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The Cybernetics of Design and the Design of Cybernetics

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The Cybernetics of Design and the Design of Cybernetics

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Cybernetics in the Dialectic Between Science and Design

The mathematician Norbert Wiener (1948) coined the word cybernetics near the end of World War II, during which a variety of new phenomena emerged that seemed to be complex, adaptive, autonomous, and shared a circular form of organization. In retrospect, such forms have a long history. As early as 400 BC, Heron of Alexandria noted a peculiar mechanism that kept the flame of oil lamps stable. A structurally similar mechanism appeared in James Watt's steam engine, which literally fuelled the industrial revolution. Watt's regulator kept the RPMs of the steam engine stable under varying loads. At Wiener's time, servomechanisms in industry, target-seeking missiles in the military, and problems of coordinating the war effort, not to forget the emerging mechanization of computation, demanded new vocabularies to understand them. Although Wiener taught at MIT, a university dedicated to advancing technology, with the enlightenment project still in charge of academia, it was no surprise that Wiener defined cybernetics as a science, the science of control and communication.

A science defines its subject matter with the aim of developing theories and laws that explains it—excluding the inquiring scientist from these explanations. The Macy Conferences, which put cybernetics on the map, began by theorizing circular causal mechanisms—A causing B causing C causing A—which adjust themselves as their components respond to their own actions. Participants in this conference found such circular causalities in nature, in living organisms, and in society and began to challenge numerous orthodoxies of science. However, because it was engineers who were the first to problematize such phenomena, they also were the first to embrace cybernetic theories and principles as a way to extend their ability to design them.

Since design is the focus of this issue of *Kybernetes*, it is important to highlight the differences between what scientists and designers do constitutively.

- Whereas scientists describe what can be observed, hence exists, designers, by contrast create something new, something not yet observable and measurable
- Whereas scientists celebrate generalizations, abstract theories for example, designers propose artifacts that must end up working in all of their details, not in the abstract
- Whereas scientists insist on causal explanations, excluding themselves as causes of the phenomena they explore, designers intend to cause something by their own actions, something that could not result from natural causes, defying causal explanations in effect

- Whereas scientists say they seek knowledge for its own sake, value-free and without regard to their utility, designers value knowledge that improves the world, at least in the dimension they attend to

These contrasts are telling. Regrettably, the extraordinary celebration of enlightenment science and its scientists has rendered professions that make things happen—artists, designers, engineers, managers, and agriculturalists—into practitioners of a craft, mere consumers of "pure" science, physics, for example. Herbert Simon (1969) sought to overcome the disparity of pure versus applied science by proposing a science of the artificial. Unfortunately, his proposal did not go far enough and did not manage to change this inequality. He defines design as an effort to improve a system—technological or social—but limited his concerns to rational, not human-centered choices among alternatives. I would cast the net for design more broadly and equate design, at least to start, with any effort to shape if not invent the affordances for new practices of living, forms of organization, and even languages to arise. Abstractions, by definition, are removed from everyday practices of living and can therefore easily mislead people into undesirable ventures and cognitive traps (Stolzenberg, 1984).

The cybernetician W. Ross Ashby (1956) adopted a less philosophically committed definition of cybernetics. While acknowledging the circularities that are inherent in numerous phenomena—from the realization of purpose to the emergence of self—he defined cybernetics as the study of all possible systems, which is informed by what cannot be built or evolve in nature. He thus put designers and observers on an equal footing and right into the domain that cybernetics is to explore. His definition also applied the very theory of information it advanced—reducing uncertainties by experiencing constraints on possibilities—to itself, here to systems that are imaginable but reveal themselves as unrealizable.

