

THE INTERDEPENDENCE OF LINEAR AND CIRCULAR CAUSALITY IN CAAD RESEARCH

A unified model

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Abstract. This paper discusses the relationship between linear and circular conceptions of causality and questions the common mutually-exclusive bivalent logic applied in distinguishing them. It argues that (circular) conversation *and* (linear) control both have their place in the design process. This calls for open minds and a reconsideration of value systems in CAAD practice and research, without which CAAD remains the futile attempt to deploy techniques developed to identify and enforce linear causation for the benefit of a practice that depends upon circular causality.

Keywords. Control; technique; novelty; predictability; surprise.

1. Background: Dual polarities and mutual arising

Chances are that your education and your thinking are influenced to some degree by Aristotelian logic, including the “principle of the excluded middle” (lat.: *tertium non datur*) according to which two opposites (A and not-A) can never both be true. This notion suggests that one can only be either right or wrong, that one can only either win or lose, and that a bit can only either be 0 or 1. This notion is an excellent foundation for performing reductionist science by using the kind of logic that is commonly performed today¹, not only on digital computers, but also by modern minds, which, after all, thought up the digital computer. Downton (2004) warns design researchers explicitly of dual oppositions as figments of the mind that are enforced by language. From the perspective of the Aristotelian tradition of thought, however, alter-

native notions of reasoning can seem bizarrely misguided and irrational. For example the Hindu notion that each thing implies, and must in time become, its opposite (represented by the goddess Bagalamukhi) can appear outlandish to Western observers. This notion that every A necessarily implies and brings about not-A can be further traced within Buddhism (Macy, 1992) and in the Taoist tradition where it is expressed in the Taijitu symbol (☯). Indeed, in much of Asian thought, the holistic notion of interdependence of any thing with anything else, including its perceived opposite, is deeply engrained – albeit rapidly disappearing with the influx of the globalising modern thinking of the Western world, whose reasoning is largely based on the drawing of dual, mutually-exclusive distinctions (yes/no, true/false, good/evil etc.). Accepting the co-existence and possible joint validity of A and not-A implies the acceptance of possible circular interaction, interdependence and gradients and spectra between them. While this, as I argue here, offers some advantages, it is perceived as a threat to conventional linear logic. In order to protect the basis from which they operate, scientists tend to avoid interdependencies in their theories and models, even when they admit the relevance of interdependencies to the phenomena they describe and model (for example Minsky, 1986, p. 48).

The emphases on reductionism, linear logic and linear causality on the one hand and on holism, circular logic and circular causality on the other hand mirrors the ideological rift between the two strands of our field's dual heritage in the sciences and the creative arts (Kvan, 2004). Despite the CAAD field's positioning at the junction of science, technology and the arts, remarkably, the subjects of causality and logic have not yet received much attention in our discourse. We have, be it for convenience or out of ignorance, acquired the bulk of our philosophical foundation from natural science and with the logic embodied in the digital technology we use. As a consequence, we tend to straightjacket design-related phenomena into conventional scientific and machine logic, where the development of alternative kinds of reasoning and machine logic that do justice to designing should be developed or considered. Moreover, circular causality and logic as well as holistic thinking, as mentioned above, are fundamental to important Asian traditions of thought (Nisbett, 2005, pp. 173ff.), which I believe makes the reflection I am proposing here particularly relevant in the Asian computer-aided design research context.

2. Relevance to CAAD (research)

Two key principles that are essential ingredients of models of designing but incompatible with common notions of logic and causality are interdependence and self-contradiction. Before I describe the essential role of circularity in

designing, I will illustrate the pertinence of these principles to our field using some concrete examples.

