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Cybernetics and Design: Conversations for Action

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Working for decades as both theorist and teacher, Ranulph Glanville came to believe that cybernetics and design are two sides of the same coin.

Working as both practitioners and teachers, the authors present their understanding of Glanville and the relationships between cybernetics and design.

We believe cybernetics offers a foundation for 21st-century design practice. We offer this rationale:

- If design, then systems: Due in part to the rise of computing technology and its role in human communications, the domain of design has expanded from *giving form* to *creating systems* that support human interactions; thus, systems literacy becomes a necessary foundation for design.
- If systems, then cybernetics: Interaction involves goals, feedback, and learning, the science of which is cybernetics.
- If cybernetics, then second-order cybernetics: Framing wicked problems requires explicit values and viewpoints, accompanied by the responsibility to justify them with explicit arguments, thus incorporating subjectivity and the epistemology of second-order cybernetics.
- If second-order cybernetics, then conversation: Design grounded in argumentation requires conversation so that participants may understand, agree, and collaborate on effective action.

Second-order cybernetics frames design as conversation for learning together, and second-order design creates possibilities for others to have conversations, to learn, and to act.

A Conversation about Conversations-for-Action

In October of 2014, the authors began a conversation with Ranulph Glanville about the relationships between cybernetics and design. Our all-too-brief conversation with him is the basis for this paper. We should acknowledge that this paper is not a review of Glanville's extensive writings and that we may not fully understand his views. However, we would like to report on the points he made, sometimes quite vehemently, to us—and we would like to comment on the many places where we concur and the few where we do not.

The catalyst for our conversation was Glanville's masterful presentation at the RSD3, Relating Systems Thinking and Design 2014 Symposium in Oslo (Glanville, 2014a). Glanville argued that first-order cybernetics, far from being mere mechanics or calculation, provides a necessary alternative to linear causality: It brings us circular causality, critical to understanding and realizing (making) interactive systems that evolve through recursion, learning, and co-evolution. Second-order cybernetics is fundamental to design because it gives us an epistemological framework for designing.[3] Second-order cybernetics moves us from a detached, "objective" pose where we can duck responsibility, and right into the messy middle of things, where only we can be responsible for our actions.

Second-order cybernetics frames design as conversation for learning together. This creates the conditions for better-directed, more deliberate outcomes: hence the second half of our title, "Conversations for Action."

Sadly, Glanville's passing cut short our conversation. We strive to present his views as best we understand them, quoting him when possible. We appreciate his gifts, and we miss him. We invite continued conversation, especially with others who have collaborated with him and who may see his intentions differently. Together let us evolve the field.

The Context for Cybernetics and Design

We construe design as a conversation for action—that is, as cybernetics. Action may either conserve or change a situation. In other words, design is a conversation about what to conserve and what to change, a conversation about what we value. Both design and cybernetic systems involve a process of observing a situation as having some limitations, reflecting on how and why to improve that situation, and acting to improve it. This follows the circular process of observe > reflect > make that is common to the recursive and accumulative process of learning in service of effective action, as is found in science, medicine, biological systems, manufacturing, and everyday living (Dubberly et al., 2009).

We construe cybernetics as a process for understanding (von Glasersfeld, 1995) as well as a practice for operating in the world that focuses on systems that contain loops that enable the attaining of goals (Pickering, 2014). The term *cybernetics* comes from Greek roots meaning to pilot or to steer; on moving into Latin it becomes to govern. Some erroneously construe cybernetics to be mechanical. Some even hear in the word *system* the march of jackboots—unthinking, mechanical control. What interests us is quite the opposite—the messy chaos of natural and social systems, which cybernetics can help us begin to understand. We believe there is huge range for variation and possibility while applying the cybernetic frame to designing objects, interactions, services, and more. We also believe it is a misunderstanding to construe cybernetics as requiring a reductive stance or focusing on engineering. Glanville himself makes the point that Norbert Wiener ought to have published his most famous book *Cybernetics: Communication and Control in the Animal and Machine* after he had published *The Human Use of Human Beings*—because the former left an imprint of cybernetics as engineering grounded in mathematics, while the latter explains cybernetics as "a way of thinking and a way of being in the world" (Glanville, 2014a). The flowering of cybernetics in the 1940s came from conversations among a vast range of world-experts from both the hard sciences and the social sciences, all of whom celebrated the field as uniquely focused on a new way of seeing systems (von Foerster et al, 1950-1957; Dubberly & Pangaro, 2015).