Much of Ashby's work can be characterized as exploring the epistemological difference between synthesis and observation, between what can be designed and what can be learned from using a design without knowing its internal structure, intentions or origin. He took the notion of a "black box" that hides its makeup from its observer or experimenter as a metaphor for exploring brains, self-organizing systems, and large social phenomena such as the stock market. For example, he gave his students the task of figuring out the behavior of a non-trivial machine he had devised. As a machine, it was determinate, but its internal structure made it not obviously predictable from the relationship between its inputs, which the experimenter could set, and its outputs, which that experimenter could observe. The concept of a black box gave brain research a practical methodology as the interior of a working brain is hardly accessible and what one knows about cognition must be deduced from what the brain does. It also became a paradigm for social research, hoping that the complexities of social phenomena can be ignored in favor of overarching regularities. Ashby certainly cared for his use of language and always acknowledged the role of designers and experimenters (observers) of the systems he explored, but he never looked into the role of language and communication in conceptualizing the systems he studied.

The latter was introduced by the anthropologist Margaret Mead (1968), also a participant in the Macy Conferences, who suggested that cyberneticians apply cybernetic principles to themselves, a suggestion that Heinz von Foerster (1974) coined "second-order cybernetics" and defined as the practice of including the observer in the observed. I prefer second-order cybernetics not to be limited to observers, spectators or theorists. As already mentioned, Ashby derived many cybernetic insights by exploring to the extent possible the dialectic between what designers of mechanisms know and what scientific experimenters with such mechanisms can find out without that knowledge. Second-order cyberneticians need to embrace this dialectic. Mead went much further, calling on cyberneticians to systematically explore how societies organize themselves around cybernetic ideas and to be reflective of what the language of cybernetics brings forth and does, including to their own role—in effect treating cyberneticians more as designers than as scientists.

Second-order cybernetics—in von Foerster's terms "the cybernetics of cybernetics or the control of control and the communication of communication," and in my terms, *the cybernetics of participating in systems under continuous reconstruction by their constituents*—is my entry point to a conception of design whose practitioners participate in creating the affordances of desirable practices of living with artifacts of technology, communication, and organizations. I call my approach to design *human-centered* in contrast to technology-centered design. The latter proceeds from functional requirements to objective tests of whether these requirements are met, which excludes the conceptions that the stakeholders in a design bring into it (Krippendorff, 2006a).

Second-order Cybernetics and Human-centeredness

From the perspective of second-order cybernetics:

Worlds arise in sensory-motor coordinations.

It suggests that the worlds as we know them cannot exist without human involvement. They are brought forth when re-cognizing stabilities in the circularity of acting and sensing the consequences of one's actions in return. Stabilities of this kind enable us to draw distinctions among them and to rely on them selectively. This is the conclusion of von Foerster's (1981) recursive theory of eigen-behaviors.

Consistent with the above, the first axiom of human-centeredness states:

In human use, artifacts are manifest in the form of interfaces.

It mentions artifacts, not objects, as they arise in the experiences of sensory-motor coordinations, not separate from them. They are constructed by those involved and account for their experiences under conditions of recursively stable and hence reliable interactions. Thus, what we ordinarily call objects are artifacts indeed, made up, enacted, and afforded. Incidentally, the word "fact" derives from the Latin "factum," something made. Hence, artifacts are crafted skillfully. Artifacts may come about materially by design, conceptually by re-cognition, and interactively in the form of interfaces, which can be distinguished along the lines of less reliable interactivity.

When an interface works as expected, one can say with James Gibson (1979) that the artifact in question *affords* the construction that a user has of it; and when it does not work as expected, one can say that the artifact objects to being treated the way it is, without revealing why this is so. I like to interpret the noun "object" as referring to something that will object to certain kinds of uses. Incidentally, this interpretation applies also to the German word for object, "Gegenstand," literally standing up against, resisting. Gibson's conception of affordance is important in that it admits no privileged knowledge of the objects of an external world other than how one conceives of them and interacts with them. There is no implied truth, only affordances or their absence.

Today, interfaces are most familiar to computer users. They are designed as the medium between users' abilities and the work that a computer does, solely to exhibit the relevant consequences of one's actions. The user interface with an artifact is all that matters to its user. The remainder is a black box of unimportant and often unknown makeup or structure. Indeed, as ordinary users of computers, we tend to have no clue as to what is going on inside them when opening a file, editing a document or discarding it, yet experience no problems with conceiving what we do in these ordinary and non-technical terms. Human-centered design does not limit itself to human-computer interfaces, however. The steps one walks up on is an interface; the chair one sits on amounts to an interface; holding a cell phone to one's ear, listening to the sounds it reproduces and speaking into it constitutes its interface; and the steering wheel of a car and its controls has to be seen as an interface as well. Save for the simplest kinds—handling a spoon, writing with a pencil, and using a pair of scissors—most interfaces shield the user from the incomprehensible complexities or ignorable materialities that support them.

