Design Research as a Variety of Second-Order Cybernetic Practice

Ben Sweeting • University of Brighton, UK • r.b.sweeting/at/brighton.ac.uk

> **Context** • The relationship between design and science has shifted over recent decades. One bridge between the two is cybernetics, which offers perspectives on both in terms of their practice. From around 1980 onwards, drawing on ideas from cybernetics, Glanville has suggested that rather than apply science to design, it makes more sense to understand science as a form of design activity, reversing the more usual hierarchy between the two. I return to review this argument here, in the context of recent discussions in this journal regarding second-order science (SOS). > **Problem** • Despite numerous connections to practice, second-order cybernetics (SOC) has tended to be associated with theory. As a result, SOC is perceived as separate to the more tangible aspects of earlier cybernetics in a way that obscures both the continuity between the two and also current opportunities for developing the field. > **Method** • I review Glanville's understanding of design, and particularly his account of scientific research as a design-like activity, placing this within the context of the shifting relation between science and design during the development of SOC, with reference to the work of Rittel and Feyerabend. Through this, I summarise significant parallels and overlaps between SOC and the contemporary concerns of design research. > **Results** • I suggest that we can see design research not just as a field influenced by cybernetics but as a form of SOC practice even where cybernetics is not explicitly referenced. > **Implications** • Given this, design research offers much to cybernetics as an important example of SOC that is both outward looking and practice based. As such, it bridges the gap between SOC and the more tangible legacy of earlier cybernetics, while also suggesting connections to contemporary concerns in this journal with SOS in terms of researching research. > **Constructivist content** • By suggesting that we see design research as an example of SOC, I develop connections between constructivism and practice. > **Key words** • Science, design research, second-order cybernetics, second-order science, practice, Ranulph Glanville.

Introduction

« 1 » In recent years there has been a resurgence of interest in cybernetics amongst designers. This has been prompted in part by the increased availability and affordability of technologies with which to augment the environments we design, and those we design in, which has fuelled interest in ideas regarding interactivity. While this technological focus is an important aspect of what cybernetics offers design, the relations between the two fields run much deeper. These connections have been explored explicitly in the work of Ranulph Glanville (1999, 2006a, 2006b, 2007a, 2007b, 2007c, 2009a, 2011a, 2014b, 2014c), whose work I use as a point of departure in this article.[1]

« 2 » Drawing on Gordon Pask's (1976) conversation theory and the common characterisation of design in terms of conversation (such as by Schön 1991), Glanville (2007c, 2009c) has suggested a close analogy between cybernetics and design, understanding both as "essentially constructivist" activities (Glanville 2006a: 63; 2013). The parallels Glanville draws are significant enough for him to claim that "cybernetics is the theory of design and design is the action of cybernetics" (Glanville 2007c: 1178).

« 3 » While part of Glanville's motivation in developing the connection between cybernetics and design has been the insight that the former might bring to the latter, it is an important aspect of his position that the converse is also the case: that design can set an example to cybernetics in terms of practice and so inform it, not just vice versa. Thus the relationship between cybernetics and design is to be understood as one of mutual overlap and support and, as such, one that avoids the difficulties that can follow from the application to design of theories external to it (a problem that seems to recur in architecture in particular) and the more general shortcomings that can follow from our tendency to see the relation of theory and practice as predominantly the application of the former to the latter (Glanville 2004a, 2014a, 2015; see also Sweeting 2015c).

« 4 » More specifically, Glanville's understanding of design as being the action of cybernetics is part of his characterisation of second-order cybernetics (SOC) as being concerned with how cybernetics is to be practiced rather than, as can tend to be the case, a theoretical reflection on this (Glan-

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1 | Together with Neil Spiller, Glanville supervised my PhD research, and although this article has been developed after his passing, it is significantly influenced by my conversations with him. In addition to his work, on the relationship between cybernetics and design see also: Dubberly & Pangaro (2007, 2015); Fischer (2015); Fischer & Richards (2015); Furtado Cardoso Lopes (2008, 2009, 2010); Gage (2006, 2007a, 2007b); Goodbun (2011); Herr (2015b); Jonas (2007a, 2007b, 2012, 2014, 2015a, 2015b); Jones (2014); Krippendorff (2007); Krueger (2007); Lautenschlaeger & Pratschke (2011); Lobsinger (2000); Mathews (2005, 2006, 2007); Pratschke (2007); Ramsgard Thomsen (2007); Rawes (2007); Spiller (2002); Sweeting (2014, 2015c).

ville 2011b; Sweeting 2015b). This concern was particularly evident during his time as President of the American Society for Cybernetics (ASC), during which he often referred to Margaret Mead's (1968) challenge, delivered in her address to the inaugural ASC conference, to practice cybernetics in line with its own ideas. While the principal legacy of Mead's remarks has been the epistemological concerns of SOC, as developed by Heinz von Foerster (1995, 2003a) and others, their original context is that of the practice of the society itself. It is this aspect to which the ASC returned during Glanville's presidency, in terms of both the form and content of its conferences, which explored cybernetics' relation to practice using conversational, cybernetic, formats (Baron et al. 2015; Glanville 2011b, 2012; Glanville, Griffiths & Baron 2014; Glanville & Sweeting 2011; van Ditmar & Glanville 2013).[2]

« 5 » In contrast to this understanding of its relation to practice, Andrew Pickering (2010: 25f) has characterised SOC as a turn away from the more tangible modes of experimentation in earlier phases of cybernetics, and towards the linguistic. This view can be countered: SOC is a reflection on the performative involvement of observers within their observations, in contrast to the separation of observer and observed in conventional science. This is very much in line with Pickering's own emphasis, for example in his comments on R. D. Laing's psychiatry as taking seriously "the idea that we are all adaptive systems, psychiatrists and schizophrenics alike" (ibid: 8) or his reference to Pask's account of the "participant observer," who tries to maximise interaction with what he or she observes in order to explore it (ibid: 343f).

« 6 » However, even its advocates must admit that SOC can run the risk of becoming overly introverted, especially given its central concern with self-reference. Recent thinking regarding von Foerster's development of SOC has addressed this concern by

understanding it as the beginnings of a research programme rather than as primarily a form of worldview, and as prompting the "new course of action" suggested in this journal under the heading of "second-order science" (SOS) (Müller & Müller 2007; Müller 2008, 2011; Riegler & Müller 2014).[3] In this light I suggest that Glanville's understanding of design, and particularly his (1999, 2014c) account of the relation between design and science that I discuss below, allows us to view the currently expanding field of design research as a contemporary variety of SOC practice, whether SOC is explicitly invoked or not.[4] My purpose in doing so here is not primarily to add to what SOC can bring to design research, which has been explored in depth elsewhere by many others. Rather, my focus is on what design can bring to cybernetics, in line with what I have understood as being part of Glanville's own motivations for developing this analogy, as noted above. Design research offers an example of how SOC can develop as a practice-based and outward looking enquiry, while also suggesting a way of integrating the legacy of tangible experimentation from earlier cybernetics with its contemporary concerns.

Method and practice in design and research

« 7 » During the period of scientific and technological optimism that followed the Second World War, there was a tendency, as evident in what is usually referred to as the design methods movement, to see design as something that should be put on rational

scientific foundations.[5] Since around 1980 this view has been countered by arguments that have seen design as a discipline in its own right and so as being of the same status as science rather than something to be corrected by it. Amongst these, the account that Glanville (2014c) presented at the 1980 *Design: Science: Method* conference, later expanded as the journal article *Researching Design and Designing Research* (1999), is particularly strongly framed, reversing what had been the more usual hierarchy. Rather than seeing design research as one specific form of scientific research, Glanville argues that, instead, we can see science as a specific form of design enquiry. This follows from the way that scientific research inevitably involves design activity, for instance in devising and setting up experiments, but not vice versa.[6] Design is, it follows, the more general case and, therefore, "it is inappropriate to require design to be "scientific": for scientific research is a subset (a restricted form) of design, and we do not generally require the set of a subset to act as the sub subset to that subset any more than we require [that] the basement of [a] building is its attic" (Glanville 1999: 87f).

« 8 » This argument and others like it around that time, such as those put forward by Bruce Archer (1979), Nigel Cross (1982) and Donald Schön (1991), consolidate a shift during the 1970s from trying to base design on the scientific method to the idea that it has its own epistemological foundations, independent of science (for an overview of this shift, see Cross 2007b). The attempt to order design according to a linear version of the scientific method, understood as moving from analysing the problem at hand to testing and optimising solutions to it, failed for reasons that seem obvious in retrospect: because design involves the creation of new situations, design questions cannot be fully formulated in advance but shift and change as they are explored and as proposals are en-

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2 | See also the recent special issue of this journal on alternative conference formats, which was inspired in part by these ASC conferences (Hohl & Sweeting 2015; regarding the ASC conferences, see especially: Richards 2015; Sweeting & Hohl 2015).

3 | See also http://www.secondorderscience.org

4 | Given that cybernetics stresses the interdependency between acting and understanding, and so between theory and practice (see e.g., Glanville 2014a; Sweeting 2015c), I could equally refer to design research as a contemporary variety of second-order cybernetics as to one of second-order cybernetic practice. Nevertheless, I feel it is important to stress the practical here, given that SOC, and constructivism generally, currently risk being seen more as a worldview than an active research tradition.

5 | See for instance: Alexander (1964); Broadbent & Ward (1969); Simon (1996). For a critical discussion of the design methods movement, see Gedenryd (1998).

6 | This is not to say that designers do not make use of scientific research but that doing so is not essential to what design is, whereas design is a core aspect of research and so science.

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acted. One of the most important accounts of these limitations is that developed by design theorist Horst Rittel, who, writing with the urban designer Melvin Webber, characterised the situations that designers encounter as "wicked problems," the complex interdependencies of which make them unsolvable using conventional linear problem solving (Rittel 1972; Rittel & Webber 1973, 1984).

« 9 » On the face of it, Rittel and Webber's observations mark an incompatibility between design and science in terms of method. Indeed the exhaustion of the design methods movement by the 1970s – with leading figures such as Christopher Alexander (1984), John Christopher Jones (1984) and, indeed, Rittel distancing themselves from it – along with the unravelling of modernism more generally during that decade, marks something of a parting of the ways between design and science (architecture, for instance, would increasingly turn towards history and philosophy, rather than science, for theoretical support). However, given Glanville's SOC-inspired argument noted above, this separation between design and science is not what we might expect. If science is a limited form of design, then is it not the case that scientific approaches should be commensurable with design, even if not a basis for it? This apparent disjunction is only the case if we follow the changes in how design was thought about during this period without also following the comparable changes regarding science.

« 10 » Design research and the philosophy of science broadly parallel each other over this period. Both move from a concern with method in the 1960s through a critique of this in the 1970s to new foundations from the 1980s onwards, focusing on what designers and scientists actually do in practice rather than on what seems ideal in theory. As noted above, this led to design being seen as a discipline in its own right (Archer 1979), with its own "designerly ways of knowing" (Cross 1982) and a refocusing from methodology to broader and more practice-based concerns, under the heading of design research (for an overview, see for instance: Grand & Jonas 2012; Michel 2007; Rogers & Yee 2015). In the context of science, there was a comparable turn during

the 1970s and 1980s towards understanding it in terms of the social and material agency of research as practiced, with the growth of the fields of the sociology of scientific knowledge (SSK) and science and technology studies (STS), such as in the work of Karin Knorr Cetina, David Gooding, Bruno Latour and Pickering amongst others (for an overview see Pickering 1992). These accounts are suggestive of a more designerly paradigm in science, in line with Glanville's argument. Indeed, accounts of experimentation in SSK/STS can be read almost as if describing the activities of a design studio; see for instance: Gooding (1992), Pickering (1993, 1995) and Knorr Cetina (1992), who even uses a direct analogy with architecture.

« 11 » In this light, what appears to be a rupture between design and science during the 1970s is instead a close parallel. Indeed, key critiques advanced in each area – that of Rittel in design, and that of Paul Feyerabend (1970, 1982, 1993) in science – have similar content. Rittel and Feyerabend were colleagues at UC Berkeley while they were developing their ideas. Both were influenced by thinking in cybernetics and systems at that time. Rittel worked with Ross Ashby at the Ulm School of Design (Fischer & Richards 2015), while Feyerabend (1982: 64) refers to "new developments in systems theory," which was flourishing at Berkeley (which was also home to C. West Churchman) and elsewhere in California at the time (where Gregory Bateson, amongst others, was based), and his (1982: 18) comments regarding participant observers reflect contemporaneous preoccupations of SOC.