The Rationale for Second-order Cybernetics & Conversations for Design

The structure of our argument is:

- If design, why systems?
- If systems, why cybernetics?
- If cybernetics, why second-order cybernetics?
- If second-order cybernetics, why conversation?

We now traverse that path and offer rationale and implications.

If Design, Why Systems?

Many of today's design challenges are *complex problems*, where an appropriate formulation of the situation is neither already agreed-to nor easy to characterize. However, through conversations within a design team, an agreeable characterization may be defined (the *problem formulation*) and then tackled by defining actions to improve the situation (the *solution*).

The industrial era changed the nature of design from design-for-making (insofar as there were any explicit design steps before making) to design-for-manufacturing. Beginning in the 20th century, *design-for-systems* becomes necessary, as evidenced from World War II when operations research as a field of practice and cybernetics as a systems discipline arose (Hughes, 1998). As argued in-depth elsewhere (Dubberly, 2014; Forlizzi, 2013), designers of digital systems are faced with the challenges of *product-service ecologies*. (Later we will widen the scope beyond digital and see that design-for-systems still applies.) This new design challenge is often exemplified by the iPod, but everything the same could be said for any portable networked device. While the user interacts with a physical device, the hardware's software connects to a network of communication systems (Internet) and databases (music stores) and marketplaces (music for sale), which has relationships to other actors (social community members, artists) and related aftermarkets. The complications of this system of systems must not be exposed to a user; and the designer must know enough about the system-to-system relationships to produce an effective design. Hence, designers must be conversant with this end-to-end mesh of (sub)-systems in order to design for a tractable set of rich choices from which the user lives her experience.

The rise of design-for-systems has further consequences. Good *form-giving* is largely table stakes—necessary but not sufficient to ensure the success of new ventures. New value-creation has moved to the development of systems. The term *platform* is often invoked in reference to complex, distributed interactions of hardware and software, networks and users, transactions and markets, for which primary examples are Alibaba and Amazon; Facebook and Google; Apple and Samsung (Dubberly, 2014).[4]

Design for complex problems that bridge product-service ecologies requires new skills:

> "Looking at a specific system, recognizing the underlying pattern, and describing the general pattern in terms of the specific system constitutes command of the vocabulary of systems, reading systems, and writing systems—that is, systems literacy (Dubberly, 2014, p. 7)."

If Systems, Why Cybernetics?

> "One of the things I should do is try to make a little difference between cybernetics and systems, or see if there is one. (Glanville, 2014c, 2'28")"

From the 1960s, The Club of Rome (Meadows, Meadows, Randers, & Behrens, 1972) popularized *systems dynamics* (SD) as a modeling language for complex systems, and since then Donella Meadows' and others' work has brought SD to a wide range of populations, including design students (Meadows & Wright, 2008). Conceived as a toolkit for explaining ecologies and economies, the vocabulary of SD—resource *stocks* and their *flows*—is well suited to its original application. However, we see limitations in SD for modeling systems for interaction. Meadows only briefly mentions regulation. SD does not clearly differentiate system behaviors that are the result of variations in levels (stocks as well as flows) from system behaviors that are the result of feedback. Perhaps most limiting is SD's lack of distinction between the effects of changes of levels (for example, an increase in population) and a deliberate act to effect an outcome. Goals require agency, and agency implies actions taken by participants that are based on data interpreted as feedback to the system's goals.

Goals and information are about the immaterial aspects of systems while stocks and flows are very much the materiality of them. The originators of cybernetics sought to make a clear distinction between the material and the immaterial. Ashby goes so far as to say "the materiality is irrelevant" (Ashby, 1956, p. 1) in order to further distinguish cybernetics as a discipline focused on information in purposive systems. As Glanville states while invoking Ashby, cybernetic systems are "not subject to the laws of physics and energetics, but subject to the laws of information, of messages" (Glanville, 2014a, p. 4).