I was once at a design school where administrative structures were rudimentary and funding was scarce. There was a lab with outdated, barely adequate computers. Students maintained the lab and used it to teach each other as well as local professionals, generating a modest income for small system upgrades here and there. The lab was the site of constant activity and exchanges about possibilities and desires, driven by questions usually formulated around the phrase “what if we could...?” The creative misuse of digital tools was a routine. Many of the students learned how to program computers and went on to use this skill creatively. Resulting projects and learning were often impressive (though they usually remained unpublished). Later, I was at a design school that was administratively mature. Its various committees presided over generous funds. There were several computer labs with dedicated technicians and annual upgrades of all hardware and software. There were also some pieces of expensive advanced computer equipment that had been purchased to maintain the flow of research funds even though nobody was capable of or interested in using them. Students attended, and very often dreaded, scheduled computer lab classes covering text book exercises. Hardly any of the students learned how to program computers or ever used them in unexpected ways.

This juxtaposition not only casts a liberating light on the utilitarian quest for bigger and faster tools. The first school’s gain of opportunity in its lack of opportunity, and the second school’s loss of opportunity in its gain of opportunity also illustrate unavoidable dilemmas: Upsides come with downsides and downsides come with upsides. There is loss in gain and there is gain in loss².

Virtually everybody desires and appreciates positive surprise and dreads prolonged absence of stimulating unpredictability. At the same time, everyone appreciates a predictable supply of necessities and waking up in the morning with their heart still beating reliably. The desires for reliable predictability and for surprising unpredictability are seemingly at odds with one another. These two mutually contradictory desires are not only present in practically every individual. They are also present in the deployment of strictly controlled technology (and methodology) in support of (and to investigate) the generation of surprising novelty.

This apparent contradiction dissolves when we embrace stability *and* change and when we accept that stability leads to change and change leads to (dynamic) stability. This resolves the perceived incompatibility of scientific rigour and design thinking. We hence need to explore the question of how the two go together and whether there is an operational compass to navigate the

spectrum between designerly production of change and scientific description, prediction and control of stability.

Conventional logic advocates

“either A *or* not-A”

I advocate acknowledging

“A *and* not-A”

Using conventional logic, the difference between both can be mistaken as

either “either A or not-A” *or* “A and not-A”

while I regard it as

“either A or not-A” *and* “A and not-A”.

I regard the design process as a conversation (circular interaction) between a self and an other (Glanville, 2007): “I sketch this because of something I saw in my previous sketch, which I drew because of something in my preceding sketch etc.” Or: “I say this because of what you said because of what I said etc.” The self/other distinction must not be taken as a literal or reference to necessarily two persons. The number two is chosen since it is the smallest possible group and because attention in encounters is usually focused on one other. The line of distinction between self and other does not have to coincide with physical boundaries of the participants since groups can act as one and individuals can be split. The minimum requirement for novelty generation is the ability of self to multiply the set of conceptions with which (s)he enters into a conversation with an other (who may reside inside self).

3. Causality

CAAD research investigates (scientifically) what already is, while seeking to determine (designerly) what shall be. While this positions the concept of causality as a central issue in our field, it is however not yet much discussed. I understand causality as an observer’s way of describing the connection of events, which that observer recognises as connected. In this view, it does not exist independently of an observer’s mind. It is a useful phantom that is constructed to establish descriptive and predictive powers. Linear causality (“A affects B”) is the causality of the reliably predictable and of the known. Circular causality (“A affects B, B affects A”; or simply: “A affects A”) is the causality of the surprisingly unpredictable and of coming to know something new. Both ways of conceptualising causality can co-exist and complement one another: Linear causality, the emphasis of which I have grown tired of because

within my field of experience it is grossly overemphasised, offers suitable ways of describing processes of exploitation, instruction, dominance and technique that offer static and conclusive results. Circular causality, to which I am sympathetic because it is neglected and because it delights me, offers suitable ways of describing perpetual processes of mutuality, interaction, interdependence, designing, researching and learning.