Different people may interface rather differently with the same artifact. What is a screwdriver for one person, maybe an ice pick, a lever to pry a can of paint open, and a way to bolt a door for another. Not only do different computer users do different things with their machines, they may also use entirely different tools to accomplish the same task. Given the complexity of contemporary artifacts, it is unlikely, indeed, that someone could explore all its possibilities, let alone facing the occasion of applying them. Moreover, using an artifact is a different activity than designing it, assembling it, installing it, and repairing it. It is tempting to think that computer engineers, having designed the computer, are the only ones who really know that machine 'inside out.' When it comes to understand where a particular file is kept, however, nobody really knows, and when it comes to using a computer, expert users may invent ways that designers had not dreamt of. The point is, whatever different people do with an artifact, neither can claim to have privileged access to what the artifact "really" is. There are only interfaces. Human-centered designers must realize that they interface with their artifacts in anticipation that the result of their interactions affords others to meaningfully interface with their design—without being able to tell them how.

An interface consists of sequences of ideally meaningful interactions—actions followed by reactions followed by responses to these reactions and so on—leading to a desirable state. This circularity evidently is the same circularity that cybernetics theorizes, including what it converges to, what it brings forth. In human terms, the key to such interactions, such circularities, is their meaningfulness, the understanding of what one does in it, and towards which ends. Probably most important to human-centeredness is the axiom:

> *Humans do not respond to the physical qualities of things*
> *but act on what they mean to them* (Krippendorff, 2006a).

This axiom acknowledges the second-order cybernetic insight that humans experience reality only through detailed conceptions, models, and narratives they create within their discourse community. Physics, it must be pointed out, is but one discourse within which the community of physicists constructs its own objects (causal theories of a uni-versal nature, without human beings). Biology is another discourse (realizing theories of living organisms, explaining how their parts serve to preserve the identity of the whole). What describes the world as human-centered is a discourse as well. It addresses how artifacts are con-sensually (sensed in each other's presence) experienced and describes these experiences in relational terms, as interaction sequences, in which humans and machines participate but in different ways. Physics leaves no place for humans in their constructions. Hence, the physical properties that physicists theorize have nothing to do with how humans experience them, make sense of them or use them in their constructions of everyday reality. This is the reason for asserting the primacy of meanings in human-centered conceptions.

It is important to emphasize that meanings are not entirely subjective. They reside in the expectation of afforded interactions much like Gibson suggested. Equally important is that artifacts for one discourse community may have entirely different, even incommensurable meanings for members of another discourse community. Indeed, it is a well known phenomenon that when artists, architects, or industrial designers make the extra effort to go into the field and inquire about how their artworks, designs or buildings are perceived by others—by connoisseurs, users, critics, even fellow designers—they often are surprised to learn how different their designs are seen from what they thought to be obvious and clear to everyone. Unlike what semiotics conceptualizes, from a cybernetic perspective, artifacts do not "carry" meanings from designers to their users. They do not "contain" messages or "represent" meanings. Meaning cannot be inscribed in material entities nor do such entities have agency as proposed in actor network theory (Latour, 2005). There are only alternative ways of seeing (Wittgenstein, 1953:154). Taking one way of seeing in one context or by one community as leading to another way of seeing at a changed context or by a different community, is the basic idea of meaning in the course of interfacing with the world (Krippendorff, 2006b).