Because design involves human beings—what we want and how we might act to get what we want—systems literacy for designers must go beyond SD and incorporate goals and agency. Designers must therefore understand the workings of systems with agency. Cybernetics offers both language and models for understanding and describing such systems.

A cybernetic viewpoint on design also invites (if not demands) consideration of the capacity of a given system to achieve goals (whether imbued by a designer or inherent in the system itself). This of course is the concept of variety (Ashby, 1956). When the system is a team of designers, the question need be asked: Do we have the requisite variety to successfully design and construct an outcome that will achieve our goals?[5] This question raises other questions, how do these goals arise, and whose are they? To answer requires a shift to second-order.

If Cybernetics, Why Second-order Cybernetics?

> "I have also developed the analogy between second-order Cybernetics and design so as to give mutual reinforcement to both. Design is the action; second-order Cybernetics is the explanation (Glanville, 2003, p. 22)."

Today's most critical design challenges are global in scale and have direct impact on quality of life—and its very existence. They include the future of the climate, water, food, population, health, and social justice. They are characterized as *wicked problems* (Rittel & Webber, 1973) because the challenge to be addressed appears irredeemable. Even defining "the problem" is itself elusive, subjective, and controversial. Calling these situations problems is misleading; a better term might be *mess* or *tangle*.

It gets even worse. Wicked situations are impossible to solve fully; rather, we work as hard as we can to minimize their negative effects, but we cannot eradicate them. In part this is because these situations operate across complex systems of systems, with emergent and unpredictable behaviors, including *unintended consequences*, even when well-intended actions are taken. Now add that some of the systems employed are human networks, comprising ecologies of language and conversation, with concomitant ambiguity, conflict, and human defects at play.

In sum, creating a formulation of a wicked situation such that actions may be identified, whose execution has some likelihood of effectiveness, is a design challenge of the greatest degree of difficulty and greatest importance for our future.

Rather than speaking of solving in the context of wicked situations, the convention is to speak of positive change as taming. Taming wicked situations requires the acknowledgment of the need for *framing*—the subjective look at situations from a perspective that is only one possibility of many. The value of one frame above another is guidance to an effective path forward, usually through a frame's power to explain why the system behaves as it appears to. This is a form of taming complexity through language (von Foerster, 1984). Framing must support objective facts but only by being explicit about the values that forefront some "facts" above others. Fundamentally, it must create an argument for some design approaches above others—the design rationale. Systems dynamics and even first-order cybernetics are not enough:

> "The systems-approach "of the first generation" is inadequate for dealing with wicked problems. Approaches of the "second generation" should be based on a model of planning as an argumentative process in the course of which an image of the problem and of the solution emerges gradually among the participants, as a product of incessant judgment, subjected to critical argument. (Rittel & Webber, 1973, p. 162)"

Rittel is important in part because he is among the first to frame *design as politics*—as discussion and argumentation—as opposed to *design as art* or *design as science* (Simon, 1969). Similarly, Buchanan (1985) later framed *design as a branch of rhetoric*.[6]

Rittel points out that the stance of designer as expert problem-solver is largely a myth. There are few design problems with clear solutions. Design is not objective; it's subjective. It's messy. The designer never stands outside the situation. The designer is always part of the situation—and other constituents of the situation also have necessary roles to play in the design process.

Thus design becomes centered in an argumentative process that involves "incessant judgment, subjected to critical argument" (Rittel & Webber, 1973, p. 162). Rather than existing outside the design situation, judgment and argument appear inside when the stance is that of second-order cybernetics. For the shift from first- order to second-order occurs when the observer—the designer, the modeler, the problem-framer, the participant in design conversations—is aware of her observing.

In sum, design for wicked problems, and the required (re)framing, calls for second-order cybernetics, which makes the role of the observer explicit, which in turn makes explicit the subjective position of every design rationale.

If Second-order Cybernetics, Why Conversation?