« 12 » Science, like design, involves creating new ideas and understanding; therefore, as in design, the criteria and methods that are appropriate will change as part of the process and cannot be defined in advance if science is to progress:

> 66 …to ask how one will judge and choose in as yet unknown surroundings makes as much sense as to ask what measuring instruments one will use on an as yet unknown planet. Standards which are intellectual instruments often have to be *invented*, to make sense of new historical situations just as measuring instruments have constantly to be invented to make sense of new physical situations. 99 (Feyerabend 1982: 29)

« 13 » Feyerabend's (1970, 1993) *reductio ad absurdum* argument against the predefined methods that were characteristic of the philosophy of science at the time concludes by showing that the only criteria that can be given in advance, that will not inhibit scientific progress, is that "anything goes." This also appears in Rittel and Webber (1973: 164), while Rittel (1972: 393) has "everything goes": because designers inevitably encounter new and ambiguously defined situations (it being the purpose of design to create the new), they have no well-defined problems to solve or enumerable lists of options to pick from and "any new idea for a planning measure may become a serious candidate" (Rittel & Webber 1973: 164). This phrase is also anticipated by theatre director Joan Littlewood (1964: 432) in describing the Fun Palace project, on which cybernetician Pask was a key collaborator along with architect Cedric Price (see e.g., Lobsinger 2000; Mathews 2005, 2006, 2007; Spiller 2006: 48–50), and that is equally concerned with the in-principle unpredictable. Furthermore, Feyerabend's (1982: 202) comment that the proponents of scientific theory are out of touch with scientific practice echoes the situation in design, where design methods had become an academic game divorced from practice, as both Alexander (1984: 309) and Jones (1984: 26) point out.[7]

« 14 » While Archer (1979) differentiated design as a third disciplinary pole with the same status as the traditional "two

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7 | As one of the anonymous reviewers of this article suggests, the shift away from science in design can be thought about in terms of a search for forms of rigor that make sense in a design context, such as for example those described by Schön (1988). Feyerabend's (1982, 1993) argument, however, indicates that the scientific method as it had been promoted was unsatisfactory not just in making sense of design but also in accounting for scientific practice itself (Feyerabend demonstrates that examples commonly regarded as paradigmatic by the advocates of method violate the methodological principles they propose). That is, in this period, the need for an understanding of rigor that makes sense in the context of practice is a feature not just of design but also science. Thanks to the anonymous reviewer for prompting my thoughts on this point.

cultures" of the arts and sciences (Snow 1961), Glanville (2014c) argues against this separation and, instead, characterises all research as being a design-like activity. This designerly continuity across different fields is, however, obscured by popular misrepresentations of science as a logical and predictable activity, such as are perpetuated in the structure of traditional scientific papers, which Peter Medawar (1996) has critiqued as a fraudulent account of what scientists actually do in practice. Glanville (2014c: 111) calls for honesty about how research is practiced in all disciplines, and suggests that this will make similarities clear between apparently quite different fields. In this, Glanville reflects a willingness to transcend disciplinary boundaries that is characteristic of cybernetics' origins, which had cut across distinctions between research fields as well as those between objectivity and subjectivity, human and machine, and mind and body.

« 15 » In stressing the continuities between design and other disciplines, Glanville (2014c) contrasts his account with that of Archer (1979), whose positioning of design in terms of its own disciplinary pole, separate to the arts and the sciences, risks isolating it from other research traditions. Glanville's understanding, however, still gives design research the special status of Archer's account: given the parallels he draws between design and research, Glanville recognises design research as a self-reflexive activity of *researching research* (Glanville 2014c: 116–119). That is, as design is a core part of research activity, to research design is to inquire into an aspect of research activity itself. In so doing, Glanville anticipates recent discussions in this journal regarding second-order science (SOS) as research activity focused on research itself (Müller & Riegler 2014a, 2014b; Riegler & Müller 2014). I return to this below.

Design research and second-order cybernetics

« 16 » SOC was developed in the context of the shifts in understanding science and design that I have summarised above, and parallels these concerns. As such, SOC sits in a pivotal position within cybernetics' wider history. In consolidating its episte-

mology and, with it, an ability to address rigorously the issues of self-reference towards which a field concerned with circularity is inevitably drawn, it is with SOC that cybernetics reaches maturity as a discipline. That this happens simultaneously with the fragmentation of the field during the 1970s – under pressure from changes in the external funding climate and professional accreditation (Umpleby 2003; Umpleby & Dent 1999) – has consequences not just for the ideas of SOC but also for how we understand earlier, and other, aspects of cybernetics.

« 17 » Firstly, as the earlier work occurred before the maturity of the field, it is inevitable that it contains inconsistencies in epistemology, approach and terminology. This is further complicated by the way that the fragmentation of the field is often associated with the emergence of critiques of science and technology during the 1970s, of which SOC is one instance. SOC has often, for this reason, been presented in contrast to first-order cybernetics (FOC), which tends to be associated with the earlier work. The "first" and "second" should not, however, be understood as implying a sequence or the surpassing of one by the other.[8] Rather, SOC is specifically the application of cybernetics to itself – "the cybernetics of cybernetics," as von Foerster (2003b: 302) titled Mead's (1968) paper.[9]

« 18 » The terminology of "first" and "second" can obscure the continuity between SOC and earlier cybernetics. While Glanville has spent considerable effort in

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8 | While Fischer and Richards (2015), rightly point out considerable overlaps between the development of SOC and Rittel's characterisation of first- and second-generation design methods, it should be remembered that "first" and "second" are used in different ways in each context.

9 | This development was both necessary for the field to consolidate its own disciplinary foundations, and has also made possible innovatively reflexive research programmes that are of particular interest in exploring those questions regarding cognition, society, epistemology and ethics that inevitably involve self-reference. For a fuller discussion of SOC see e.g.: Glanville (1997, 2002, 2004c, 2011b, 2013); Müller & Müller (2007); Müller (2008, 2011); Scott (2003, 2004, 2011); Foerster (1995, 2003b); Foerster & Poerksen (2002).

distinguishing the two (e.g., Glanville 1997, 2004c), he has also recognised that cybernetics always involves second-order considerations and did so even at its origins (Glanville 2013: 28) and that "it would be better, nowadays, to talk only of Cybernetics, without orders: thus bringing the different approaches into proximity" (Glanville 2002). This is certainly the case for Mead and Bateson, whose backgrounds in anthropology involved a consideration of the participation of observers in what they observe (see e.g., their discussion in Brand, Bateson & Mead 1976), and for Ashby in his (1991) understanding of the black box system as involving the observer as part of it. Even Norbert Wiener, according to Pask (as reported by Glanville 2002; 2013: 33), recognised that there were further steps to take in developing the subject. Indeed, Alvin Toffler's (1970) *Future Shock*, a book that is emblematic of the criticisms of science and technology that are often assumed to apply also to cybernetics (e.g., Lobsinger 2000: 134), is anticipated two decades earlier in the similar, cautionary account of technological change in Wiener's (1950) *Human Use of Human Beings*. In addition, while Pickering (2010) sees SOC as being in contrast to the tangible modes of exploration of the earlier cybernetics in which he is interested, the performative quality of the devices through which Pask, Ashby, Grey Walter and others explored their ideas is an example of the participation of observers in observation on which SOC reflects and places value.

« 19 » Secondly, it is difficult to judge the consequences of SOC for practice, as the field within which these implications would have been explored had broken up by the time the possibility of doing so had emerged. The tendency of SOC to be largely theoretical in orientation – which leads Pickering (2010: 25f) to view it as a form of linguistic turn – needs to be understood in this context of a lack of opportunity for experimental work.

« 20 » With the break up of cybernetics, many of its ideas were absorbed back into its constituent fields. Some research in other disciplines, such as for instance robotics or complexity, can be recognised as a continuation of its ideas and research programme, including its performative approach to experimentation (see, for instance, the discus-

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sion of Rodney Brooks, Stephen Wolfram and Stuart Kauffman in Pickering 2010: 60–64, 156–170). Given its continuities with cybernetics, as introduced in part above and discussed further below, the field of design research can be thought of, similarly, as one such successor field.[10]

« 21 » There is a longstanding history of connection and influence between cybernetics and design, as has been summarised by Hugh Dubberly and Paul Pangaro (2015). In particular, Ashby and Pask both engaged directly with design.[11] Ashby lectured at the Ulm School of Design with Rittel (see Fischer & Richards 2015) and was also a significant influence on Alexander.[12] Pask, meanwhile, became increasingly involved in architecture from the 1960s onwards. He was a significant contributor to the prominent Fun Palace project with Price and Littlewood, and collaborated with Nicholas Negroponte at MIT, for whose *Soft Architecture Machines* (Negroponte 1975) he contributed a chapter. In addition he held a consultant position at the Architectural Association in London, wrote explicitly on architecture and design (Pask 1963, 1969) and influenced the development of interactive architecture through Negroponte and others such as John and Julia Frazer (Frazer 1993, 1995; Furtado Cardoso Lopes 2008, 2009; Spiller 2006: 204–210). More recently, figures such as Pangaro, Glanville and Klaus Krippendorff, influenced particularly by Ashby (Krippendorff) or Pask (Glanville, Pangaro), have made prominent contributions in both design research and cybernetics, while many others have worked in one field in a way informed by thought in the other.

« 22 » As well as this continuity of people, there is a significant continuity of ideas and approach such that cybernetics can be thought of as design's "secret partner in research" (Glanville 1999: 90f). While this is not the place for a full discussion of these parallels – I defer here to the accounts of Glanville and the others who I have cited – key points include the following:

- There is a conversational, and so cybernetic, structure that is central to what is distinctive about the way designers work (see for instance Schön's (1991: 76) characterisation of design in terms of a "reflective conversation with the situation"). Glanville has developed this parallel to the extent that, as I have noted, he claims that "cybernetics is the theory of design and design is the action of cybernetics" (2007c: 1178) while it is also what lies behind his (1999, 2014c) characterisation of research in terms of design, as discussed above.
- Both design and cybernetics are concerned with the new, as supported by the tendency of conversation to involve invention at every turn. Both are "essentially constructivist" activities (Glanville 2006a: 63; see also: Glanville 2006b; 2013; Herr 2015b) that enable a form of "forward-looking search," as Pickering (2010: 18) has described cybernetics, developing new ideas and possibilities rather than looking to correspond to, or replicate, the real or the optimal.
- The way that designers use drawings and models *for* exploring ideas rather than as representations of them (Glanville 2009b) resonates closely with the performative nature of the work of Pask and others, who played out their ideas using physical, experimental devices in much the same way (as emphasised in Pickering's (2010) account). In contemporary practice-based design research, some work has strong continuity with the sorts of devices made in earlier cybernetics (e.g., that of Mette Ramsgard Thomsen (2007), Jennifer Kanary Nikolov(a)[13] or Ruairi Glynn[14]), but even the use of more analogue media (such as the sorts of pen drawings with which I work; see Sweeting 2014) has a similar attitude to modelling as part of thinking rather than as a representation of thought.
- Design research is often concerned with epistemological questions regarding the interrelations of designers, other stakeholders, working methods and the knowledge embedded in what is designed. This has often been articulated in terms of differences between research *about/into*, *through/by* and *for* design, following Frayling (1993) and others, and as reviewed and synthesised by Jonas (2012, 2015a, 2015b). These distinctions distinguish between that research which looks at design from the outside or which is applied to it, from that which is conducted as an integral part of it. This resonates strongly with SOC concerns regarding the participation of observers in their observations, and the active difference made by how this participation is configured. Jonas (2007b, 2012, 2015b) in particular has explicitly used the framework of cybernetics, drawing on Glanville (1997), to clarify these points. I return to this below.
- Design is a self-reflexive activity in much the same way as cybernetics, both involving circular reflective processes and being examples of disciplines that can be applied to themselves, in the design of design or the cybernetics of cybernetics.

« 23 » While design research and cybernetics mostly differ in their subject matter, the above parallels are significant. They share both ways of working – a conversational forward-looking search and an interactive, non-representational use of modelling – and also core concerns with observer positions and self-reflexivity in the constitution of their research processes. These parallels hold to the extent that, while design research continues to make reference *to* cybernetic ideas (for instance in exploring the possibilities of new technologies (e.g.,

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10 | By "successor field" I do not mean to imply any sense of superiority, but rather the inheritance of ideas.

11 | Other figures could also be mentioned. Dubberly and Pangaro (2015) and Müller and Müller (2011) also stress the interest of Heinz von Foerster in design. He addressed design audiences (e.g., Foerster 1962) and was connected to figures such as architect Lebbeus Woods and Stuart Brand, who can be mentioned in his own terms as a cross-over figure. Fischer (2015) has suggested connections between Wiener and recent work in design, while the work of Bateson, who introduced Brand and von Foerster to each other, is a point of reference for contemporary discussions of architecture and ecology (see e.g., Goodbun 2011; Rawes 2013).

12 | Although, as Upitis (2013: 504f) notes, Alexander's (1964) use of Ashby's ideas can be questioned.

13 | http://www.labyrinthpsychotica.org/Labyrinth_Psychotica

14 | http://www.ruairiglynn.co.uk

BEN SWEETING
is a senior lecturer at the University of Brighton where he is the course leader for the undergraduate degree in architecture. He studied architecture at the University of Cambridge and the Bartlett, UCL. In his PhD, supervised by Neil Spiller and Ranulph Glanville and funded by the Arts and Humanities Research Council, Ben explored epistemological and ethical questions in relation to architecture and design, drawing on second-order cybernetics and radical constructivism as well as on practice-based research methods. He is a member of the American Society for Cybernetics and was awarded the Heinz von Foerster Award in 2014.

