Turing’s Machines

Dorian Wiszniewski, Richard Coyne and Christopher Pierce

We outline four types of machine that informed Turing’s investigations: the subversion machine, the improving machine, the perfect machine and the dysfunctional machine. We show how each deals with the issue of dysfunction, and argue that in design the ways that machines do not work can be just as illuminating as how they do. In this investigation we call on the reflections of the surrealists who sought the incongruity of object and context as the means to understanding the anarchical play of design.

Keywords*: CAD, Turing, architecture, machine, surrealism*

Introduction

Alan Turing worked with and invented machines, notably the encryption, Turing, universal and cipher machines. These early computers pre-date CAD (computer-aided design) systems, evolutionary computer systems, putative expert systems, and the countless configurations of hardware and software that constitute and populate virtual reality and cyberspace. Though at opposite ends of the philosophical spectrum, aspects of Turing’s machines also resonate with the quasi-mechanical devices of the surrealists, and their conjectured electronic descendant, the peculiar human-machine hybrid known as the cyborg (Harraway, 1995).

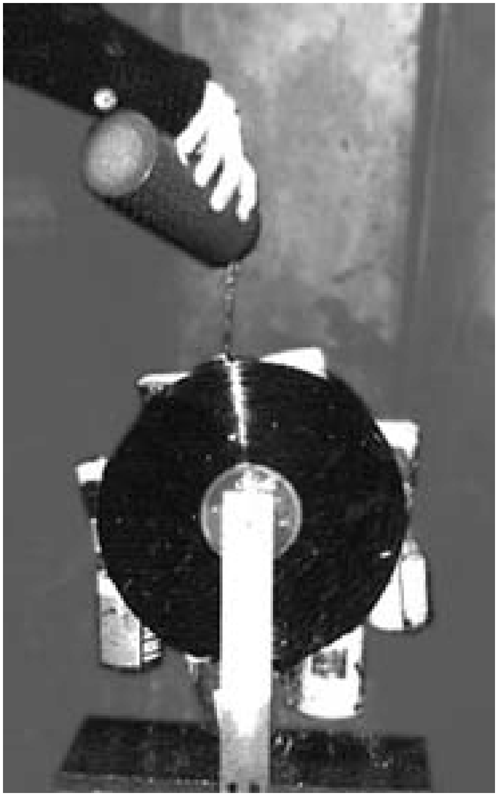
We commonly associate the machine with function. A machine works, instrumentally, to extend our capability, allowing us to design faster or more accurately, and solve more complicated problems. As we shall see, Turing’s machines had a complex relationship with the concept of work and function. In this paper we present the case that the machine can also be understood productively through the concept of dysfunction, and the relationship of the machine to failure further opens up its possibilities in design, and computer-aided design.

The Subversion Machine

As well as carrying out a function, a machine can serve to expose and exploit dysfunction. Turing’s early encounter with encryption machines was as strategic instruments of war. Military operations were only effective if internal communications could go undetected. The encryption machine exploited the weakness in enemy communications.

This subversive role of the machine is similar to how certain design theorists understand the machine. A reading of Vitruvius (1955) suggests that a builder needs to know the construction appropriate to what a machine is capable of accomplishing: the work of cranes, pulleys, wheels, aqueducts and viaducts. However, Vitruvius also outlines the machines of destruction: catapults, balistae, ram-tortoises, movable towers, ditch filling tortoises, tortoise diggers and siege engines. Before building a city one must also consider the machines for its destruction, as between the construction and destruction machine lies the place to gain intimate knowledge of the city which can adapt to them.

This reading of the subversion machine supports the popular narrative about the invention and development of the Internet (and its predecessors), as a distributed and redundant, rather than a centralised, system to counter the possibility of its destruction through a nuclear strike. Generalising Vitruvius' exhortation, we design artefacts (cities, buildings, computer systems) to withstand the ravages of whatever we can design to subvert the function of the artefact. The potency of this play between construction and destruction is exemplified in the computer world through the perpetration of computer "viruses," a subversive movement within computer programming culture that is not entirely destructive. The constructive/destructive game of the computer hacker places security, robustness and automated agency on the agenda. As part of an industry of moves and countermoves, it informs the development of operating systems, networks, and programming practices.