> "Conversation is the bridge between cybernetics and design (Glanville, 2014a, p. 8)"

> "Design is a circular, conversational process (Glanville, 2003, p. 22)"

Developing judgment and making arguments are, of course, forms of conversation. Glanville further tightens his assertion about the relationship of design and conversation by stating that conversation is a requirement for design, even when the conversation is with oneself, perhaps just using pencil and paper. (Schön, 1983, makes a similar point.) There is the person who draws and the (other) person who looks. The difference between these personae—between *marking and viewing*—is, in and of itself, a major source of novelty, Glanville claims. (We prefer the terms *variation* or *invention*. Our position on the role of novelty in design is given below.) Engaging multiple perspectives is a necessary condition for conversation, and without conversation, he writes, "You're not doing design, you're doing problem-solving."[7] Design, instead, is "to do something magical" and "to find 'the new'" (Glanville, 2014a, p. 10).

We state elsewhere (Dubberly & Pangaro, 2009) that conversational interaction is required in order to converge on shared goals. To share goals is to agree on (re)framing a situation in order to act together. We see the development of arguments in the course of designing (for or against different ways of framing situations) and the derivation of different choices or actions as the same as conversation. Thus we concur with Glanville's eloquent, albeit general, statements about conversation, cybernetics, and design.

However, we find some of Glanville's stated positions to be assertions without an accompanying rationale. For example, he was clear and even adamant that design knowledge is tacit, not explicit. We take this as part of his argument that design knowledge exists only in relation to action. If design is conversation, however, and if conversation is learning—very often, or at least consistently so in relation to design—then is not both the goal and the effect of the design conversation to make its subject explicit? We assert that for the major design challenges of today, making design knowledge explicit is a necessity. Form-givers may have the luxury of working alone, but designing systems and designing platforms require teams—and thus goals and methods must be made more explicit so that designs are coherent and actions are coordinated. Just as design is different than problem-solving, making choices in designing is different than making choices in creating a work of art. When designing, fit-to-purpose is the rationale for one choice above another; the question, of course, is do we agree on the purpose? When designing for systems, articulating that rationale is an irreplaceable component of the design conversation that takes place across the individuals, disciplines, and languages that comprise a design team.

A retort might be that a given design conversation is about some specific situation or artifact—not about design. But then, a design conversation about design must be the subject of design education, and we arrive at the same point—making the tacit explicit is a requirement for effective design. Not doing so leaves design stuck in its medieval master-apprentice craft tradition, where change is slow, and innovation is difficult.

Implications for Designers

We have argued that 21st-century design requires conversation, as well that (in complete alliance with Glanville) design is conversation. When we say *conversation* we mean it explicitly in the second-order sense of recognizing our (subjective) participation in the process of framing and justifying our choices, and therefore our responsibility for it all.

If designers are to be responsible for the process of design, we must seek the most effective tools and methodologies—and to document, evolve, and disseminate them into the community of design and into the world of wicked problems.

Therefore, designers must themselves be responsible for systems literacy as the foundation for design; for working within a second-order epistemology where they take responsibility for their viewpoints; for processes of collaboration through conversation; and for articulating their rationale as an integral part of their process. This has deep implications for the development of curricula for teaching design.

Implications for Teaching Design

Glanville was influenced by his experience of design methods during his time as a student at the Architectural Association in the 1960s. Perhaps it was in rejection to prescriptive design methods of the first generation that he came to prefer to say that design is "at once mysterious and ambiguous" (Glanville, 2014b, pers. comm.).

We agree that when narrowly interpreted in its first-order form, cybernetics as engineering, may suggest a sort of problem-solving which accepts or even assumes goals rather than inviting conversation about what our goals should be. But in its second-order form—with subjectivity, values, and responsibility explicit—isn't teaching design as cybernetics more common-sense than straight-jacketed engineering, more about possibility than determinism, more emergent than mechanical? Teaching vocabulary and grammar does not deny poetry. Quite the contrary: A knowledge of vocabulary and grammar, if not a prerequisite, seems at least a more fertile ground for the emergence of poetry, and her sister, delight.

Novelty, Design, and Second-order Design

> "For me, one of the most important things is how to find novelty, and that I don't think can be done by specification or purposeful action, it needs wobbly conversation and deep speculation. After it's found, it can be specified. (Glanville, 2014b, pers. comm.)"