Ramsgard Thomsen 2007; Spiller 2002), or in understanding the relationship between research and design (e.g., Jonas 2007b, 2012, 2014, 2015a, 2015b), I suggest we can also understand it as a contemporary variety *of* cybernetic research, whether the connections with cybernetics are made explicitly or not. Seeing design research as an example of SOC in this way suggests a continuity between the epistemological focus of SOC and the tangible experimentation of earlier cybernetics, a connection that can easily become obscured, as is evident in Pickering's (2010) account.

Second-order science

« 24 » As well as helping integrate the more practice-oriented legacy of early cybernetics with SOC, design research can also provide an important point of reference for contemporary discussions of SOS, which have been a recent focus of this journal (and which have led to the present special issue). Karl Müller and Alexander Riegler (2014a) proposed SOS as "a new course of action" in order to reinvigorate SOC – and constructivist approaches generally – as an active research field. They characterise SOS as a reflexive form of research, either in methodological terms through the inclusion of observers as participants (a direct continuation of von Foerster's (1995, 2003a) SOC as the "cybernetics of observing systems"), or through self-reflexive domains of research, in the sense of the science of science or, similarly, the cybernetics of cybernetics or the sociology of sociology, such as through meta-analyses of the products or practices of other scientific enquiry.

« 25 » Müller and Riegler position SOS as a specific research agenda within the significant transformations currently underway in the landscape of science (Müller 2008, 2011; Müller & Riegler 2014b). These have partly been, as noted above, in terms of how science has come to be understood in terms of its practice by fields such as SSK and STS, but also through significant changes in this practice itself. This has included: a change of focus away from a mechanistic and reductionist paradigm (associated with Newton and Descartes) towards one based in complexity, adaptation and evolution, which Rogers Hollingsworth and Müller (2008) have labelled in terms of a transition from Science I to Science II; significant changes in the organisational structure of knowledge production, with an increased emphasis on its social robustness and the context of application, which has been labelled as a shift from Mode 1 to Mode 2 (see Nowotny, Scott & Gibbons 2006); and growing interest in transformative and transdisciplinary aspects of research (e.g., Nicolescu 2012; Schneidewind & Augenstein 2012).

« 26 » These various changes in science have all had the effect of science moving towards a more designerly paradigm, in line with Glanville's (2014c) argument discussed above (as noted by Jonas 2014, 2015a). Given this convergence and the historical and conceptual connections that I reviewed above, there is reason to consider SOS as a potential point of interchange between design and science. This is especially so given that there is a considerable overlap between core interests of design research and the two "motivations" for SOS that Müller and Riegler (2014a: 2f) have put forward: self-reflexivity, and the inclusion of observers.

« 27 » Firstly, self-reflexivity is important in design research in various ways. In a general sense, designers often do this implicitly as they work, reflectively redesigning their design processes to suit the specifics of the situations they encounter. More explicitly, design is a field that, like cybernetics, can be applied to itself in the sense of the design of design. This includes such instances as: the design of particular design methods (e.g., Alexander 1964) or of technologies with which to design (e.g., Frazer 1995; Negroponte 1975; or contemporary developments such as building information modelling); the way that a design research conference is something that itself needs to be designed (Durrant et al. 2015; Sweeting & Hohl 2015); and the way that the products of design can allow for a continuation of the design process in them, such as in the architecture of Price (as Price 2003: 136 himself remarks).

« 28 » Specific design projects can also explore aspects of design itself, as for instance in Peter Downton's (2004) practice-based reflections on epistemology, or the work of Peter Eisenman (Bédard 1994). Indeed, Eisenman's Cannereggio project, for instance, can be considered a meta-analysis in Müller and Riegler's (2014b) sense for the way it takes Le Corbusier's unbuilt Venice Hospital scheme for the same site as its starting point.

« 29 » Most significantly for SOS, understanding design as a core part of research, as per Glanville's (2014c) account discussed above, positions design research as a field of researching research. This observation holds possibilities yet to be fully explored, offering design research a field of application in science rather than vice versa, as is more often the case.

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« 30 » Secondly, as noted above, the position of the observer has been a theme of particular importance in design research as part of the field's shift from its mostly professional origins to being seen in more academic terms. This has included careful delineations between ways in which designers and others observe and participate in design, and of the ways in which material artefacts operate variously as part of the research process, as the object of enquiry, as output or dissemination and sometimes as more than one of these depending on their context. As noted above, one important and widespread way in which these distinctions have been made is by distinguishing in terms of research *about/into*, *for* and *through/by* design. As Jonas (2012: 34) discusses, the value of this sort of categorisation is that it differentiates on the basis of the attitudes and intentions of designers, rather than in terms of subject matter (which would not make sense in design because of its tendency towards diverse and ambiguously delineated content). This has helped clarify where design is used actively as a research process to explore a topic (*through/by*), where separate research is applied in design, such as in research and development or market research (*for*) and where design is the object of separate study by another discipline, such as history or sociology (*about/into*). In elaborating on and clarifying these distinctions, which were initially rather ambiguous, Jonas has drawn on Glanville's (1997) description of different observer positions and orientations as a foundation, associating research *through* with the engaged SOC observer, and *for* and *about* with the detached observer of FOC. Jonas distinguishes a new category of research *as* design to correspond to where, in Glanville's scheme, the observer is inside the inquiring system and looking inwards, and interprets this in terms of "design as the inaccessible medium of knowledge production" and the role of abductive reasoning (Jonas 2015b: 35).[15]

« 31 » Categorisations of this sort are very much in the spirit of SOC and are highly relevant for SOS; and we can think of research *for*, *about/into*, *through/by* and *as* in this context in much the same way as in design. It is the observer-included modes of research *through/by* and *as* that are of most relevance (these being associated with SOC). Examples include Glanville's approach to conference design in terms of using cybernetic processes (so the content of the conference can be acted out in its form; Glanville 2011b; Sweeting & Hohl 2015) and the performative aspects of the devices of Pask and others, as stressed by Pickering (2010). The more detached modes of research *about/into* or *for* also have their counterparts, and would include historical and theoretical work, including this present article and also accounts such as that of Pickering and others to which I have referred.[16]

« 32 » While Jonas has used the terminology of FOC and SOC to give a foundation to these designerly categories, in turn they offer complementary possibilities back to cybernetics. Whereas the phrasing of FOC and SOC invites a sharp distinction in terms of whether the observer is included or not, and can be confusingly interpreted in terms of a chronological sequence as discussed above, the categories of *for*, *about/into*, *through/by* and *as* distinguish something of the nature of an observer's involvement, not just the acknowledgement of it, enabling these different observer positions to be seen in productive combination. This latter point is important for SOS, especially where it is conceived in terms of reflexive operations such as meta-analyses, as it requires a close relationship to the more conventional first-order science on which it is to operate (Müller & Riegler 2014b).

« 33 » Given these significant overlaps, design research is a productive point of comparison for SOS. In particular, it suggests a possible example for how SOS can be constituted as a research field that is practice based and outward looking, both aspects that are important in this "new course of action" (Müller & Riegler 2014a). This is partly through the connections between SOC and earlier, more tangible, forms of cybernetics that are suggested by design research, and also through examples of research through design, which is notable for the way that even some of its most abstracted and introverted moments retain rich potential for concrete connections with the world.

Conclusion

« 34 » I have drawn on the continuities, both of concepts and participants, between SOC and the field of design research in order to position SOC in terms of practice rather than as a mainly theoretical perspective. I have drawn, in particular, on Glanville's (2014c) account of scientific research as a form of design activity, understanding this in the context of the shifting relationship between design and science during the formative period of both SOC and design research, and since.

« 35 » I have suggested that design research is not just a field that is influenced by SOC but a contemporary variety of it, whether this connection is made explicitly or not, in a similar way that other fields can be regarded as continuing or reinventing cybernetic concerns. Understanding design research in this way suggests a continuity between the epistemological concerns of SOC and the material experimentations of earlier cybernetics, in contrast to the way that SOC is sometimes regarded as a turn away from these more tangible qualities.

« 36 » These connections with cybernetics' past are also relevant to contemporary discussions of SOS. Given that design research shares the central concerns of SOS with both self-reflexivity and the inclusion-of observers as active participants, it is suggestive of ways in which SOS may develop as a field of research.

15| Given Glanville's (1997) enigmatic silence regarding this category, it makes sense to associate it with the role of tacit knowledge in design, especially when seen in the context of Jonas's (2015a, 2015b) presentation of these categories in terms of their relations with each other. Locating the tacit here can help clarify the relation between

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the research involved in any design act and research through design, which is in need of more explicit articulation, even if this could still be through various media or embedded in artefacts.

16| Note that to write *about* SOC is a first-order activity. This is why neither von Foerster (2003b: 301) nor Glanville (2002) see the need for any third or fourth orders of cybernetics; these would simply be instances of its first or second orders.

Open Peer Commentaries

on Ben Sweeting's "Design Research as a Variety of Second-Order Cybernetic Practice"

Design Cycles: Conversing with Lawrence Halprin

Tom Scholte
University of British Columbia,
Canada • tom.scholte/at/ubc.ca

> Upshot · This commentary adds environmental architect Lawrence Halprin to Sweeting's list of examples of design research as second-order cybernetic practice.

« 1 » Ben Sweeting's target article provides an informative outline of the conceptual confluences of design research and second-order cybernetics, explicit and otherwise, as they have unfolded over the last several decades. A practitioner absent from Sweeting's summary (and from any other cybernetic overview of design practice of which I am aware) whose work might be fruitfully included in this analysis is environmental architect Lawrence Halprin. This OPC will endeavor to provide a brief sketch of the second-order cybernetic features of Halprin's RSVP cycles in the hopes that they may find their way into the ongoing discourse on the cybernetics of design that Sweeting has framed.

« 2 » In the 1960s, while second-order cybernetics was incubating in Heinz von Foerster's Biological Computer Laboratory, architect and environmental designer, Halprin, in collaboration with his wife Ann, choreographer and artistic director of the San Francisco Dance Workshop, were engaged in their own inward examination of group creative processes in search of a theory outlining their main features. Similar to Ranluph Glanville, Halprin explicitly rejected "the attempt to make a science out of community design" claiming that…

" [h]uman community planning cannot ever be a science anymore than politics can rightly be called political science. Science implies codification of knowledge and a drive toward perfectibility none of which are possible or even desirable in human affairs. " (Halprin 1969: 4)

What Halprin did desire was a "means to describe and evoke (creative) processes on *other* than simply a random basis" in the hopes that it "would have meaning not only for (the) field of environmental arts and dance-theatre, but also for all the other arts where the elements of time and activity (particularly of numbers of people) would have meaning and usefulness" (ibid: 1). It may be argued that, in his own way, Halprin may also have been looking for something one might call "rigour," but not as a means of justifying design's place in the academy on intellectual grounds. He simply wanted to help people work more efficiently on a purely pragmatic level and, at the same time, avoid the undesirable outcomes of a narrowly linear, dare call it "scientific," approach to the transcomputable complexities inherent in any and all design processes. He formalized his findings in the 1969 book *The RSVP Cycles: Creative Processes in the Human Environment*, describing a recursive schema of iteration and evaluation bearing striking resemblances to the conversational conception of second-order cybernetics.

« 3 » Below are the four components of the RSVP cycles as defined in Halprin's book (ibid: 2):

" *R – Resources* which are what you have to work with. These include human and physical resources *and* their motivation and aims.
S – Scores which describe the process leading to the performance.
V – Valuation which analyzes the results of action and possible selectivity and decisions. The term 'valuaction' is one coined to suggest the action-oriented as well as the decision-oriented aspects of V in the cycle.
P – Performance which is the resultant of scores and is the 'style' of the process. "

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« 4 » While the arrangement of the acronym RSVP (the request for a response) was chosen for its elegance in naming an essentially conversational process (ibid: 2), a typical iteration of the cycle would more accurately be expressed as RSPV: the articulation of an inventory of the resources available, and desirable, for inclusion in the project, the articulation of a score indicating what is to be done with/to the resources, the performance (implementation) of the score, and a period of valuation during which the results of the performance are evaluated and re-enter the next iteration of the cycle as new resources, for which a new score will be articulated.

« 5 » From a second-order cybernetic perspective, it is significant that the "motivations and aims" of all of the individuals involved in the project must also be articulated and taken into account in addition to the purely physical or financial resources at play. This is, in fact, the ethical foundation of the entire schema, as "its purpose is to make procedures and processes visible, to allow for constant communication and ultimately to insure the diversity and pluralism necessary for change and growth" (ibid: 5). This ethical foundation seems entirely commensurate with the "desirable ethics" of Glanville (2004b).

