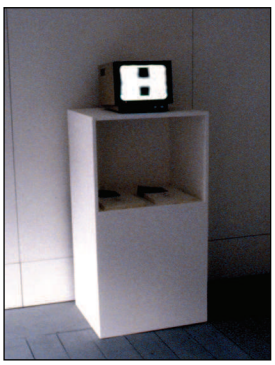

Figure 1. Fragment in Exhibiting Space, 1985

Once computers became used in art, and the consequences of Turing's ideas had been absorbed by artists, the form of art, now known as 'Generative', appeared [7]. Generative art is one of the notable new art forms that arose in the twentieth century. Here, the artist specifies a set of rules, they may relate to A-life that Turing also, in effect, researched [8]. A

[1] De Montfort University, Leicester, UK and University of Technology, Sydney, Australia. Email: ernest@ernestedmonds.com

computer then uses the provided rules to construct or compute the artwork Often it is time-based and the audience watches or listens to the generative process. Unlike a film, of-course, a time-based generative work can go on forever without looping.

The author's own first time-based generative work was made by recording directly onto video. It is called 'Fragment', made in 1984-5 and first shown in his one-person exhibition at Exhibiting Space, London, in 1985, see fig.1.

3 'BEYOND COMPUTABLE NUMBERS' REVISITED

In his 1937 paper, Turing recognized that a human could influence the processes defined for his machines to follow. In other words, he saw that an interactive version of the Turing Machine was possible, although he chose not to deal with it within that paper. This is much like the interactive computer of today.

The author gave an Inaugural Professorial Lecture on the topic of Alan Turing's influence on art at Loughborough University, UK, in 1987 [5]. The lecture was titled "Beyond Computable Numbers". In it, it was argued that the implications of Turing's 1937 paper went far beyond technology and its economic exploitation: "the most significant implication…might finally be seen in the constructs of the artist." The systems used by Kenneth Martin in his art were presented as an example and pointed to the importance of interaction and the interactive art that can be seen as an extension of such art practice.

Since 1987, Generative Art and Interactive Art have both grown very strongly. See, for example, the range of work reported in the recent book "Interacting" [9]. Burraston, for example, has worked extensively with automata (a kind known as 'cellular automata') in generating new music and has evolved new forms of music in that process. His research into the use of automata in music making has even extended our knowledge of the automata themselves [9:112].

Seevinck looked in depth at interaction with her computer-based artworks and considered some very specific issues in relation to participant experience [9:242-256]. She showed how the interactions with the automata like artworks could lead, for example, to the experience of 'emergence' by participants and she made this a central concern of her art. Participants can discover, or perhaps create, new forms as a result of the interactive process. So interaction with automata can yield new kinds of experiences in art.

In the author's own work, he has continued to make time-based pieces that use the generative processes that Turing's ideas enabled. The processes have been interactive ones where external events. Typically sound or motion, have modified the process or the rules determining that process.

Figure 2. Three Stills from Shaping Form, 2012

These works are designed to interact with the environment in which they are found. They work with structural relationships between visual elements that determine how these images are constructed. The works are made to learn from external movement such as a hand waving or a person walking by. The way it 'learns' determines the choice of colour and pattern in the images displayed as well as the timing of changes. Fig. 2 shows some still images from one of these works.

The behaviour of the work is not intended to always be obvious, so that if you continuously try to force a response by waving or shouting, that might result in a period of stillness. A computer program continuously analyses movements detected in front of the work. As a result of this analysis, the rules are steadily modified in a way that accumulates a history of experiences over the life of the work. The shaping of the form is a never-ending process of computed development.

4 CONCLUSION

Alan Turing enabled the development of the generative arts, including interactive art. Whilst it is important to recognise the significance of Turing's vision and contribution to artificial intelligence and artificial life, for example, that vision was, in fact, a result of an open and intelligent deduction of the inevitable consequences of his discovery and inventions in formal computation.

The whole idea of formal computation, which is embodied in the machines that we know as computers, has brought a new form into art practice and continues to offer new directions for artists to explore and exploit. Artists are building automata that generate artworks. Far from being surreal, this is extending the role of the rational into deeper parts of the art making process.

REFERENCES

[1] A. M. Turing. 'On Computable Numbers with an Application to the Entscheidungs Problem' *Proceedings of the London Mathematical Society* Ser **2**-42. 230-265 (1937).

[2] B. J. Copland, (ed) *The Essential Turing*, Oxford University Press, 2005.

[3] D. Wiszniewski, R. D. Coyne and C. Pierce, 'Turing's Machines', *Proc. ECAADE99: Turing to 2000*, Liverpool. 25-32, (1999).

[4] A. Breton, 'Manifesto of Surrealism'. English translation in R. Seaver and H. R. Lane (translators) *Manifestos of Surrealism: Andre Breton.* University of Mitchigan Press, 2-28, 1972

[5] E. A. Edmonds, *Beyond Computable Numbers: Inaugural Lecture*. Loughborough University of Technology, 1987. Published in a revised form as 'Culture, Knowledge and Creativity - Beyond Computable Numbers'', *Languages of Design*, **1 (**3), 253-261, (1993).

[6] M. Gough. *The Artist as Producer: Russian Constructivism in Revolution*, University of California Press. 2005

[7] P. Brown, (ed) Special issue on Generative Art. *Digital Creativity*. **14** (1) (2003).

[8] A. M. Turing. 'The Chemical Basis of Mophogenesis' *Transactions of the Royal Society*, Series B. 37-72, (1952).

[9] L. Candy and E. A. Edmonds (eds) *Interacting: Art, Research and the Creative Practitioner*, Libri Press, Oxfor. 2011.