The encryption machine was part of a larger system of machinery: the machinery of war, which included the German Enigma machine built to counter espionage. For Turing, "ciphering [coding] was the necessary consequence of wireless telegraph communication" (Hodges, 1986, p. 162). Turing's work in encryption was motivated by an attempt to establish strategic supremacy over the Enigma, and this led to the creation of the Colossus by Flowers, Broadhurst and Chandler. The encryption machine was caught up in networks of moves and countermoves. Each machine was designed to outdo the other, and there were other machines, of communications networks and bureaucratic organisation, that were designed to accommodate and/or withstand them.

Many theorists have shown how this oblique, de-constructive mode of invention pervades design activity, and can be made explicit in the educational design studio. In a recent project we required students to build a machine for understanding the city (Figure 1).

The character of the city was revealed through the way it accommodated and resisted the machine. Students subsequently designed an intervention into the city derived in part from that understanding, through the operations of accommodation and resistance, function and dysfunction.

It is also useful to attend precisely to how Turing thought the encryption machine exposed the enemy's weakness, and how this informs the project for artificial intelligence in design. The encryption machine subverted by breaking the enemy's "will." As an early exponent of artificial intelligence, Turing was concerned with reason and thinking as rule-based operations. The "work" of the machine is merely a mechanised version of the work of the mind, the human computer, and can replace it: "The human computer is supposed to be following fixed rules; he has no authority to deviate from them in any detail. We may suppose that these rules are supplied in a book, which is altered whenever he is put on to a new

Figure 1 (keft). Objects found on an urban site reconfigured into a sampling machine for "remixing" the historical terrain, by Jimmy Bell, Will Lindley, Tom Miller and Tom Robbins. The eventual project was the design of a school for "difficult children."

job. He has also an unlimited supply of paper on which he does his calculations" (Turing, 1995, p.14). The mechanical version of this worker, now known as the Turing Machine, makes a "store" of the human computer's paper, the rule book or "table of instructions," and with human memory; it constitutes an "executive unit" which carries out the "individual operations involved in a calculation," from basic commands to those that are quite complicated; and a "control" which monitors the executive unit to be sure that it carries out the instructions properly and in the right order.

Cipher machines have "codes of conduct," which constitute "states of mind," and of course, the more complex the codes the more states of mind the machine has: "each state of mind of the human computer being represented by a configuration of the corresponding machine" (Hodges, 1986, p. 106). But these states of mind are determined as codes, and as the success of the wartime decoding operation demonstrated, they can be broken. In breaking their sates of mind, their will, the will of the enemy is broken. Research into evolutionary systems, shape grammars and artificial intelligence commonly invoke Turing's concept of the rule-based reasoning machine. But, following Turing, we can also see that systems of rules can be decoded, subverted and broken. By this reading, if such rule-based systems are to have a role in creativity, it will be accomplished to the extent that they can take their place in a network of functional and dysfunctional operations, constructions and destructions, operations not altogether alien to the workings of Turing's machines.

The Improving Machine

The role of the machine in this network of construction and destruction recalls the workings of natural selection: fitness for survival, progression and evolution. Furthermore, any machine is on the way to perfection, full and perfect functionality: if not in this generation then through its successors. Turing's machines are often invoked in a lineage of devices to situate the computer, to give it a legitimate place in history. For both the computer and for architecture there are lineages of artefacts, family relations, inheritance and evolutionary progressions. In the case of the computer there is the abacus, the Lullian Wheel, Babbage's Analytic Engine, the Jacquard loom, and the Turing Machine, a narrative also recounted by Turing (1995). In the conventional account the narrative establishes the computer's place on a trajectory of progress and improvement. We can overlook the current inadequacies of the machine as its perfection will be realised in its successors. In a more romantic account the origins of the computer reside in the marginal domains of craft and weaving, to which we may some day return with the computer's help (Plant, 1998).