For example, the meaning of a button is what pressing it sets in motion: ringing an alarm, saving a file or starting a car. The meaning of a soccer ball is the role it plays in a game of soccer and especially what its players can do with it. The meaning of an architectural space is what it encourages its inhabitants to do in it, including how comfortable they feel. The meaning of a chair is the perceived ability to sit on it for a while, stand on it to reach something high up, keep books on it handy, for children to play house by covering it with a blanket, and staple several of them for storage. For its manufacturer, a chair is a product; for its distributor, a problem of getting it to a retailer; for a merchant it means profit; for its user, it may also be a conversation piece, an investment, a way to complete a furniture arrangement, an identity marker, and more. Typically, artifacts afford many meanings for different people, in different situations, at different times, and in the context of other artifacts. Although someone may consider one meaning more important than another, even by settling on a definition—like a chair in terms of affording sitting on it—it would be odd if an artifact could not afford its associated uses. One can define the meaning of any artifact as the set of anticipated uses as recognized by a particular individual or community of users. One can list these uses and empirically study whether this set is afforded by particular artifacts and how well.

Human-Centered Design

Taking the premise of second-order cybernetics seriously and applying the axioms of human-centeredness to designers and users alike calls on designers to conceive of their job not as designing particular products, but to design affordances for users to engage in the interfaces that are meaningful to *them*, the very interfaces that constitute these users' conceptions of an artifact, for example, of a chair, a building or a place of work. Taking moreover seriously the above-mentioned experiences that different people may bring a diversity of meanings to a design, meanings that are especially different from how designers conceptualize their designs, calls on designers to apply considerable cultural sensitivity to different users' epistemologies. Designers who intend to design something that has the potential of being meaningful to others need to understand how others conceptualize their world—at least in the dimensions that are relevant to their design. Understanding users' understanding is an understanding of understanding and qualitatively different from the kind of understanding that is required to handle the material artifacts of one's world. I call the understanding of understanding "second-order understanding" (Krippendorff, 1996, 2006a) and suggest it to be fundamental to human-centered design:

To design artifacts for use by others requires second-order understanding

The difference between first-order understanding and second-order understanding is the difference between understanding something that is conceived of as incapable of understanding, for example, nature from the perspective of physics or functional artifacts from the perspective of engineering, and understanding human interfaces with technological artifacts, which unfold according to how users understand what they are facing *and* what they afford them to do.

Technology-centered designers, it must be noted, typically object to the need for this distinction, insisting that they too take into account that their design needs to be understood in order to be used. However, such designers tend to measure others' understanding relative to their own expertise, for instance, regarding lay understanding as inherently simplistic if not flawed. Witness frequent claims that "they do not understand" my design, my building, my artwork, my intentions or how it is meant to be used. Privileging one's expert knowledge is also evident in the insistence on intended uses, and when this turns out to be difficult, in efforts to train users in what *is* correct and efficient. Technology-centered design, it should be noted, originating during the industrial era. This era was dominated by engineering, which provided the paradigm for functional architecture, social engineering, and, of course, industrial design. The industrial design profession served as industry's arm into the then emergent consumer culture. Although some industrial designers saw themselves as advocates of users, industry had the power to determine what was produced and where and how their products were to be employed. Technology-centered design is still appropriate in engineering whose artifacts need to function according to technical specifications that do not need to consider diverse users' conceptions. It is practiced in the military where soldiers can be trained to handle their equipment properly and in bureaucracies where workers serve clearly delineated functions. Technology-centeredness also underlies the science of ergonomics, studying human operators in terms of objective performance measures. However, intended uses are hardly enforceable in an information/market driven society whose members care less of others' intentions, have far more choices, and exercise them intelligently with information that is readily available in their environment. Understanding users rather than insisting on one's authority and objectivity is a radically new social situation, which requires a radically different kind of approach to design.

In contrast to taking one's own expertise as a measure of the abilities of others, human-centered designer must regard others' understanding with respect, regardless how sophisticated it may be. They listen to the stories users tell them about how they conceive their world and themselves in it and what they prefer to do, are willing to learn, have reasons to acquire, make them feel comfortable or excited, etc. Such efforts to understand others' understanding also includes an understanding of the motivations that bring users to a particular artifact, to which ends it may be employed, what they are willing to explore on their own, and how serious disruptions of their interfaces are taken. For designers to respect the conceptual abilities of others means, ideally, not judging whether they are right or wrong but finding ways to afford whatever abilities potential users bring to a situation. Developing artifacts that accommodate users' conceptions is *the* challenge for human-centered designers.

