Frontiers of Architectural Research (2014) 3, 368–375

Available online at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/foar

Frontiers of Architectural Research

RESEARCH ARTICLE

Circular causality and indeterminism in machines for design

Thomas Fischer

Department of Architecture, Xi'an Jiaotong-Liverpool University, Suzhou 215123, China

Received 29 September 2013; received in revised form 15 June 2014; accepted 16 June 2014

KEYWORDS
System boundaries;
Design;
Predictability;
Enigma

Abstract
Presenting a hard-to-predict typography-varying system predicated on Nazi-era cryptography, the Enigma cipher machine, this paper illustrates conditions under which unrepeatable phenomena can arise, even from straight-forward mechanisms. Such conditions arise where systems are observed from outside of boundaries that arise through their observation, and where such systems refer to themselves in a circular fashion. It argues that the Enigma cipher machine is isomorphous with Heinz von Foersters portrayals of non-triviality in his non-trivial machine (NTM), but not with surprising human behaviour, and it demonstrates that the NTM does not account for spontaneity as it is observed in humans in general.

1. Background

From the inside, it can be challenging to determine the scope, shape and development of the field one is operating in. Are the frontiers of architectural design research static, unvarying limits? Or are the frontiers of architectural design research changing borderlines, shifting according to modes, depths and directions of enquiry? To what extent do its design and research aspects overlap, and to what extent are design and research comparable or compatible? Do design and research have enough in common to be approached as equals, rendering insights into one of them applicable to the respective other? Are they viable models or metaphors for one another, or are they too different to allow such analogies between them? Answers to these questions, of course, depend much on what is meant by design and by research.

Understandings of design and research, of their methods, tools and standards, diverge considerably in different contexts. The argument presented here addresses design, design tools and research methods in reference to systemic boundaries and circular re-entry, and with regards to the notion of determinability in order to shine a critical light on those instances where design and design research are approached in terms of purely linear cause and effect. It is shown that conceptualisations of design (research) in terms of (natural-scientific or computational) linear causality may be unduly limited.

Peer review under responsibility of Southeast University.

http://dx.doi.org/10.1016/j.foar.2014.06.003

The argument below draws parallels between the designing human mind and a mechanical (cipher) machine. This is not to say that the mind is like a mechanism, or that mechanisms can act in the ways human minds do. The point made is merely that minds and some mechanisms are characterised by circular re-entry, which, in both cases, leads to indeterminable behaviour, i.e. novelty. Neither circular causality nor indeterminism, however, is recognised by natural-scientific reasoning.

2. System boundaries, input, output and re-entry

Computer-aided architectural designing is an endeavour in which the boundaries of systems are crossed. "System" is understood here as whatever set of elements an observer considers to act together, following a common goal. An observer may choose to regard the components that make up a computer as a system. Similarly, an observer may choose to regard the organs making up the organism of a designer as a system, or consider the designer and the computer together as a system. With these different ways of looking (Weinberg, 2001), the imaginary boundary that circumscribes what is regarded as a system changes, and what is considered as a system lies in the eyes of the observer. Sometimes there are physical boundaries containing what is regarded as a system, such as the skin of a designer and the case of a computer but this is coincidental. Designer and computer together may be regarded as one system contained by an imaginary, but without a physical boundary. Patterns in the widest sense crossing the imaginary boundaries of systems are, depending on perceived direction, called inputs and outputs.

A common example of systems whose boundaries are crossed by incoming inputs and by outgoing outputs is the behaviourist-type stimulus-response structure of the kind shown on the left-hand sides of Figures 1 and 2. This structure offers convenience in modelling various systemic relationships not only by way of abstraction and of being broadly applicable. It is also conveniently compatible with common basic tools of rational modern thought such as linear logic and syllogistic reasoning. Humans are frequently described as systems which, prompted by input, produce output. And, typically, so are computers. Alternatively, although this happens less frequently, an observer may also choose to view multiple systems (inter)acting together as one system which responds to input by producing output. Human-computer interaction in CAAD may be viewed in this way, along the lines of the following statement by Bateson (1972, p. 317): "The computer is only an arc of a larger circuit which always includes a man and an environment from which information is received and upon which efferent messages from the computer have effect." Other examples in the design context include the interactions between members of a design team, and the interaction between a designer and his or her sketching (Fischer, 2010, p. 612).

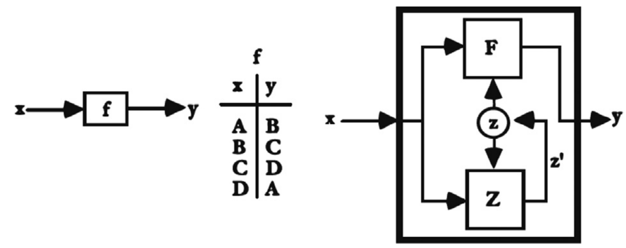

Figure 2 Trivial machine with truth table (left) and non-trivial machine (right), reproduced from Von Foerster (2003, pp. 310-311).

Any of these systems – human, computer, human-human, human-computer and so on – is defined by an imaginary boundary projected by an observer. This imaginary boundary sets the system's interior apart from its exterior. If a human considers herself or himself as a system, then making (the interior self-affecting the exterior other) and learning (the exterior other affecting the interior self) constitute instances of outputs and inputs crossing boundaries. While cyclical relationships such as the ones observable in human-computer interaction are commonly dissected and broken up into pieces, it is uncommon to turn systems back on themselves to form closed loops. This is because modern culture appreciates systems which allow description in terms of linearly-causal logic and which offer predictable control in terms of defined states. Closed loop structures tend to be appreciated only where they facilitate control, typically in the form of negative feedback and error correction or of stable oscillation. Unpredictable fluctuations and out-of-control patterns tend to be unwelcome outside of artistic and experimental domains. They are rarely the subject of formal analysis, and attempts at their formal analysis are hampered by the linear nature of common tools of description. Nonetheless, the (designing) human mind must be acknowledged not merely as a static stimulus-response system, as a static translator between inputs and outputs, but as a system whose input channels are subjected to its own output. Contrary to the technologies it currently tends to develop, the human mind is subjected to what it itself produces and is thus changed by its own performance (see Figure 1).

As stated above, design, being at least in part out-of-control (Glanville, 2000), involves not only linear but also circular causality – between design team members, between designers and their sketches etc. (Fischer, 2010). Common algorithmic devices for generative, computer-based design likewise involve circular feedback such as the potentially circularly-causal relationship between any two cells in a cellular automata system, or the self-referential relationships in L-systems, in evolutionary algorithms and so on. Input-output operations can leave traces inside of (designing) systems equipped with suitable "internal state"

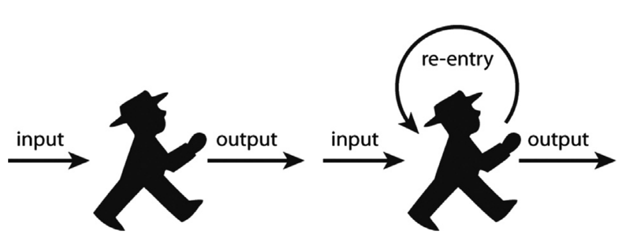

Figure 1 Human viewed as a linear stimulus-response system (left) and with the acknowledgement of circular self-reference (right).