Turing had a vision of how this trajectory of improvement can be realised in a single machine. For Turing, there is the possibility that a computer's "rule book" can be extended over time. As new knowledge becomes available new rules can be written. A machine that can write its own rules, or learn to write its own rules, is on the path to perfection. Turing posits a kind of computer that accelerates the learning process, a process "more expeditious than evolution" (Turing, 1995, p. 32). The machine in its initial state correlates with the child's cerebral genetic structure. Following the reasoning of the early empiricists, this is like a notebook, with "rather little mechanism, and lots of blank sheets" (Turing, 1995, p. 31). Information is written on these pages. The processes of natural selection come about by the interventions of a human teacher or scientist. This scientist-judge is responsible for determining the acceptability of the genetic mutations in the "child's mind." The scientist is a partner in the eugenically produced new child. If the scientist "can trace a cause for some weakness he can probably think of the kind of mutation which will improve it" (Turing, 1995, p. 32). Over time the scientist will acquire greater knowledge and will input the benefits of this knowledge into the machines directly. The machines will be better as a result.

However, as Turing acknowledges, there is a paradox to the evolutionary machine. If the machine is constituted on the immutable rules of logic, how can they change? For Turing there are rules that have only ephemeral validity and can be changed. The choice of rule makes "the difference between a brilliant and a footling reasoner, not the difference between a sound and a fallacious one" (Turing, 1995, p. 33). But the learning machine raises the question of the eternal validity of the putative universal logic on which the machine is founded. The learning machine seems to subvert the claims of the Turing Machine to universal validity, a controversy encountered in artificial intelligence, "nonmonotonic" logics and "automated learning" generally.

Faced with this dilemma, Turing deflects from the issue of truth to that of goals. Truth is not the objective in judgement but, the objective is to have an objective. So Turing's project raises the question: what is the logic of goal setting? The legacy of the surrealists provides an answer, at least as far as design is concerned, by presenting a "logic" of aimlessness, a logic of an anti-rationalist, non-positivistic outlook on making. As we have shown elsewhere, developments in multimedia and the world-wide web owe as much to the surrealist impulse (the strange juxtaposition, the object in a new context, the surprise encounter of the flaneur, the dysfunctional machine, fractured identity, the cyborg) as to an instrumental logic (Coyne, 1999). The surrealist impulse also informs design practice in so far as design appropriates the language of difference (poststructuralism), the subversion of conventional oppositions (deconstruction), and the residence of the imaginative impulse in the space between the metaphorical and the literal (Ricoeur, 1977).

Feyerabend brings scientific inquiry into line with these aspects of design, taking the objective of science towards anarchy, advocating that the scientist could take a spoonful of the "medicinal anarchy" of Dadaism and Surrealism, to temporarily disrupt the rationalist machine, to create friction in the course of its momentum:

> *A Dadaist is convinced that a worthwhile life will arise only when we start taking things lightly and when we remove from our speech the profound but already putrid meanings it has accumulated over the centuries ("search for truth"; "defence of justice"; "passionate concern"; etc., etc.) A Dadaist is prepared to initiate joyful experiments even in those domains where change and experimentation seem to be out of the question ...* (Feyerabend, 1978, p.21).

As a controversialist in the philosophy of science, Feyerabend attempts to challenge the teleological imperative of scientific investigation. The same exhortation can be applied to the improving machine. It is not just that Turing's learning machine does not work — it contains within it the germ of anarchy, of aimlessness, the subversion of its own logic.