« 6 » Halprin opens his book with a definition of scores:

❝ Scores are *symbolizations of processes* which extend over time. The most familiar kind of 'score' is a musical one, but I have extended this meaning to include 'scores' in all fields of human endeavor. Even a grocery list or a calendar, for example, are scores. ❞ (Halprin 1969: 1)

❝ The essential quality of a score is that it is a system of symbols which can convey, or guide, or control (as you wish), the interactions between elements such as space, time, rhythm, and sequences, people and their activities and the combinations which result from them. ❞ (ibid: 7)

« 7 » Halprin goes on to expand his list of sample scores to include plans for buildings, mathematics, stage directions and dialogue for a play, Navajo sand paintings, the intricacies of urban street systems as well as plans for transportation systems and the configurations of regions, and much more. The most significant feature of any score is

its position on a spectrum from "open" to "closed" in terms of the amount of control it exerts.

❝ The real nub of the issue […] is what you control through the score and what you leave to chance; what the score determines and what it leaves indeterminate; how much is conveyed of the artist-planner's own intention of what is to happen and to what degree what actually happens and the quality of what actually happens is left to chance; the influences of the passage of time; the variables of unforeseen and unforeseeable events, and to the feedback process which initiates a new score. ❞ (ibid: 7)

« 8 » As to the performance phase of the RSVP cycles, an analogy between scientific experimentation and the performing arts employed by philosopher Robert Crease might help further position Halprin's schema at the intersection of design research and second-order cybernetics described by Sweeting. Crease tells us that "the structure of performance is essentially the same in the theatre arts and experimental science" when we consider that "[p]erformance involves the conceiving, producing, and witnessing of actions in order to try to get something that we cannot get by consulting what we already have." In both domains, "the representation (theory, language, script) used to program the performance does not completely determine the outcome (product, work), but only assists in the encounter with the new" (Crease & Lutterbie 2010: 165). Of course, the phenomena generated by both experimentation and performance might well differ significantly from the expected outcome. Larry Richards reminds us that is is the dynamics of performance that account for these potential suprises and, in the spirit of second-order cybernetics, open up new horizons of possibility to be explored in a subsequent iteration.

❝ Formal languages remove the dynamics absolutely; in fact, the value of formalism is that it removes the dynamics to leave a skeleton of constraints to guide action and performance (like a script or score) […] A poem, a piece of music, a play, and their performance are ways to use a language to play with dynamics. They don't *cause* things to happen; they *trigger* a dynamics of interaction that can lead to new distinctions. Contradictions and paradoxes become desirable

as avenues to new ideas, new alternatives, new choices. ❞ (Richards 2010: 16)

« 9 » For Glanville, the second-order cybernetic conception of design is in direct opposition to the "slogan" in modern architecture, attributed to Louis Sullivan, that "form follows function" (Glanville 2007b: 88). The level of complexity in most design challenges calls for another approach entirely.

❝ Rather than try to specify every requirement and every relationship between these requirements, and then find an optimal solution, design starts more or less 'aimlessly' and gradually constructs an 'evolving' form that not only changes but, in doing so accommodates the required functions also, often in a novel and surprising manner, where normal relations between functions are enriched or even replaced by new ones that are unexpected, different, and often very good! ❞ (Glanville 2007c: 1196)

« 10 » Glanville tells us that "the drawing, sketch or doodle" is "central to the process of design" and that "[t]hese are often made without much purpose" (ibid: 1179). Throughout his corpus, Glanville sings the praises of purposelessness and the "gifts" that it can bring; a position that might seem, to some, to be at odds with the goal-directed preoccupations of cybernetics. It is, however, yet another theoretical commitment shared by Halprin, who claimed that "becoming *goal oriented* is "one of the gravest dangers that we experience" through our tendency to pursue social goods, based on "incontrovertibly 'good ideas,'" by "the most direct means possible" resulting, through an "oversimplified approach […] in the chaos of our cities and the confusion of our politics (or other politics – fascism and communism are clear statements of this approach)" (Halprin 1969: 4).

❝ When ekistitcians, for example, say that the 'search for the ideal is our greatest obligation' they are making the same basic error that all goal-oriented thinking does – a confusion between motivation and process. We can be scientific and precise about gathering data and inventorying resources, but in the multivariable and open scoring process necessary for human lifestyles and attitudes, creativity, inquantifiable attitudes and openness will always be required. ❞ (ibid.)

SECOND-ORDER CYBERNETICS

Is There a Place for Material Agency? David Griffiths

« 11 » If, as Halprin suggests, the "confusion of our politics" is equally a result of a flawed design process that is too dependent on narrowly defined goals and insufficiently sensitive to feedback, then, perhaps, it is not going too far to expand Glanville's audacious claim that science is but a subset of design and make a similar claim regarding governance; a term that is, after all, also commonly understood to be virtually synonymous with the term "cybernetics." A conception of governance informed by the kind of second-order cybernetic approach to design espoused by Glanville and encapsulated in Sweeting's article would have no option but to acknowledge openly the inevitability of error and eliminate the peddling of supposedly iron-clad, fool-proof "solutions" in which the politicians of every liberal democracy currently traffic. And where might that lead us? But that is a conversation for another time.

« 12 » Sweeting's article does valuable work in consolidating Glanville's legacy of design cybernetic theorization as it evolved alongside a growing awareness within the design research community that first-order, non-reflexive "scientific" models are insufficient to deal with the emergent functional, aesthetic and ethical complexities of actual design practice. This provides a robust foundation from which a whole generation of cybernetic designers influenced by Glanville (Thomas Fischer, Candy Herr, Michael Hohl, Tim Jachna and others) can further develop and disseminate this rich body of theory and practice to the generations to come. As a theorist/practitioner who independently evolved a recursive, conversational approach to design so thoroughly embodying the ethical commitments of second-order cybernetics, an additional reflection upon the work of Halprin has much to offer this on-going endeavour.

Tom Scholte is an actor/director/writer for theatre and film whose work has been seen at such film festivals as Sundance, TIFF, Rotterdam and the Berlinale. His research focuses on cybernetics in the Stanislavski System of Acting and narrative drama as a modeling facility for the study of complex social systems.

Understanding Design from a Second-Order Cybernetics Perspective: Is There a Place for Material Agency?

David Griffiths
The University of Bolton, UK
d.e.griffiths/at/bolton.ac.uk

> Upshot · This commentary supports Sweeting's case for the relationship between the design tradition, second-order cybernetics and second-order science. It argues, however, that the extension of this argument to other intellectual traditions and areas of practice is complicated by differing views of material agency.

« 1 » The main focus of Ben Sweeting's target article is to examine the terms "design" and "second-order cybernetics," together with the practice designated by them, and to discuss their relationship. This task is simply described, but leads inexorably into deep waters, in part because of the entangled relationship between the terms, and in part because both terms are contested. In the main, Sweeting navigates this complexity with skill, but inevitably there are loose ends in the argument, which are worth pulling on to see if they lead to further insight.

« 2 » The argument is founded on Sweeting's analysis of Ranulph Glanville's ideas on design and second-order cybernetics (SOC), a task that he is particularly well-positioned to undertake, given his long relationship with Glanville as both a student and a collaborator. Sweeting cites Glanville as stating that "cybernetics is the theory of design and design is the action of cybernetics" (§2), and reports that "Glanville […] characterises all research as being a design-like activity" (§14) and that he "recognises design research as a self-reflexive activity of researching research" (§15). On the basis of Glanville's work, exemplified by the above quotations, Sweeting makes the core proposal of the article, suggesting that

> ❝ Glanville's understanding of design, and particularly his […] account of the relations between design and science […], allows us to view the currently expanding field of design research as a contemporary variety of SOC practice. ❞ (§6)

This proposal is both well-founded and useful.

« 3 » I also find Glanville's argument regarding the relationship between science and design, and Sweeting's discussion of it, to be convincing: "Design is, it follows, the more general case and, therefore, 'it is inappropriate to require design to be 'scientific': for scientific research is a subset (a restricted form) of design…" (§7). The argument is in line with the critique made by authors such as Stuart Umpleby (2014) and Karl Müller (2014), who have contributed greatly to second-order science (SOS), to which Sweeting dedicates a substantial section. This critique focuses on the important role of the scientist as an observer and active constructor of the scientific process, a role that is systematically erased from positivist accounts of scientific activity.

« 4 » Sweeting thus establishes two alignments: between design research and SOC, and between design and SOS. The question that arises in the reading of the article is the degree to which it is possible to extrapolate from the alignment between these discourses in order to draw conclusions that are applicable to science as it is carried out beyond the cybernetic tradition and to design that is carried out without a reflexive turn.

« 5 » When Glanville spoke about design, he did so not as an external observer surveying the field, but as a participant explaining his experience of the process of design (including his design of musical environments and performances). Indeed, given the view of cybernetics that he sustained and lived by, we should not expect anything less. Sweeting does not discuss Glanville's practice but implies that it was in line with Horst Rittel's argument that "'everything goes': because designers inevitably encounter new and ambiguously defined situations (it being the purpose of design to create the new), they have no well-defined problems to solve or enumerable lists of options to pick from" (§13), and that the problems encountered by designers are "wicked" (§8) because of their complex inter-dependencies. Much design practice is illuminated by an analysis conducted from this position, but many design problems are perceived by designers in much simpler terms, and are not seen as being wicked.

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The Chambers Dictionary definition of the verb "design" is "to develop or prepare a plan, drawing or model of something before it is built or made," and readers will be able to confirm that other dictionaries have similar definitions. This definition includes many contexts where designers are convinced that they are working with well-defined problems, and that enumerable lists are available, including much of the field of engineering. A reading of Sweeting's article with a focus on this issue is complicated by the fact that the logic of the argument leads to thematic sections that discuss both design research (which necessarily has a reflexive aspect) and design (which, in the view of many practitioners, does not necessarily involve a self-reflexive aspect).

« 6 » The designers of scientific instruments such as the CERN particle collider have a well-defined goal, in this case to provide an apparatus capable of detecting the Higgs Boson. But even in design that does not involve engineering, well-defined problems can be identified. The builders of musical instruments provide a good example of designers who have well-defined problems with lists of options. Iris Bremaud describes the choice of woods for construction in the case of the designers of xylophones and slit-drums in Africa:

" Many species could be encountered in either xylophones designed for temporary use, or slit drums with strong aesthetical meaning, involving the ability of wood to be intricately carved […]. On the contrary, the more prominent the purely 'acoustic' function of instruments was, the higher the proportion of use of Pterocarpus […]. This choice is nearly exclusive in most elaborate xylophones and in slit-drums that were used for message transmission – up to more than 10 km distances. " (Bremaud 2012: 812)

These designers are clearly making choices from a list of predefined options, and deploying their design expertise in making the trade-off between the contrasting benefits of different materials and the range of predefined purposes to which the instrument will be put.

« 7 » In a rather different musical context, Brian Eno, often described as a sound designer, also explains the act of creating a musical composition in terms of selection:

" What the composer had was a kind of menu, a packet of seeds, you might say. And those musical seeds, once planted, turned into the piece. And they turned into a different version of that piece every time. " (Eno 2011)

Eno relates this approach to the influence of Stafford Beer, and perhaps this cybernetic connection should not be surprising given the importance of selection in cybernetics since the early work of Claude Shannon (1948).

« 8 » The purpose of this digression into music, a field that was one of Glanville's main areas of activity, is to argue that there exist design practices that are well-defined, involve selection from a list of pre-determined options, or both. I suggest, therefore, that Sweeting's characterization of design is best seen as an accurate description of a particular type of design. It may also be an argument and exhortation to other designers who do not share these ideas or practice to consider more deeply the recursion involved in their design activity, and I believe that this was the intention of much of Glanville's work. The question arises, however, how far (if at all) it is possible to make a convincing argument about design in general on the basis of this SOC analysis to those who do not share the epistemological position of the field, a challenge that is common to SOC as a whole. I see Sweeting's discussion of Andrew Pickering as being central to this question.

« 9 » Sweeting cites Pickering extensively, and mostly with approval. However, he disagrees with Pickering's characterization of SOC as "a turn away from the more tangible modes of experimentation that characterized earlier phases of cybernetics, and towards the linguistic." Sweeting counters this argument by pointing out that "SOC is a reflection on the performative involvement of observers within their observations" (§5), but that the opportunity to carry out this function was limited because the field of cybernetics had "broken up" (§19) by the time that SOC emerged. I have some sympathy with this view, but nevertheless I believe that it is incumbent on those who feel there is value in the heritage of cybernetics to investigate Pickering's point more deeply. Specifically, we need to assess the degree to which the risk that Sweeting identifies that SOC can become "overly introverted" (§6) may have played an

active part in the break up of the field. Sweeting's concern is not to conduct such an inquiry into the decline of cybernetics, but rather to explore how its legacy can be applied and revived in design research. Nevertheless, I believe that there is a key point at issue here, as I now discuss.