I propose that the CAAD (research) field's current focus on linear thinking and logic should be balanced by paying greater attention to circular relationships. For this purpose, the following section introduces a new model that integrates the reliably predictable and the surprisingly unpredictable and their underlying linear and circular conceptions of causality. It shows that these two conceptions of causality can be thought of as occupying the same logical space, being positioned at different locations of the same conceptual spectrum, along which each of them offers specific benefits and penalties when applied to different kinds of concerns.

The need for orientation in this logical space poses a navigational challenge that brings us back to the Hindu goddess Bagalamukhi whose role as the pivot between dual polarities allows us to master them just as a compass allows us to navigate unknown territory. This is the purpose of the model presented below.

4. Development of the Model

We start by drawing a distinction between an A and a B – for example (your) *self* and (someone) *other* (see Glanville, 1990). This gives us the essential ingredients for modelling encounters: A minimal set of entities between which causal relations can be observed (even if A and B may be considered identical. For example: 'I the tired' can make 'me the eager' take a break.). Note that the mentioned observing can be done by participant-observer A or B within the encounter of interest or by an observer C from outside the encounter of interest. Further note that C's observation forms another encounter³ – possibly leading into a potentially recursive, but soon boring cascade.

To develop this model, we may choose a simple approach: We consider the set of possible encounters between As and Bs (see left of figure 1 below), ignoring self-observation of A and B and contenting ourselves with considering linear causality only. We assume the position of the outside observer C similarly to the idealized *locus observandi* assumed by scientific experimenters. Now, two possible linearly-causal scenarios can be observed in the encounter, each one being a mirror image of the other: A dominating B ($A > B$) or B dominating A ($B > A$) as illustrated on the right of figure 1.

A: "Do as I say! Otherwise [some threat]"
 B: "Your wish is my command!"

or

B: "Do as I say! Otherwise [some threat]"
 A: "Your wish is my command!"

To A and B, the insiders of the observed encounter, there is no symmetry at all. (One)*self* is either dominant or dominated, which makes a great subjective difference. We, C, find ourselves outside the encounter, empathetic with A or B or maybe both. We cannot help but draw a second distinction besides the distinction between A and B: that between A dominating B and B dominating A. These correspond (for A and B immediately or via C's empathy) to *self* dominating *other* and *other* dominating *self*.



Figure 1. Set of all possible encounters of As and Bs (left). Encounters in which A dominates B and encounters in which B dominates A, distinguished by a line (right).

Distinction-drawing is widely perceived as helpful. The ability to distinguish between friend and enemy, for example, is not only a prerequisite for naming them as such – it can be vital for survival. But where lines of distinction are drawn too coarsely and where the named deserves a chance to get another name (a good way of eliminating an enemy is to make friends with her), it comes at a price. Thus, distinction drawing facilitates both convenience and violence. Consider any distinction of the “black or white” type. For as long as we focus on the most obvious instances, the conveniences gained from drawing the distinction appear to outweigh the penalties. Further away from the most obvious instances, gradients appear: spectra on either side of the line of distinction. There is an infinite variety of ways and degrees of being somewhere between “black” and “white”. Towards the one side of the distinction appear As that are more and more like Bs while Bs that are more and more like As appear to the other side. These gradients also appear in the case of the distinction between A dominating B and B dominating A.

Gradually, the perceived unidirectional dominance between A and B can decrease, the more A and B meet ‘at eye level’⁴. There are two ways of getting there: Inside the encounter, A and B can take less dominating and less dominated attitudes respectively by negotiating the terms of their interaction. Inside

and outside the encounter, (self-)observers A, B and C can assess domination (linear causation) across varying observational scopes, to allow larger portions of the encounter to enter the observation and a more balanced picture to appear, provided A and B take turns in affecting each other. The more balanced the encounter is perceived to be, the less unidirectional dominance is apparent and the more of a conversation appears. Balance is found towards the far left as well as to the far right from the initial line of distinction shown in figure 2. Thus, both sides can be joined to form a continuous gradient from one side of the distinction line to the other. The right of figure 2 shows the initially distinguished gradients joined, in what I call (due to its overall shape) the Q-model⁵.