While not presuming too much about Glanville's possible elaborations on the relationship of novelty and design, we want to be clear about ours: Novelty is not the primary goal of design. (There is a risk that traditional designers will hear the pursuit of novelty as the pursuit of new form for its own sake.) Like Glanville, we embrace conversations for design, specifically as a way of discovering new goals and new opportunities, as we co-construct our shared frames and persuading arguments. But as yet tacit in our argument is the role of value and values. Design is a particular set of conversations which explicitly and implicitly, whether to oneself alone or with others, embody what we value and what we seek to conserve. Maturana's framing of possible change in the context of what we do not wish to change is directly useful and actionable:

> "Every time a set of elements begins to conserve certain relationships, it opens space for everything to change around the relationships that are conserved. (Maturana et al., 2013, p. 77)."

Of course we must be aware of what we are conserving, to open the possibility of second-order change. Unstated but what we hear implied in Glanville's position, is the notion that the results of design should not be fixed—that is, that designers create possibilities for others to have conversations, to learn, and to act. This idea may be the most important of all. It represents a paradigm shift. Le Corbusier's publication of *Le Modulor* may be a fulcrum point, the visible signal of the new paradigm. (Though moveable type with its inherent reuse sets the stage for what comes after modernism, even as moveable type creates the revolution of modernism itself.) To single out one example, the Schiphol Airport signage system from 1967 by the Dutch firm Total Design and Benno Wissing is one of the first and most famous examples in practice—creating not a complete system, but a system in which others can create. As a platform for creating—in our terms, a platform for conversations for designing—a signage system is quite limited, but still the outlines are there. The relationship of designer to outcome is changed: The signage system is never completely finished, never completely specified, never completely imagined. It is forever open. Second-order design is born.

We see this as the emergent space of design for the 21st century and aim for it as our goal. Whether designing interactive environments as computational extensions of human agency or new social discourses for governing social change, the goal of second-order design is to facilitate the emergence of conditions in which others can design—and thus to increase the number of choices open to all.

Endnotes

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From 2002 through 2007, the authors co-taught the course "Introduction to Cybernetics and Design" at Stanford University in Terry Winograd's Human-Computer Interaction program. Pangaro taught a related course in the School of the Visual Arts Interaction Design MFA program in New York and brings these perspectives to his position as chair of the masters program in interaction design at the College for Creative Studies in Detroit from April 2015. Dubberly uses the materials in lectures and courses taught at Northeastern University, California College of the Arts. For details of the approach, see Dubberly & Pangaro, 2013.

4
The platforms mentioned are grounded in digital technology and therefore incorporate hardware/software infrastructure, but not all platforms are digital (see later example of the Schiphol Airport signage system). Our definition of *platform* includes the capacity for others to build systems within it, no matter the medium. We distinguish three levels of design: 1) design of *things to be used*, 2) design of *tools that can be used to make other things,* and 3) the design of situations in which others can create, that is, the design of platforms.

5
For elaboration of design for variety, which is beyond the scope of this paper, see Geoghegan and Pangaro, 2004.

6
There can be no mistaking that this approach to design has little to do with engineering qua problem-solving. Following Rittel and Buchanan, we situate design squarely in the realm of rhetoric. This does not, however, deprecate the value of rigorous modeling of systems nor the making of tools (for example, software and services). Software and services can be difficult to see—unfolding over time and space, intangible, often hidden or veiled. Absent clear referents (designations of the subject), conversations (and conversants) can become confused. Susan Star (Star & Griesemer, 1989) suggests the importance of *boundary objects* in supporting conversations between disciplines, by providing referents. Architectural plans, elevations, and all the rest of the architect's devices are boundary objects aiding conversations. (They are quite literally designations.) A traditional architecture education introduces these devices, starting with orthographic projection and moving on to isometric projection, perspective, and the rest. These constructions are a sort of language of their own, an argot of the profession. Software and service design is just beginning to develop such devices (its own forms of designation). Systems theory (e.g., systems dynamics, cybernetics, and the rest) offer distinctions and frameworks—a language—which designers can learn and use to create boundary objects, which can facilitate conversations about software and services (and their users, context, and environment) in the same way that plans, elevations, and sections facilitate conversations about buildings.

7
While we accept the distinction between design and problem-solving, we can imagine typical cases of problem-solving that require conversation. For example, a team might discuss how best to break down a problem into more manageable components.

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