« 10 » The examples that are given of Pickering's performative approach can indeed be situated within SOC (R. D. Laing's work on therapists, Pask and the participant observer). But there are many aspects of Pickering's thinking about the performative that are not easily situated in this way. Pickering describes his conception of the performative as an "…image of science, in which science is regarded as a field of powers, capacities and performances, situated in the machinic captures of material agency" (Pickering 1995: 7). In his book *The Mangle of Practice*, Pickering examines the history of the bubble chamber in physics research. He argues that we should see this as a "dance of human and material agency" (ibid: 51). Pickering goes on to describe how…

" [r]esistance (and accommodation) is at the heart of the struggle between the human and material realms in which each is interactively restructured with respect to the other – in which, as in our example, material agency, scientific knowledge, and human agency in its intentional structure and its social contours, are all reconfigured at once. " (ibid: 67)

Here, I think, is the heart of the problem of the generalizability of insights from SOC. The idea that the object of investigation (or design) has material agency that pushes back at the scientist (or designer) is one that sits uncomfortably with an SOC view of constructivism, and certainly of the radical constructivist tradition within SOC as exemplified by Ernst van Glasersfeld (1995). To put it another way, the conception of the performative within design research as described by Sweeting, and perhaps within SOC as a whole, may be different from that which Pickering proposes.

« 11 » In my view, SOC does not necessarily preclude the ascription of agency to the material world. For example, the reformulation of the scientific method undertaken by Humberto Maturana (1990: 18) implies constraints on our ability to engage with the

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What Can Cybernetics Learn from Design? Christiane M. Herr

agency of the material, but it does not preclude its existence, and is compatible with Pickering's "mangle of practice." The analysis proposed by Sweeting, however, does not encompass the agency of the material. He does mention "the ways in which material artefacts operate variously as part of the research process, as the object of enquiry, as output or dissemination and sometimes as more than one of these depending on their context" (§30), but there is nothing to suggest that the physical world "pushes back" at the designer, or even that such a thing might be possible. I do not see this as a problem for the analysis proposed by Sweeting per se, as the design practice described may indeed consist of a recursive interaction between the designer, the design and the people for whom it is intended. Moreover, from a radical constructivist perspective, it may be argued that the perception of material agency is no more than a perception, and that a methodology based on this is intellectually misleading and practically unreliable. It does, however, raise a problem for the claim that design is a category that subsumes science. Sweeting's argument that scientific activity is a kind of design holds for a broad definition of design, but the specifically SOC view of design put forward in this article does not map well onto mainstream conceptions of science. The same applies even to first-order cybernetics in the performative mode, for example for Grey Walter, whose robotic "tortoises" addressed a well-defined problem: "to model goal seeking and, later, learning. But he did so as economically as he could" (Boden 2006: 244). The problem of mapping from design to science can be resolved in one of two ways. One option is to broaden our understanding of design so that it includes material agency, in line with Pickering's mangle of practice. This would enable the insight from SOC into the role of the designer in a recursive process of construction to be generalized across the whole range of scientific and design activities. Alternatively, we can make it clear that we are adopting a critical view of science, engineering and craft. This would embrace the differences between different types of design and scientific practice, and challenge practitioners to question the externality of the material agency that they ascribe to the surrounding environment and independent of themselves. There is indeed a role for such a practical critique.

Sweeting refers to "pre-defined methods that were characteristic of philosophy of science" in the 1970s, but a glance around the bodies funding research today would show that this preference for pre-defined methods is alive and kicking.

« 12 » Divergent opinions on the performative may in turn account for Sweeting's disagreement with Pickering on the linguistic turn in SOC. Sweeting comments that "SOC is a reflection on the performative involvement of observers within their observations" (§5). However, material agency is at the core of Pickering's view of the performative but is not represented in design seen from a SOC perspective, as represented in this article. Consequently, from Pickering's perspective SOC is lacking an account of material agency and its effects, whereas Sweeting does not discuss any such lack. It is the discrepancy on this lack, I suggest, that leads Pickering to identify a linguistic turn in SOC, and also leads Sweeting to disagree with him.

« 13 » In conclusion, the important contribution of this article is to bring together and extend the thinking of Glanville, and to show how this can both inform design research and serve as "continuing or reinventing cybernetic concerns" (§35). In doing this, Sweeting offers a much-needed response to the lack of practical research being carried out within SOC, a concern that Glanville also shared. In doing this, the article also raises important issues, going beyond its main focus, about the nature of the relationship between second- and first-order cybernetics and the possible role of material agency as a point at issue in the understanding of the performative in these two aspects of cybernetics.

David Griffiths, commonly known as Dai, is a Professor of Education at the University of Bolton. He holds a PhD from Universitat Pompeu Fabra, Barcelona, and has worked as a teacher at many levels of the educational system. For the past twenty-five years, he has focused on understanding the systemic implications of the use of technology in education. In the course of this work, he has participated in and led a large number of European projects. He was co-chair of the American Society for Cybernetics (ASC) 2013 conference in Bolton, and was a co-editor of the proceedings for ASC conferences in 2012, 2013, and 2014.

What Can Cybernetics Learn from Design?

Christiane M. Herr
Xi'an Jiaotong-Liverpool Univ., China
christiane.herr/at/xjtlu.edu.cn

> Upshot · Based on Sweeting's central question of what design can bring to cybernetics, this commentary extends and adds further depth to the target article. Aspects discussed include the nature of practice in relation to design, the introduction of designerly ways of acting and thinking through acting to cybernetics, and the re-introduction of material experimentation typical of early cybernetics.

Differentiating externally motivated application and internally motivated practice

« 1 » Ben Sweeting's focus on the relationship of cybernetics and design presents a valuable counterpoint to recent attempts at renewing interest in cybernetics by framing it primarily in reference to science (§24). Based on Ranulph Glanville's (2007c: 1178) characterization of design as the action of cybernetics, and cybernetics as the theory of design, Sweeting positions design research as a variety of second-order cybernetic (SOC) practice (§4). This central point of Sweeting's article deserves further strengthening, as practice is not to be understood in this context as the *application* of theory (§§6–10). As argued by Sweeting based on Glanville (2014a, 2015) (§3), SOC should not be conceived of as a theory preceding and determining subsequent action. When seen from the perspective (and experience) of design, theory is more appropriately understood as a framework for making explicit thoughts developed in and through action. While generated from action, such a theory can then also be used for abstract argument and analysis, but this should not be seen as its primary purpose. Design reasoning is typically implicit: a form of thinking immanent in, expressed, and developed through acting. This is illustrated in Donald Schön's (1991) well-known characterization of design processes as *reflection in action*. It is this recognition of the fundamental involvement of the observer in the process that sets

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design (and cybernetics, specifically SOC), apart from the sciences, as Sweeting shows (§14).

« 2 » Cybernetic descriptions of processes frequently revolve around goals, in particular the pursuing of goals within circular processes (Ashby 1957). While such processes may be described from the perspective of an outside observer identifying purposeful actions, it makes much more sense to shift perspective to that of the involved inside observer. From the perspective of the involved observer, goals appear more flexible, as they are deliberately selected, often temporary, and typically subject to change in response to various constraints encountered in the process of acting (Fischer & Richards 2015; Glanville 2007c). Consideration of this constructed and process-oriented nature of goals is essential when aiming to understand the actions of designers. With goals as well as ways to pursue them being the subject of choices, the resultant cybernetic process relies strongly on personal values and ethics. In the context of cybernetics, this observation has led Heinz von Foerster (1992) to distinguish what he termed *in principle undecidable questions* – questions that cannot be decided objectively or from an external perspective. This is well known by designers, who must rely on personal values for much of their decision making (Trimingham 2008), as any kind of design practice involves questions of an ethical nature. While designers rarely make this explicit, cultivating personal values forms part of what can be described as *design rigour*, in reference to conventional scientific research. This observation may lead to further examination of the role of personal ethics in cybernetic practice.

The pleasure of constructing the world

« 3 » While design may be understood as describing a particular kind of process (§§12, 22), it may be argued that design is also, and perhaps most importantly, a way of thinking and perceiving the *other* (Glanville 2007c: 1197). This way of thinking and perceiving cultivates not only keen awareness of the *what is* but also of the *what could be*. To designers, the world is always a constructed world (Herr 2015b), where self and other are dynamically merged: this worldview may be

described as much as an analytical one as an aesthetic-appreciative and constructive one. From this perspective, it becomes obvious why designers are typically flexible in their employing of a wide spectrum of tools and methods, ranging from science to art. Engaging with the other in this manner initiates conversational processes of exploration that may be started by premeditated goals, but are in essence driven by perceptions of potential and possibility. I would argue that cybernetic processes may be understood in a similar manner.

« 4 » While designers construct their realities, they tend to pay little attention to the nature of the world in which they construct their realities (Glanville 2006a; Herr 2015b). When engaged in explorative processes of designing, designers typically cast away theoretical preconceptions in favour of what is found to be practically viable in a given particular situation. What matters most is the immediate response of the other generated from action, and the changes in thinking and perception this response in turn generates in the designer. Designers construct realities through processes of informed participation, which resonates with radical constructivist theory (Glanville 2006a) as well as Margaret Mead's call for cybernetically informed ways of acting (§4).

« 5 » Although designers are usually comfortable acting, they are not necessarily comfortable or able to make explicit the nature and mechanics of the processes in which they engage. This generates challenges when communicating beyond specific instances of design processes and especially beyond disciplinary boundaries. In addition, the implicit nature of designing makes it difficult to discuss design processes in educational settings. It is here where I see great potential for integrating the formal rigour of the cybernetic body of thought with action-oriented design. As Sweeting has argued (§14), cybernetic vocabulary was specifically developed to transcend disciplinary boundaries and is well suited to supporting designers in describing, perhaps also in fine-tuning, their acting. In addition to transcending cross-disciplinary boundaries in this manner, I would argue that design-cybernetic perspectives can also help in transcending cross-cultural boundaries, as I have previously discussed (Herr 2011).

Cybernetic machines for thinking and showing

« 6 » Sweeting (§22) points out that material experimentation, as it happened in earlier cybernetics, could inform similar experimentation in contemporary SOC to allow it to be more outward looking (§33). In this respect, cybernetics could adopt techniques well honed in design, where models are employed not only for purposes of representation or prediction, but mainly to support the exploration of ideas (§22). For a design-based variety of cybernetic practice, the continuation of making automated models of an explorative and performative nature seems a particularly fruitful direction. Such machines can be understood to be similar to conceptual models in design and may be developed based on cybernetic themes. Besides the precedents in design research discussed by Sweeting (§22), there are further examples of devices constructed in this spirit and relating explicitly to cybernetics.

« 7 » Over the past 15 years, Thomas Fischer and myself have built and documented various – often automated – devices for conceptual idea exploration in architecture based on cybernetic ideas. We have characterized these devices as *machines for showing* (Herr & Fischer 2013, 2004), intentionally sidestepping expectations for prediction or immediate applied utility. I have recently continued this line of thought with an analysis and discussion of cellular automata models as they are used in design, where I have emphasized the explorative and flexible nature of such models (Herr 2015a). Once designers work with tools, they tend to adapt them to their own purposes, which results in rules being interpreted in a flexible manner and tools being used against their intended purposes (Fischer & Herr 2007). In a similar manner, designers tend to adopt vocabulary and theory from various fields other than design (§3). What is often not reflected well is that such processes of adopting external theory and vocabulary should be understood as part of creative conversations, in which terms are interpreted flexibly and vocabulary as well as theory is typically transformed to fit a particular design situation.

« 8 » One recent occasion where cybernetic devices were presented was an informal exhibition held as part of the 2014 annual

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conference of the American Society for Cybernetics, http://asc-cybernetics.org/2014. Most of the devices displayed were, however, of a representational nature, with only a few of the presented items intended to create questions or initiate new thoughts. With cybernetics' growing maturity and increasingly complex body of ideas, it seems contemporary cyberneticians are primarily concerned with explaining existing principles clearly rather than inventing new ones or playing with these ideas in an open-ended – and perhaps messy or incongruent – manner. It is this manner of acting and thinking through acting in a playful and explorative spirit that cybernetics can learn from design.

Christiane M. Herr is an architectural researcher and educator focusing on the areas of cross-disciplinary and cross-cultural studies in design and education as well as digitally supported design. In her PhD, she explored cellular automata as a means to establish architectural design support, which led to her strong interest in diagrams, designerly ways of seeing, and radical constructivism. Christiane is a board member of the American Society for Cybernetics and CAADRIA (Computer-Aided Architectural Design Research in Asia).

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Rigor in Research, Honesty and Values

Michael Hohl
Anhalt University of Applied
Sciences, Germany
mh/at/hohlwelt.com

> **Upshot** · I reflect on the theme of honesty in research and discuss the adjoining requirements of rigor from an academic perspective. Central to my discussion is Glanville's assertion that what researchers – from either science or design – presented was not what they actually thought and did.

« 1 » In §14 of his target article, Ben Sweeting examines Ranulph Glanville's concept of honesty. I think the concept of honesty, while not being central to the main

argument of the target article, deserves some more reflection, especially in relation to the concept of rigor.