At the same time, human-centered designers do not need to be at the mercy of prevailing and often conventional practices. They can make newness attractive to potential users, encourage learning, and compel seeing things differently. But they have also choices to afford or not to afford particular user conceptions. For example, designers may not want to enable children to open the medicine bottles of their parents, prevent the use of handguns by unauthorized persons, and make it difficult to delete computer files accidentally. Therefore, human-centered designers do not need to merely serve the conceptions of others; they can and should take the opportunity to lead where possible. But this too requires second-order understanding, having a sense of what conceptions their design may be facing, conceptions that, when enacted, could lead their beholders to succeed or into fatal accidents.

Human-centered design is greatly facilitated by various forms of cooperation between designers and the users of their design—from focus groups to hiring them as consultant to a development. Listening to what users have to say generates second-order understanding and supporting how they think and live is second-order understanding in action. While it requires extra efforts to be fair to the conceptions that a community of users brings to a design, the fluidity of modern markets, the democratization of everyday life, and the variability of the information society makes second-order understanding a necessity for contemporary designers.

In view of the above, two prominent concepts need to be questioned. Both are leftovers from the design discourse of the industrial era. The first is the concept of THE user. THE user is a convenient prop for designers who are unwilling to face the challenge of the multiplicity of existing user conceptions that a design needs to afford. As a designer's construction, THE user does not speak, has no conceptions other than granted by its creator, and cannot make creative contributions to a design. THE user does not exist in a reality of many, who have their own and often unexpected approaches to reality, know about what they are doing, can process information, make intelligent choices, have the ability to form user groups, advocate the positions they hold, and may act in support or against a design. Human-centered designers need to acknowledge this diversity, but must moreover recognize that the design they are proposing needs to be realized by many: by clients who need to employ their workers; financiers who want their investment to bear fruits; builders who need to see some benefit in producing a design; advertisers who need to find good arguments for promoting its use; sales people who need to make a profit from it; critics who need to be impressed; repair persons who need to know what to do when it fails; recyclers who need to be able to separate reusable components from trash; and ecologists who see the need to protect the ecosystem from its side effects and waste.

All of these professionals are essential for a design to succeed and constitute its *stakeholders*. Stakeholders have an interest in a design or a particular technology, resources to promote it or prevent it from happening, and act accordingly. They can influence each other, form alliances or oppose each other. They are also creative in what they are doing. Users are stakeholders of one kind, and so are designers. I am suggesting that the concept of THE singular user be retired in favor of a multiplicity of stakeholders. We can thus say that

Human-centered design takes place within networks of stakeholders,

which is to say that design essentially is a social process, one in which many interconnected agents play different roles in bringing a design to fruition. While designers like to conceive of themselves as playing the key role in what happens to their design, in fact, they never are the only ones who drive the process of its realization. In some cases, designers merely modify a design that then passes through a well-institutionalized network of stakeholders. In other cases, a design could become the core of a reorganization of all those interested or opposed to its realization. Marketing research is likely to derive the criteria of a design from buyers, not necessarily users. Users differ in the role that an artifact plays in their lives. Regarding some designs, users spent far more time with an artifact than their designers and producers, for example a building. Once a house is built, it may stay there for a long time. Regarding other designs, users spend comparatively little time with them, for example a prescription drug. A pill takes a second to swallow, maybe a day to have effects, but years to develop. Stakeholder networks are varied, self-organizing, not easily generalizable, and difficult to track down. Because artifacts cannot come to fruition without supportive stakeholders who approve of a design and make their know-how and resources available, designers cannot afford to ignore such networks—or be at the mercy of them.

A second concept that stands in the way of conceptualizing human-centered design is the idea that designers design products, architects build buildings, and engineers create mechanisms. This conception may have been closer to the truth during the industrial era than it is now. When industry reigned supreme, designs, once approved or authorized, left little choices to those who had to turn them into products. The process occurred within a hierarchically organized manufacturer. The connection between a worked out design and the product it specified was therefore far more direct than it is now. However, even in the industrial era, designers never literally created products. They made drawings, built models, and wrote specifications for products to be realized by others. This is true today as well, except that the connection between a design and its realization has shifted from obedient employees to complex networks of stakeholders.