The Perfect Machine

The evolutionary metaphor suggests progress towards an ideal machine. Turing had such a machine in mind as he broached the concept of the Oracle, the universal machine that could perform "uncomputable" operations. Mathematicians harbour the concept of the ideal machine, the mathematical and logical construct that is theoretically useful, but otherwise impractical to build and use. Furthermore, the computer world is caught up in anticipations, utopian images, re-creations of former machines, and it seems to matter less what computers can accomplish now than what they will or should accomplish in their idealised form in the future.

Turing's perfect machine relies on a re-articulation of the question "Can machines think?" The perfect machine or universal machine is the "one particular machine that could simulate the work done by any machine" (Hodges, 1985, pp.102-103). The point of simulation is the key to radicalising Turing's question. His universal logic relies on a metaphorical association between mind and machine, thinking and mechanics.

In positivist style, Turing deflected the question of a thinking machine from a consideration of exactly how the mind operates, which is the subject of mere conjecture, to the verifiable proposition that a machine can be made to imitate thinking, such that it produces output as though it were thinking, to be verified by the so-called Turing test. So the actual working of the mind is beyond meaningful analysis. This silence on the actual mind deflected his attention towards a further metaphor of the perfect machine, that of the skin-of-an-onion. The child mind, simple mind, or animal mind is sub-critical, that is, capable of only a superficial treatment of an idea. It can respond to an idea with the same or only one other idea. There are “basic machines” that can fulfil this function. However there is a kind of mind that is super-critical, that is capable of receiving an idea and extending it into “secondary, tertiary and more remote ideas.” This adult mind reveals layer upon layer, stratum upon stratum of possible ideas, numerous enough to quantify approximately to a sophisticated model. As with the skins-of-an-onion, the structure of the mind resides not in the core, the “real mind,” but in the layering.

Again, there is an operation in play that subverts aspects of the programme for the thinking machine. The core of the thinking apparatus is conjectured to disappear the closer we get to it. This is the paradox of idealism. Turing’s model of the successive peeling back of layers resonates with the multilayered model of knowledge and the cosmos outlined by the Neoplatonists, and succumbs to the same inadequacies. As shown by Derrida, on detailed analysis, the ideal, the transcendent, disappears, which is to say it depends on that which it purports to support (Derrida, 1976). In this case the substrate depends on the layers.

The problem with Turing’s learning machine recalls Yate’s account of the seventeenth century memory theatre of Camillo, an earlier “thinking machine.” Contrary to the workings of Turing’s learning machine, the memory machine uses imagery to help an actor recall her lines. But here information is not only seen instrumentally, but as providing access to the divine order of the cosmos: “representing all that the mind can conceive and all that is hidden in the soul — all of which could be perceived at one glance.” (Yates, 1984, p.161) But the memory theatre as machine promotes an occult mystery, shrouded at every turn in incomprehension. Turing encounters similar obstacles. The ideal core of thought eludes capture. As with the positivist project in general it results in silence. Turing attended Wittgenstein’s lectures (Hodges, 1985, p.215) in the 1940s, and it was Wittgenstein who brought the ineffable to centre stage in modern philosophy: “Whereof one cannot speak, thereof one must be silent” (Wittgenstein, 1922, p.189). The perfect machine, and the mind as its instantiation, is beyond comprehension, a concept that caused difficulty for positivism, and arguably contributed to its demise. The concept of resistance to linguistic expression became a central theme for poststructuralist philosophers of mind such as Lacan (1979), and those who invoke Lacan in their surreal accounts of the disruptive effects of electronic communications (Hayles, 1998).

The Dysfunctional Machine

Machines can be rendered dysfunctional by other machines. The Colossus was the undoing of the German Enigma machine, rendering its coding strategies dysfunctional. The learning machine attempts the progression from dysfunction and partial function to perfect function. The ideal in turn recalls the unworkable. The paper-based Turing machine is impractical, which is to say unrealisable. In its less metaphorical form, as a formal production system of rewrite rules, it presents an unworkable procedure for constructing most practical computer programs (it requires the programmer to think at too detailed a level, amongst other things), functioning rather as a means of establishing certain theorems about computability. Formal proofs in turn rely on affirming the negation of a hypothesis: disproving that something is not the case (that is, demonstrating that the negation of the hypothesis produces a logical contradiction) rather than proving that it is the case. Dysfunction (the consequence of falsification) has a role in science. Like Popper, Turing concedes that it is a fallacy that scientists progress from one certain fact to another. Often unproved conjecture is the impetus for experiment (Turing, 1995, p. 19).