« 2 » While "rigor" in research is often mentioned, I think its constituents are rarely thoroughly discussed. I would like to use this opportunity to discuss these further, as Sweeting's article allowed me to get a much deeper understanding of Glanville's concept of honesty, especially linking it to post-rationalisation, which I found very enlightening.

« 3 » When I was conducting my PhD research at Sheffield Hallam University, between 2003 and 2007, we had regular debates about academic rigor and what constituted rigor in the research process of artists and designers. Adopted from research in the sciences, the significant terms associated with rigor, and associated with PhD research, were that the research had to be "*thorough, exhaustive, accurate, and systematic.*" In art and design *critical* and *reflective* were often added as well. In our seminars, it emerged that "thorough" and "exhaustive" were related and could described as together forming a "T"-shape: the horizontal line of the "T" consisting of an exhaustive, broad and comprehensive overview of what is considered the context of research and related practice, while the focus area, the vertical element of the "T," consisting of going deep into it and being thorough in one's own contribution. I assume "objective" might have been included in earlier definitions of rigor in research in art, design and architecture, however in the research of artists, designers and architects, the requirement of the term might have been abandoned at some time. In artistic research, the individual creative process involves necessarily subjective, intuitive and explorative phases in which adhering to "objectivity" might be more of a hindrance and lead to post-rationalisation. More about this below.

« 4 » When we examine the next term, "accurate," meaning "correct in all details" or "faithful representation," it is perhaps to this that Glanville's demand for honesty is most related. How may "accuracy" be possible from a constructivist perspective? Does the demand for accuracy refer to observations, measurements, models and analysis only? Then how might it include a playful exploration, intuitive insights, creative leaps of mind, random iterations or doodling con-

versations (Glanville 1999) that may lead to new understanding, insights, methods, techniques or discoveries? Glanville views such creative moments as "[…] pointless, undirected, seemingly purposeless, playful and dreamy activity that is at the heart of design" (Glanville 2006a: 105). When such designing is at the heart of research, then research has dreamy and purposeless aspects to it. How might these be documented and interpreted accurately?

« 5 » In the spirit of honesty, I would like to reflect upon my own PhD research process. In retrospect, it had aspects of double-bookkeeping: presenting my methodology, plans and intentions to my supervisors (and myself) accurately, yet the results being post-rationalisations. From my own perspective, I relied on hunches, connections between facts "suddenly" becoming clear, a rather unstructured and unclear, sometimes "terrifying" process riddled with insecurities of "poking around in the fog" in order to understand what I was learning, make sense of it and proceed to a next step. The applied methodology emerging quietly almost on its own in the background. Later, after completion, I would end presentations of my PhD Research with the statement: "Told as a story, my research appears pretty straightforward and top-down. In fact it was bottom-up and came together step-by-step over three years. The research process was a constant learning process." From that perspective, the written thesis did not describe in thorough, "honest" detail how new insights emerged, but made sense of it in post-rationalisation (Glanville 1999: 5). For example, even a meticulously kept journal would not reveal how exactly the grounded theory emerged in the analysis of interview data.

« 6 » The following term, "systematic," is in my view the most problematic in the research of artists and designers. Systematic, meaning "acting according to a fixed plan or system, methodical." Following a fixed plan in practice-based design research contradicts, in my view, exactly the possibility of acting on new insights and diverging from a perhaps planned trajectory. It is this creative freedom that allows for new connections, experiences and discoveries. I believe it lies at the heart of research in the creative disciplines. Without it, we would be "drawing by numbers," while serendipitous and radically

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new discoveries would be less frequent. As a result, I think "systematic" may be relevant to the general overall structure or model[1] of the research process of PhD research but should be avoided in the active creative phases in which new ideas emerge and solutions are developed.

« 7 » In this context, I ask where the "values" in scientific research might enter. In artistic research, they often are referred to, or better emerge, in a reflective chapter. Karl Popper asks why few scientists care to write about ethics and values:

" […] values emerge together with problems; that values could not exist without problems; and that neither values nor problems can be derived or otherwise obtained from facts, though they often pertain to facts or are connected with facts. " (Popper 1976: 226)

« 8 » I would say that it is here where a second-order cybernetics perspective might provide a valuable contribution to avoid the "view from nowhere" (Turnbull 2000: 221). When design research aims to answer a research question, a process that also involves looking at problems, then this should be linked to particular values held by the researcher, fundamentally informing the thinking and acting. However, these are rarely made explicit. If this happens this usually takes place in a reflective chapter towards the end of the written thesis.

« 9 » I believe that Sweeting's emphasis on Karl Müller and Alexander Riegler's proposal (§§25f) linking second-order cybernetics and design creates a most promising direction for both disciplines. This might be especially so in view of current developments in design such as transition design (Irwin 2015), design for social change and user experience design. All three examples include theoretical models that inform acting, which may lead to designing intangibles, such as processes, involving (§25) complexity, adaptation and evolution, and (§26) self-reflexivity and the inclusion of observers (§30).

1| See Hugh Dubberly's "How do you design: A compendium of models," http://www.dubberly.com/articles/how-do-you-design.html

Michael Hohl is a designer, design researcher and educator. He is interested in how design researchers can be educated to develop the well-balanced skills, empathy, rigor and intuition necessary to conduct their research. Central to his research are "designing for all senses," for designers to consider qualities beyond mere usability or visual appeal, taking into account all our sensorial modalities, considering embodied cognition. Related to this are interests in the epistemology of data-visualizations and mentoring students in making use of appropriate research methods in the context of their research.

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Digital Design Research and Second-Order Cybernetics

Mateus de Sousa van Stralen
Universidade Federal de Minas Gerais, Brazil
mateus-stralen/at/ufmg.br

> Upshot • I claim that the parallels between design research, second-order cybernetics (SOC) and second-order science (SOS), as discussed by Sweeting in the target article, are more explicit in digital design. The discussion of SOC and SOS can point towards the creation of an epistemological foundation to digital design, where self-reflexivity and the inclusion of the observer are central questions.

« 1 » Gordon Pask pointed out "it is easy to argue that cybernetics is relevant to architecture in the same way that it is relevant to a host of other professions; medicine, engineering or law" (Pask 1969: 494). Indeed, there are several publications about the application of cybernetics in design. In the target article, Ben Sweeting looks at this the other way around and proposes that design research can contribute to cybernetic thinking by suggesting that design research is not just a field influenced by cybernetics but is a form of second-order cybernetic practice. Sweeting relies on Glanville's work to underpin the strong relation of second-order cybernetics (SOC) to practice and design.

Through his work, Glanville has shown that not only can cybernetics contribute to design, but that design can also inform cybernetics, understanding cybernetics and design not as separate entities but as a circular interwoven process of acting and reflecting, theory and practice. The discussion I put forward in the commentary is that Sweeting's arguments can be made even more explicit if we focus on a more specific form of design research that is based on digital processes – digital design – and look how it is practiced. The connections between digital design, design research and SOC can serve as bridge for a new generation of designers to access and incorporate radical constructivism in their reflections and actions.

« 2 » In the last decade, there has been a growing interest in cybernetics amongst designers, especially young ones, driven by the increasing use of digital technologies in design. Computer programming and its promise of machine intelligence in the process of design,[1] manufacturing[2] or embedding it in the environment[3] are part of today's design practice. The development of the different digital processes and techniques was mainly motivated by transformations in praxis led by architects and designers trying to explore the potential of digital technologies in their work. As Neil Leach (2012) points out, much of the research in digital design was done outside the traditional academic environments. Designers had to develop their own software and building process to ensure the feasibility of their designs,[4] and many reached out to theories external to design to

1| Among others, the following AI-based techniques are popular: neural networks, genetic algorithms, multi-agent systems, evolutionary architecture (Frazer 1995).

2| Topology optimization, digital fabrication, and self-assembling are examples of techniques in which computation is applied to the manufacturing process.

3| In interactive environments and relational architecture, computation is embedded in the environment to enable reactive, interactive and dialogical behavior. See, e.g., the works of Usman Haque, http://www.haque.co.uk, and Ruairi Glynn, http://www.ruairiglynn.co.uk.

4| See, e.g., the design companies Gehry & Partners and Zaha Hadid Architects.

support their works.[5] But as Rivka Oxman (2006: 232) has noted, the impact of digital design on practices has resulted in a need for a revision of current design theories. Many research groups and designers have looked to cybernetics to create conceptual frameworks to guide research and development.

« 3 » Digital design research can be seen as a subcategory of design research, but given the impact of computation in designing and in production practices, it is evolving to become a unique field in design (Oxman 2006). In digital design, computation can be integrated in the total process of design, from the initial concept through to materialization, production and use. In this "digital continuum," as it is called by Branko Kolarevic (2003), design is directly connected to materialization, from the initial conceptual stages with rapid prototyping techniques, to the final object with digital fabrication processes and interactive systems. The connection between design and materialization, research and action indicates how the relations between design research and cybernetics can be even more evident in digital design. It is not a surprise that most examples of connections between cybernetics and design listed in §21 of the target article can be seen as examples of early digital design. Nicolas Negroponte's *Soft Architecture Machines* (Negroponte 1975) discusses computer-aided architecture related to machine intelligence in design. John Frazer's *An Evolutionary Architecture* (Frazer 1995) investigates form-generating processes by considering architecture as a form of artificial life. Glanville also had several articles related to digital design, such as "CAD Abusing Computing" (Glanville 1992) and "Variety in design" (Glanville 1994). Further evidence can be found by bringing the discussion of the concepts of self-reflexivity and the inclusion of the observer into the light of digital designing.

« 4 » Sweeting discusses how self-reflexivity and the inclusion of the observer can be seen as important points of interconnection between design research, SOC and second-

order science (SOS). Self-reflexivity is one of the central issues in digital design processes today. This becomes more evident in those practices where computation is inextricably part of the process, such as algorithmic and parametric design, in which the designer designs computational process to generate form. The design of the design process that generates form gives the idea that form is not "given," but "found." In the first case, data forces shape onto passive matter, and in the second case, matter and data interact and give shape. The idea of giving shape makes the connections between observer and process more explicit, as most designers are eager to claim their involvement in the process. That is why the inclusion of the observer does not seem to represent a problem in design. But in *form finding* this becomes more blurry, as questions can arise as to who is responsible for the design. This process, which is also called "emergence," leads to a false idea that computers themselves are generating autonomous objects. However, from an SOC perspective, the designer is also responsible for the final design because form is actually coded in the computer by the designer. The observer is included in a self-reflexive act of designing design.

« 5 » Another point worth being discussed is the impact of the *digital continuum* in design. Digital fabrication enables designers to create short feedback cycles of designing, making and reflecting. In that context, practice-based research methods have become more widely used and accepted, as designers are now able to make high-end models and products in a fast and accessible manner through different iterative cycles. Either explicit or not, these feedback cycles can be seen as examples of cybernetic practice, which reinforces Sweeting's arguments.

« 6 » In conclusion, Sweeting's target article positions design research as a contemporary variety of SOC and by doing so, establishes the connections between design and SOS, creating a circular relation where one can inform the other. The parallels between design research, SOC and SOS can be even more explicit in digital design. SOC and SOS can point towards the creation of an epistemological foundation to digital design, where self-reflexivity and the inclusion of the observer are central questions.

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5 | The special issue of the London journal *AD* on "Folding in Architecture" (Lynn 1993) has several articles that exemplify how designers reached out to theories external to design to support their works.

Mateus de Sousa van Stralen received a master's degree in architecture from the Federal University of Minas Gerais (UFMG) in 2009 and is currently a doctoral student at the same university. He is the director of KUBUS4D (an architecture office focused on digital design) and a researcher at LAGEAR (Graphic Laboratory for the Experience of Architecture, School of Architecture at UFMG). Based on his experience in architecture and urbanism, in particular planning and building projects, he focuses on the following topics: architecture and digital technologies, design process and digital fabrication.

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Cybernetics Is the Answer, but What Was the Conversation About?

Jose dos Santos Cabral Filho
Universidade Federal de Minas Gerais, Brazil
jcabral/at/arq.ufmg.br

> Upshot · It is suggested that the main arguments of the target article could be constructed in an easier way and would become even more compelling if a radical consideration of the systemic nature of design were taken into account.

« 1 » Ben Sweeting's target article shows a genuine and welcome effort to amplify our understanding of the relationship between design and cybernetics. Sweeting explores in detail the intricacies of such a relationship, presenting a well-argued investigation into the possible links between the two fields of investigation and looking for a kind of mutualism, exploring the improvement that both parts can bring to one another. He does so by continuing Ranulph Glanville's lifelong enterprise of clarifying the intertwining of the two areas, an effort that was often made in unusual ways, escaping the conventional idea of applying cybernetics to design.

« 2 » My collaboration in this open commentary is to suggest that if a radical consideration of the systemic nature of design were taken into account, the main arguments of the article could be constructed

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in an easier and simpler way. The question of simplicity here is less to attend the principle of Occam's razor and more to make the arguments even more compelling and, therefore, have a greater chance of extending their practical implications.