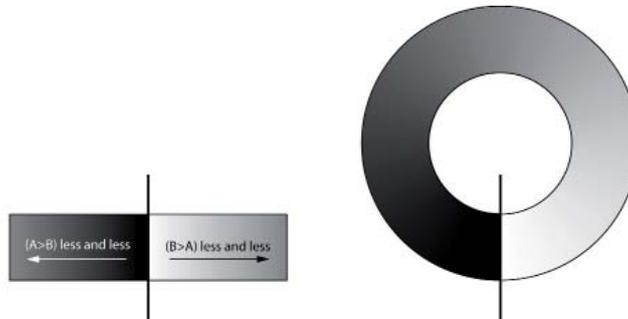


Figure 2. Clear domination (causal effect) near the distinction line, tapering out further away from the distinction line (left) and joined Q-model (right).

This is a more general and unified model of possible encounters that offers, I believe, a more viable alternative to commonly encountered polar distinctions such as those between “black” and “white”, as well as between encounters of possible power relations in encounters of As and Bs. That which is represented by the medium-grey area at the top of the model is in many cases of particular value (Glanville, 2000). Usually, however it is ignored since it undermines the Aristotelian mutually-exclusive drawing of distinctions, thereby posing a threat to conventional rational logic. With this unified alternative on offer, the choice we have is between either compartmentalising human experience for the benefit of a pure logic and expanding conventional logic for a better fit with human experience.

The annotations in figure 3 show how the conversational, circular causality located at the top of the model relates to the out-of-control (Glanville 2000) divergent (Guilford, 1967) generation of variety (Ashby, 1956; Rittel, 1972, p. 395) required to generate novelty whereas the dominant, linear causality located at the bottom relates to the in-control convergent reduction of variety required to accomplish intentions, both of which are essential to designing

(these are usually associated with the early and the later design stages respectively). The polar connectedness and interdependence or linear and circular causality shown in the annotated Q-model in figure 3 bears a strong conceptual resemblance to the Polarity Management Framework proposed by Johnson (1992). This framework shows the polar interdependence of (supposedly) contradicting opposites such as the ones between individual effort and team effort, stress and tranquility or between capitalism and socialism. Figure 4 shows an application of this framework to circular and linear causality. The poles are located to the far left and to the far right and their respective upsides and downsides are marked above and below on either side.

Johnson explains that an exclusive emphasis on the upside of either pole will lead to its downside, and thus to a gravitational pull towards the upside of the opposite pole

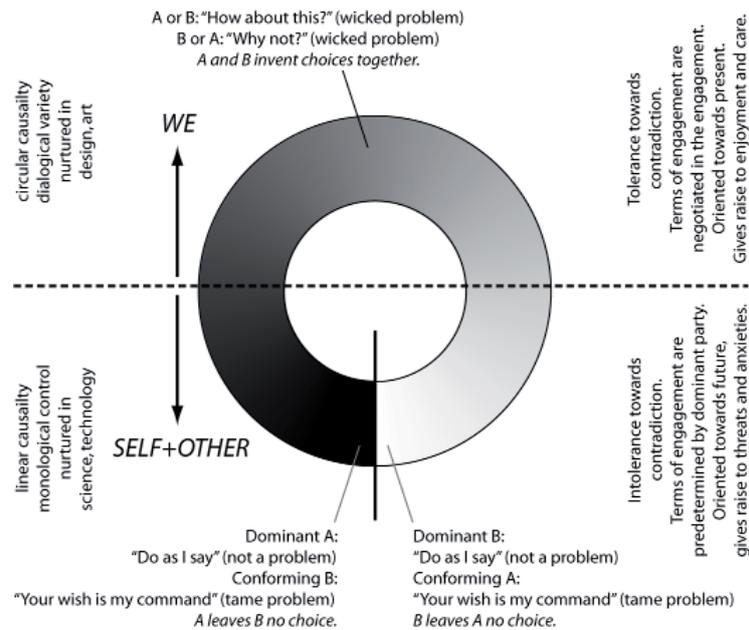


Figure 3. Annotated Q-model.

and so on, generating a lying figure-8 shape trajectory. The best way to navigate this space is by staying in motion, harnessing the upsides and minimizing the impact of the downsides as much as possible.