A typology of dysfunction would include machines that do not do what they are supposed to, machines with unexpected behaviours, incapacitated machines, imaginary machines that could never work, machines as amusement, machines conceived in ignorance of machinic operations, and machines pushed beyond the limits of their effective functioning. In so far as modernism in architecture traded on a romance with the machine, it invoked the machine at the limits of its functionality. According to Harbison, "Modern architecture's love affair with machines often stems from and ends in a sense of drastically circumscribed possibility" (Harbison, 1997, p.43). All are of use to designers. Designers, whose ultimate object is other than the design of mechanical devices, are able to maximise the play on the dysfunctional machine, no less so than in the context of cyberspace and architecture (Figures 2 and 3).

Figure 2 (left). A machine for navigating through cyberspace by Helen Woodcraft. The unlikely controls carve up information space to expose a single, contiguous crystal of information.

Figure 3 (bottom left). A machine (pavilion) for amplifying the sounds of a rock falling into the sea, by Daniel Gibbons.

The message of cyberspace is that it is a place where anything is possible — where better to turn ignorance of machinic and geometrical function into virtue? William Gibson is on record as saying that:

> *most of the time I don't know what I'm talking about when it comes to the scientific or logical rationales that supposedly underpin my books … It wasn't until I could finally afford a computer of my own that I found out there's a drive mechanism inside — this little thing that spins around. I'd been expecting an exotic crystalline thing, a cyber-space deck or something, and what I got was a little piece of Victorian engine that made noises like a scratchy old record player. That noise took away some of the mystique for me; it made computers less sexy. My ignorance had allowed me to romanticize them* (McCaffery, 1991, p.269).

Contrary to impeding the design process, such inattention to the practices of inventing, producing, and using machines seems to provide scope for the productive play of design.

Countless research programmes in computer-aided design attest to the fact that even though a computer system may not function as proposed — in providing the intelligent user interface, the seemless sketch environment, automated plan generation, user acceptance, automated design assistance — that does not invalidate the research programme or render it useless, especially if we see the machine much as the surrealists regarded the *object*, as an intervention into some context, that has the potential to expose something new by virtue of the differences it brings to light. In this light, Turing's machines are interventions into the context of reflections on thought, exposing what thought is and is not. Reflections on mind developed within analytic philosophy, phenomenology, structuralism and cognitive science, offer various forms of accommodation and resistance to the provocation of Turing's machines, which did not need to be fully functional to fulfil this role. Similarly, the design enterprise can be abetted by computer-aided design (CAD) machines, but it can also be informed by machines that do not work, and those aspects which fail to meet our expectations. This is not to champion dysfunctional computer programs, but to recognise that CAD has an impact other than making drafting easier. CAD machines have provoked new understandings of design, not only by showing what design is, but revealing what it is not.

This article is supported by a textual machine of sorts that elicits an agenda for discussing the interrelationship between Alan Turing, computing, history and architectural design under four headings: The Subversion Machine, The Improving Machine, The Perfect Machine and The Dysfunctional Machine. This textual machine is designed to show that the way machines fail to work and the way they subvert each other's functioning presents a productive line of inquiry in the context of computers and design. Turing's project towards a thinking machine by the turn of the century seems to have failed, but there are aspects of his argumentation that turn this failure into a virtue, particularly for theories of design.

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Dorian Wiszniewski (1), Richard Coyne (1) and Christopher Pierce (2)
(1) Department of Architecture
University of Edinburgh, UK
(2)School of Architecture and Building Engineering
University of Liverpool, UK