Design as an invitation to dialogue

« 3 » There seems to be widespread consensus that to consider design under the principles of second-order cybernetics is mostly to acknowledge the inclusion of the observer and the conversation that originates from this acknowledgment. However, the bibliography on the subject shows that most researchers consider the inclusion of the observer to be restricted to the design process (the work of designers), and sometimes extended to the research into the design process (the work of researchers, academic or not). This applies to different researchers, such as Glanville and Donald Schön, and, in fact, it underlies the target article. Most of the time, the issue of the use of the designed object does not get much attention, as if the design role had ended with the creation of the object. Nevertheless, the consideration of the object and its use is not enough: if we understand the systemic nature of design in a radical way, we have to come to terms with the fact that the final product of the design chain is not an object but a system, in which the object is included. Acknowledging this will change, concomitantly, the design process and design process research.

« 4 » Thus, if we want to push the idea of design research as a variety of SOC to its most interesting limits, we have to consider that what we design when designing is not merely an object but a larger system that includes the object (and in some cases, may even prescind from physical objects). That may seem common sense, obvious and self-evident, and, in fact, it is one way or another acknowledged by most designers, especially by architects (and it is surely indisputable amongst cyberneticians).

« 5 » This matter was already highlighted by Gordon Pask in his seminal paper "The architectural relevance of cybernetics" (Pask 1969). It posits, amongst other things, that "architects are first and foremost system designers," a reasoning that can be easily extended to design in general. Pask's paper is certainly one of the most quoted papers in relation to cybernetics and architecture/design, especially due to its unexpected proposition that architecture is more relevant to cybernetics than the other way round.

« 6 » However, Pask's assertion on the systemic nature of architecture is not fully taken into account by practitioners, if not even downplayed. Certainly, several researchers, particularly those with some sort of direct link to Pask himself, such as Hugh Duberly, Paul Pangaro, Usman Haque, and John and Julia Frazer, have all drawn attention to the groundbreaking aspect of Pask's contention, and have consistently tried to develop it further (§21). Dubberly & Pangaro (2015) even argue that this paper "anticipates Donald Schön's notion of design as conversation […] and goes further than Rittel and others who described design as a cybernetic process" (Dubberly & Pangaro 2015: 10). For certain, Pask goes beyond Schön's notion of design as conversation, considering that Schön, even though he pushes the idea of design beyond mere problem solving, still regards the design process as somehow ending with the object. In this way, conversation, in Schön's view, ends up been a kind of soliloquy between the designer and his or her drawings, regardless of whether he or she is using drawings to articulate ideas and not just as a representation. However, it is undeniable that Schön's book *The Reflective Practitioner* (1991) turned out to be very influential and played a significant role in the general acceptance of design as conversational outside the circle of cybernetics.

« 7 » Thus, on the one hand, we have a theoretical recognition of the importance of the systemic principle of design, and on the other hand, what we can term as a politically correct embracing of democratic intentions by designers. The problem is that despite this general and diffuse acceptance of a systemic approach, we are witnessing a continued and excessive focus on the design of non-systemic objects that is more and more tailored to meet the spectacularization of our lives and cities. In other words, we see not the use of a dialogical framework in the actual practice of design, but a dialogical discourse superficially applied to design. As a matter of fact, a dialogical discourse is a contradiction in itself, as discourse is opposed to dialogue, as the philosopher Vilém Flusser (2011: 83) reminds us.

« 8 » The problem with a superficial adoption of design as conversation is that it can lead to sterile self-reflexive attempts such as Peter Eisenman's Cannereggio project, referred to in the target article (§28). On the one hand, it is for sure a meta-reflection on the design process and apparently it articulates an ingenious convergence of the three categories of design research – into, through and for (§§22, 30). On the other hand, its design scenario excludes so many layers of the concerns and stakeholders implied on that specific architectural design that it becomes a restricted conversation, a soliloquy so to speak, that ends up as a selfish and exhibitionist exercise, no matter how intellectually flamboyant and marketable it may be. In other words, it is not enough to be self-reflexive and simply engaged to explore the full potential of being an SOC observer. The question is not only about the engagement or detachment of the observer; it is not only about where we position ourselves as observers (§30) but also about how far we are willing to take the systemic approach, that is to say, it is about the extent and nature of the included observers invited to the dialogue.

« 9 » Pask and Price, once more, have shown some possible paths to including the observer radically with their Fun Palace project – a collaboration with Joan Littlewood (§13). However, it is worth noting that the same contradiction regarding Pask's paper – praised but not fully taken into account – goes for the Fun Palace. It is widely reverenced in architectural magazines and at exhibitions but it seems to have had little practical impact on the production of contemporary architecture. The digital design trend of recent decades, for example, which is based on the design research of the 1970s, has promoted a change in practice from designing the object to designing the process of designing the object (designing design, form-finding, etc.). A radical move would change the focus on the object in itself towards a systemic and relational scenario where the object exists in its full dialogical potential; that move, however, seems unattainable (or possibly, undesirable).

« 10 » Even if we consider the development of so-called interactive architecture,

the Fun Palace proposition is still far ahead of what we have achieved, in spite of the advances in digital technology at our disposal. It seems that, contradicting Price's famous dictum "technology is the answer, but what was the question?", technology is not the answer in our present situation. At least not technology outside an SOC framework. Perhaps we should bring Price's dictum up to date by saying: cybernetics is the answer, but what was the conversation about?

Conclusion

« 11 » A significant advance in design towards a second-order level will come when designers embrace an all-encompassing systemic approach that will necessarily have the inclusion of the observer, at all possible levels, as its pivotal point. If the desire is to keep design and design research as a practical enquiry into openness, as Sweeting seems to aspire, designers must extend the conversational and recursive strategy used in the design process towards the creation of dialogical objects and the system in which they are inserted. To consider design within the complexities and seriousness of Pask's conversation theory would allow a radical rethinking of design in a way that it would necessarily become SOC in practice. Then, Glanville's assertion that "cybernetics is the theory of design and design is the action of cybernetics" (2007c: 1178; §22) would become unequivocal, and design, as well as design research, would be undoubtedly more similar to the tangible experimentation of first-order cybernetics, as the target article proposes.

Jose dos Santos Cabral Filho is an architect and Professor at the School of Architecture at UFMG (Brazil). He holds a master's and a PhD from Sheffield University and has been a visiting scholar at McGill University, NTNU and the RCA. His interests range from cybernetics to architectural performances, electronic music, play and games.

(Architectural) Design Research in the Age of Neuroscience: The Value of the Second-Order Cybernetic Practice Perspective

Andrea Jelić
Independent researcher, Serbia
jelic.andrea/at/gmail.com

> Upshot • This commentary highlights the relevance of understanding design research as a variety of second-order cybernetic practice. It does so by illustrating possible contributions of this view to several concrete issues surrounding the introduction of neuroscientific framework to architectural design. Based on the implications of Sweeting's article, I suggest that the specific case of an interdisciplinary dialogue between architecture and cognitive science can provide a plausible testing ground as a new research field for second-order cybernetic practice and second-order science.

« 1 » In the context of the increasing interest of neuroscience for architecture and, more broadly, evidence-based design, Ben Sweeting's target article offers a critical perspective for plausible positioning of design in such an interdisciplinary dialogue. Specifically, by understanding (architectural) design research as a contemporary variety of second-order cybernetics, an opportunity arises for tackling potentially crucial obstacles to future progress and the usefulness of neuroscientific investigations in an architectural context. Accordingly, the aim of this commentary is to highlight the value of the target article's view by examining its possible contribution to several crucial issues, including:

a addressing concerns of prescriptive design solutions;
b using the inherent second-order cybernetic structure of design research to question the roles of the architect-designer and the scientist in the context of experimental studies; and

c indicating the need for and possibility of a new second-order science of interdisciplinary design research framed on the basis of cognitive science and phenomenology of architectural experience and design.

« 2 » Before proceeding, it is important to contextualize the commentary's argument and motivations by sketching briefly the background and current efforts in the field dedicated to investigating the relationship between the mind, body, and built environment through a neuroscientific lens (for a comprehensive introduction, see Mallgrave 2011, 2013). On the one hand, a renewed interest in the experiential dimension of architecture and a turn toward human-centred design, and on the other, decades-long history of architectural psychology and environment-behaviour research have created conditions for a seamless opening of neuroscience-architecture dialogue. However, despite promising initial efforts, there is a lack of a systematic framework purposely aimed at defining and structuring the relationship between architectural design and scientific insights/evidence. It is in this light that the target article's cybernetic parallels between science and design are proposed as a direction for approaching this important issue.

« 3 » Concretely, the continuity of ideas between cybernetics and design research as presented by the author (§22) establish potential interpretations for neuroscientific knowledge-architectural design connection at two levels:

▪ at the level of design research being exercised as a second-order cybernetic practice, and
▪ at the level of interdisciplinary design research as a second-order science.

« 4 » Firstly, the essentially conversational and constructivist nature of the design process challenges directly any concern for developing evidence-based prescriptions for architectural solutions. In this sense, any (recurring) attempt to "scientise" design through neuroscientific methods and inputs – a genuine possibility in the age of neuroscience – can be countered effectively by bringing awareness of the cybernetic conditions governing design research into this interdisciplinary endeavour. Therefore, similarly to the capacity of the work of architecture only to trigger

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and not control the subject's experience (according to the enactive-embodied view, Jelić et al. 2016; see also Sweeting's hypothesis of architectural experience as facilitating second-order inquiry, Sweeting 2015a), neuroscientific inquiries into the experience of architecture primarily serve to shed light on design knowledge, to relate the intuitive decisions to spatial scenarios, and not to modify the design activity as such.

« 5 » Secondly, in line with the theory of embodied cognition, architectural design is in itself an embodied process: it is hypothesized as being a neurological activity that always involves embodied metaphorical thinking and multi modal image-making (Arbib 2013; Mallgrave 2011). Indeed, reflecting phenomenologically upon one's own experience as a designer and based on (auto)biographical descriptions of the process by extraordinary practitioners (e.g., Zumthor 1999), it can be suggested that architects commonly have rather suggestive, lifelike, intensive (bodily) feelings when imagining the spaces they are designing, in resonance with imagined atmospheric qualities. Accordingly, a neuroscientific, or better yet, neurophenomenological investigation of the design process may bring forward the awareness about the bodily and emotional processes involved in (pre-)reflective experiences of "living" the designs. Hence, design research with reference to second-order cybernetics principles (§22) could help to distinguish the participant's dimension – how an exchange of different observational positions occurs (i.e., imagining experience from the position of the user and one's own as a designer), how such switching is incorporated into the conversation with the medium in which the designer works, and ultimately, in what manner such an observer's awareness could be introduced to teaching design and facilitating the learning process.

« 6 » Following the target article's convincing argument for the necessary shift in understanding science as a design-like activity (§§13f), a concrete illustration can be offered in the context of the neuroscience-architecture inquiry. If design research is understood as a variety of second-order cybernetic practice, then this kind of interdisciplinary experimental work encounters a particular observer issue: who is a designer here – an architect or a scientist? Currently, the majority of neuroscientific investigations are one-sided, i.e., led and conceived primarily by cognitive scientists, with little or no support from the architectural side. In such a situation, designing experimental setups, involving the creation of architectural environments, is guided more by the requirements of scientific methods than by architectural purposes. Thus, the validity of resulting evidence can be questioned on the basis of its appropriateness and usability in design. For this reason, there is a need to strategize such an interdisciplinary endeavour by establishing a framework for the new second-order science (see, for instance, the proposal by Hugo Alrøe and Egon Noe 2014), which should include careful rethinking of the participants' roles in relation to their disciplinary perspectives, expertise, and corresponding impact on study outcomes. In other words, there is a need for self-reflexivity and differentiation according to the observer (architect or scientist), in the spirit of second-order cybernetics and science, as indicated in §15 and §30.

« 7 » To illustrate further the parallels between design research and (second-order) cybernetics (§23), this last point considers the overlap between the notion of cognitive-science-*cum*-phenomenology providing a genuine second-order science (for a detailed account, see Vörös 2014) and the proposal by Sweeting (§26) of second-order science being a potential point of interchange between design and science. In the context of neuroscience-architecture dialogue, Sebastjan Vörös's argument can be transformed into a cognitive science-*cum*-phenomenology of architectural experience and design, where the latter refers to a longstanding tradition of architectural phenomenology and the above-mentioned phenomenological descriptions of architects' works and design thinking (classical examples including Holl, Pallasmaa & Pérez-Gómez 2006; Pallasmaa 2005). In parallel, current efforts to provide a systematic conceptual framework for the complex bio-cultural nature of architectural experience prevalently belong to the enactive-embodied understanding of cognition (see, for instance, Jelić 2015; Jelić et al. 2016; Rietveld 2016; Rietveld & Kiverstein 2014). Taken all together, a new second-order science of interdisciplinary design research can be conceived of as a conversational framework between the enactive-embodied approach and the phenomenology of architectural experience and design, which focuses on the interdisciplinary research itself. Thus, its aim is to identify and establish a plausible pathway of exchange between neuroscience and architecture – that is, to create a communicative space, a "*trans-domain*" where scientific and designerly research may converge (Jonas 2015a: 34). Accordingly, the architect's ways of knowing might be able organically to incorporate alternative approaches to life-world perspectives, in this case, one that is enactive-embodied and evidence-based, and thus strengthen in turn the architectural mode of structuring and representing the world.