5. Implications for CAAD research

Always choosing one side of the coin, instead of simply choosing the coin itself (Williams, 1998, p. 82).

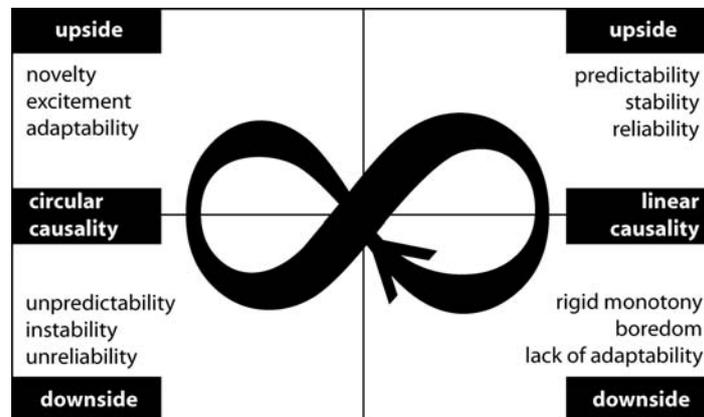


Figure 4. The polar distinction between linear and circular causality according to the Polarity Management framework (Johnson, 1992).

Acknowledging linear causality and logic and ignoring circular causality and logic (in CAAD and beyond) is like deciding that inhaling is right and exhaling is wrong. A view of either one of them by itself without the other is ultimately incomplete. In this paper I show that both views of causality can be thought of as occupying the same conceptual space. This space must be navigated wisely if the potentials and limitations of our means are to match the challenges of our ends.

In its current state, much of CAAD, and neo-positivist scientific research in support of it, are preoccupied with the deployment of techniques developed to detect and to enforce linear causation (at the bottom of the Q-model and on the right side of the Polarity Management model shown in figure 4 above) in a misguided effort to support a practice that depends upon circular causality (at the top of Q-model and on the left side of the Polarity Management model shown in fig. 5 above). The futility of this agenda has been recognised before, in particular with the demise of the design methods movement (Cross, 1984, pp. 309-316). The Q-model presented in this paper offers metrics by which the upsides and downsides of linear and circular causality can be named and weighed so that the gradual space between these polar opposites can be navigated from the perspective of those inside design conversations. The perspective assumed with the Q-model differs from the third-person perspective from which upsides and downsides are positioned objectively in the Polarity Management model. It acknowledges that within design conversations upsides and downsides are subjectively negotiable. Similarly to the Polarity Management framework, the Q-model shows that the path towards harnessing upsides can lead across stretches of sometimes severe downsides. Proficient navigation

of the presented conceptual space within which linear and circular causality co-exists corresponds, in my opinion, to Heinz von Foerster's (1973) *Ethical Imperative*: "Act always so as to increase the number of choices."

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Endnotes

- 1 Syllogistic, subject-predicate and similar straightened-out structures of reasoning.
- 2 This is why trying to set up "games" in which there is winning without losing is as futile as trying to break a magnet to obtain only a south pole (see Watts, 1975, 18–36). And thus, Western "modern lifestyle," now global, wreaks havoc.
- 3 The explicit acknowledgment of this relationship is the difference between first-order and second-order cybernetics.
- 4 Rittel speaks of "conspiracy," "symmetry of ignorance" in Cross (1984), p. 325.
- 5 Circular conversational causality happens at the top of the Q-model, linear control at the bottom. The interdependence of circular and linear encounters in designing is expressed in the overall ring-shape of the model.

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