« 8 » Finally, the value of target article in the context of constructivist approaches more broadly, can be particularly emphasized in terms of its pertinence to addressing problems beyond cybernetics – more specifically, in the domain of enactivism as related to architecture – by indicating a way of structuring interdisciplinary research and thus tackling one of the key issues of design research in the age of neuroscience.

Andrea Jelić holds a PhD in architecture from Sapienza University of Rome for her dissertation "Architecture and Neurophenomenology: Rethinking the Pre-reflective Dimension of Architectural Experience" (2015). As an architect and researcher, her current work focuses on the intersection of architecture, neuroscience, and phenomenology, aimed at investigating issues of experience, meaning, and pre-reflective place-making in architectural and urban environments.

Author's Response
Beyond Application

Ben Sweeting

> **Upshot** · I reinforce the idea of broad connections between cybernetics, design and science that become apparent when the messy processes implicit in each are reflected on more explicitly. In so doing, I treat design not as a field in which cybernetic ideas are to be applied, but one in which they are reflected on and pursued.

« 1 » I wish to thank all commentators for their stimulating contributions. The first thing to note in response to these seven commentaries is the range of ground they cover, indicating the wide potential of the relation between cybernetics and design research to inform both fields. It is significant that many of the aspects raised by commenters are focused on core topics of cybernetic research: computing technology (Mateus van Stralen; Christiane Herr); cognition (Andrea Jelić); and, broadly, the relationship between research/theory and action/practice, which is a focus of Herr and Michael Hohl, and underlies the concerns of Jose Cabral, Dai Griffiths and Tom Scholte. As Karl Müller (2010) has noted, there is a need to focus on core topics in order to reinforce the coherence of radical constructivism (RC) and second-order cybernetics (SOC) as a research field. Müller's remarks could be taken as a call for a turn away from topics such as design that have been prominent in recent cybernetics. These commentaries, and the research to which they point, suggest that design may instead offer a focus in which a number of such core issues can be explored.

« 2 » In this context, Scholte's introduction to the work of Ann and Lawrence Halprin may be valuable even beyond the project of connecting cybernetics-inspired discussions in design and theatre studies (see also Scholte's target article in this issue). Building connections such as this would seem to be a way to help broaden the relationship of cybernetics with both design and theatre beyond one of application, releasing their potential to explore central cybernetic concerns through practice (cf. Müller 2010: 36f).

« 3 » Of the commentaries, those of Griffiths and Cabral put forward the most explicit questions, and I therefore concentrate on these below. In line with my approach in the target article, I have attempted to remain focused primarily on how issues raised in design can contribute to questions in cybernetics.

Ill-defined problems

« 4 » Griffiths (§8) suggests that the account of design that I have given applies to a particular subset of design, whereas at least some other areas of design deal with well-defined problems. Some design tasks or components of design tasks are, indeed, characterised by more constrained problems than others. Yet even apparently clear and familiar design tasks regularly involve incomplete criteria or contestable premises, and a clearly-defined goal is no guarantee of a well-defined problem (cf. Griffiths §6). This is because design is always concerned with the new (target article §8), which is the case even when designers are not attempting to be especially innovative (that is, when we design a building, we are concerned with creating something new even when we stick to an established typology). This can be seen within the scope of the definition that Griffiths (§5) cites: the process of preparing a plan for constructing something is not solely a matter of setting out production information (the working drawings and specifications that will guide manufacture) but of devising what is proposed in these. This process involves forms of reflective, conversational activity whenever such a plan is considered in more than arbitrary terms (that is to say, when it is designed).

« 5 » Take, for instance, some of the questions posed in the design of a new motorway (an example within the compass of engineering, and one to which Horst Rittel and Melvin Webber refer, Rittel & Webber 1973: 163). Different configurations of road junctions will be both better and worse according to different terms of reference. Even considering only the efficiency of traffic flow, there will be trade offs between congestion at different points in the road system. There are also many other relevant criteria, such as, for instance: safety, other road users, cost, construction sequencing,

maintenance, noise pollution, air quality and impact on natural habitats. While these criteria are mostly easily recognisable, they are not all commensurable with each other, such that there is no one way to resolve definitively between them, nor is it possible to optimise against an overall goal without this being distorting. Further, the interactions between these different criteria and the limitations they set on each other in the specific situation that is at hand only become clear as particular solutions are developed, discussed and enacted. Taking a broader scope, one might also challenge the premises under which the project is advanced: having explored the likely consequences of the new motorway, we may take a different view on whether it is a worthwhile project and consider alternative options instead.

« 6 » While such situations resist exhaustive analysis and conventional linear problem solving, designers deal with them as a matter of course and without regarding them as being problematic. In so doing, they develop and refine not just their design proposals but also the questions to which these proposals respond. Indeed, as Nigel Cross (2007a: 100) points out, designers treat even well-formed problems as if they are ill-defined, an approach that has the benefits of testing the assumptions that are given at the outset and searching for new opportunities.

« 7 » Griffiths (§6) gives two counter examples – those of scientific and musical instruments – where questions are very tightly constrained. Indeed, these situations are so constrained that they might well not be considered as instances of design activity in that they respond to a plan rather than create one. The musical instrument example, which is perhaps better understood in terms of craft, is closely related to the existing tradition of musical performance in which each instrument must be usable. These constraints can, however, be understood as a result of a wider design process, one where the configuration of the musical instrument has co-evolved slowly over several generations together with the traditions of musical performance to which it is related (this is comparable in architecture to the development of a vernacular tradition). The development of scientific instruments can be thought of, similarly, as blur-

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ring with that of scientific experimentation itself, as is reflected in accounts of scientific practice (target article §10). What is learnt in experiments using the instruments generates new criteria for further experiments and so new or refined instruments. Thus we can think of this as one overall process, which we could characterise either in terms of science or design, encompassing scientific experimentation and the construction of the instruments that support this.

« 8 » **Griffiths** (§8) asks the question of to what extent an SOC account of design can be convincing to those that do not share its epistemological position. I do not see this as a question of different design epistemologies but of different degrees of explicitness about the epistemology that is acted out in design, and different ways of making this explicit. What designers do in practice is not always what they describe themselves as doing, as discussed by **Herr** and **Hohl**. It is in retrospect that the paths taken seem clear and, as it is this clarity that is what designers need to communicate, the messy process by which this clarity is developed usually remains unremarked on. Making these sorts of processes explicit is a core concern of design research and something to which SOC can contribute. The purpose of this is not, as I see it, to reconfigure design practice in some specific way. Rather, articulating what would otherwise remain tacit helps maintain what is already special about design (including attitudes towards values, as raised by both **Herr** §2 and **Hohl** §§7f), something that can otherwise become lost.

« 9 » This relation of SOC to design practice in terms of making the implicit explicit may, as **Griffiths** (§8) suggests, inform how SOC might be advanced more generally. Cybernetic processes are implicit in everyday life and, as with design, making these processes explicit reinforces what is special about them, which can otherwise become lost in the context of other concerns. Looked at in these terms, SOC's relation to practice is not limited to where its epistemological position is explicitly shared. It can enjoy a broad relation to practice in terms of implicitly cybernetic processes, while still contesting the ways in which particular practices are conventionally understood.

Material agency and viability

« 10 » **Griffiths** points out tensions between RC and Andrew Pickering's (1995) account of material agency. As **Griffiths** (§11) notes, there is not necessarily a conflict here and it seems to me that such tensions can be defused, or at least sharpened to more precisely the points at issue.

« 11 » This is supported by the case of design, which while constructivist in orientation is compatible with ideas of material agency, even if this was not emphasised in my account. This is both in terms of the media with which designers think and the technologies and industries with and in which they work:

- Media plays an active role in how designers work. It is important to how they deal with complexity (Gedenryd 1998), model the material and spatial (Sweeting 2011), and construct new possibilities (the process of sketching that Ranulph Glanville 2006a, 2007c emphasises is one that needs to be embodied in media of some kind). This includes the digital technologies discussed by **van Stralen**, as well as the more obvious materiality of the analogue. Accounts of the active role of instruments in science, such as that given by Pickering (1995), can be read as if referring to the design studio (target article §10).

- What is materially and technologically feasible is a crucial constraint on what designers propose. This is especially the case where designers try to use materials in forms to which they are particularly suited, as can be summarised by architect Louis Kahn's oft-quoted conversation with a brick – "You say to a brick, 'What do you want, brick?' And brick says to you, 'I like an arch.' And you say to brick, 'Look, I want one, too, but arches are expensive and I can use a concrete lintel.' And then you say: 'What do you think of that, brick?' Brick says: 'I like an arch.'"[1] As well as this material-focused approach, material agency can be seen in the way that technological changes have transformed the nature of material constraints (discussed by **van Stralen**

[1] https://www.theguardian.com/artand-design/2013/feb/26/louis-kahn-brick-whisperer-architect

§§2, 4), and it remains an important factor even where design approaches are focused elsewhere.

« 12 » The principle move in RC is to change the orientation of epistemology from a concern with how we know (or do not know) about any real world beyond our experience, to a focus on this experience itself. This relocates epistemology to the realm of experience, in which (our experience of) the material is important to include (as is evident in design). While, therefore, RC can be contrasted with the material where this is meant in the sense of the real, there is no conflict between RC and our material experience. Indeed, the latter can be encompassed in the notion of viability, which is central to Ernst von Glasersfeld's account. RC is not a licence for unconstrained construction. Von Glasersfeld (1990) gives the example of not being able to walk through a desk, and thus being unable to maintain a viable idea of the world that would allow him to do this. This is an example of a material condition in which we experience epistemological, not just practical, resistance.

« 13 » Von Glasersfeld sometimes referred to viability in terms of "fit." In RC, this is in the sense of "fitting with" or evolutionary fit, and so perhaps better phrased in terms of the elimination of the unfit. There is no sense of correspondence to the real and much room for contradictory explanations to be viable in our experience at different times. This is not to be confused with the athlete's notion of fit, of an idea becoming fitter and fitter in the sense of a closer match to the goal of the real. In this latter view, while it may still be acknowledged that we do not have access to the real, our experience is claimed to be a good guide to it in any case because of the constraints that are imposed on it, thus returning to a correspondence view of epistemology. The main point at issue here is, as I see it, not about material agency per se but whether this is understood in terms of the real or in the realm of experience, and about how this is then put to work epistemologically.

« 14 » Similarly to what I have said above regarding the relation between SOC and design, I think that RC is agile enough to engage with the material and the performative across the "whole range of scientific and design activities" (**Griffiths** §11), while

also contesting what is at stake epistemologically in these. Indeed, RC can help provide the honesty that Glanville (2014c) suggests will efface the differences between different research traditions (target article §14; and as expanded on by **Hohl**).

Designing systems

« 15 » **Cabral**'s call for an increased focus on the systemic nature of objects is something that I support. The issue as I see it, and as **Cabral** (§3) points to, comes back to what, especially in architecture, is a surprising gulf between theories regarding how we understand, on the one hand, what is designed and, on the other, the process through which design occurs. Recent work has addressed this in part by seeing architecture in terms of its place within the building industry (Lloyd Thomas, Amhoff & Beech 2016). From the vantage point of SOC, there are further,

more designerly opportunities for bridging between these areas. The work of **Jelić** is significant in this regard, establishing an account of architectural experience in commensurable terms to constructivist accounts of design practice. I have previously suggested there is potential in connecting conversational accounts of design with conversational accounts of architectural experience (Sweeting 2011), while in the context of the target article one can also understand particular examples such as the Fun Palace as being part of SOC enquiry not just resulting from it (**Cabral** §9; **Jelić** §4; Sweeting 2015a).

« 16 » The building of such bridges does not, however, guarantee in what manner they will be crossed. In making the argument in the target article – that design is a form of SOC even where SOC is not explicitly referenced – it was important for me to refer to work in design beyond figures such as Ce-

dric Price, Nicholas Negroponte and John Frazer, who were explicitly influenced by cybernetic ideas. My reference to Peter Eisenman is not therefore intended to validate his architecture but to point to the formal similarities between his work and second-order science (SOS) that are of interest whatever we think of his proposals. Indeed, the sort of critiques put forward by **Cabral** and others, such as that of Robin Evans (1985), may inform how SOS and SOC can be developed: as **Cabral** (§8) puts it, "it is not enough to be self-reflexive and simply engaged to explore the full potential of being an SOC observer." The question of how to design such systems is an open one, and a topic on which design research and cybernetics might collaborate.

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