What designers pass on to other stakeholders in a design are proposals. Proposals occur in language. Whether these proposals utilize drawings, models, video presentations, and more or less detailed suggestions, the products of designers are essentially communicative and their sole purpose is transmission to those who matter. If designers work within a network of stakeholders, which can make or break a design, their proposals need to enroll them into the project of a design. Without the authority that stems from being allied with a powerful institution, the only way that designers' proposals can succeed in a market driven, democratic, information based society is by being compelling communications. Successful proposals

- Survive in networks of conversations among stakeholders
- Reveal a passionate commitment to a future that would not come about naturally
- Build on what is variable, changeable
- Identify if not create relevant resources for the realization of a design
- Enroll other stakeholders into the project of a design, providing empirically grounded arguments that open possibilities to realize what interests them
- Enable these possibilities to be communicable to successive stakeholders, energizing cooperation within the emerging network of stakeholders
- Acknowledge the risks and assume responsibilities for failures.

The emphasis on possibilities chimes with von Foerster's (1981:308) ethical imperative: “Act always so as to increase the number of choices,” here, however, considered less an issue of ethics but the motivating condition for human communication (Krippendorff, 1989), for conversations that coordinate the activities of different stakeholders in a design, ultimately converging on its realization. Indeed,

Human-centered designers create possibilities for others.

Thus, human-centered designers participate in processes of realizing (making real) affordances for others, that are under continuous reconstruction by its constituent stakeholders.

The Design of Cybernetics

To me, the shift from first-order to second-order cybernetics is not merely a matter of putting the observer in the observed. The latter is familiar since Heisenberg’s uncertainty principle, known as observer effects in social science methodologies—although stated there as a limit to detached observation. It is at home in quantum physics, ethnography, ethnomethodology, hermeneutics, and various therapies. Actively participating in system under continuous reconstruction by its constituents brings second-order cybernetics closer to design—except that design tends to focuses on something other than itself, the affordances of others’ practices of living. Second-order cybernetics, by contrast, concerns also the discourse that defines cybernetics and cyberneticians by what they do. Nevertheless, if second-order cybernetics has something to offer to design, the ideas of design have something to offer to second-order cybernetics.

To me, first on the list and the only aspect I wish to discuss here is the recognition that language does not merely describe the world. Its use changes the world in the direction of its description (Rorty, 1970, 1989; Wittgenstein, 1953). It follows that theories, which are stated in language, can change their validity in the process of their communication and right in front of the theorist’s eyes, especially social theories that may reach those theorized therein. Self-fulfilling prophesies are well known, but considered unscientific and to be avoided by traditional scientists. Instead of facing the challenges they pose to the paradigm of scientific inquiry, traditional scientists prefer to theorize subject matters that have less of a chance of being affected by theories about them, so-called natural phenomena, for example. In effect, as already suggested above, scientists, treating language as merely representational, have no place for design as a way of understanding the world in the process of being made and remade. Scientists prefer ontology to ontogenesis.

The idea of including observer effects in theories about a subject matter that is profoundly influenced by acts of observation—in quantum physics as well as in the social scientific uses of interviews and other so-called obtrusive measures, for example—goes only half way. It preserves the enlightenment idea of language as a system of representations and of understanding by observation. From the perspective of human-centered design, what cybernetics needs to embrace is the circular process of designing affordances and observing the practices of living they enable.

Taking my own suggestion to heart, I am suggesting that theorizing, describing, explaining or simulating something should not merely acknowledge their effects but be undertaken in view of creating effects that are desirable to their stakeholders, that is, they should be viewed as acts of designing, of introducing changes in the world, not as acts of exploring what allegedly exists. It means assuming responsibilities for what one's theories and their communication can bring forth. From this perspective, enlightenment science appears as an irresponsible illusion, the illusion that that language is neutral and knowledge stated in its terms, hence ineffective, would somehow enlighten the otherwise dark world.

I feel the need to add that design is a basic human activity and far more common than the search for abstract propositions. When someone arranges her furniture at home, she designs the arrangement. When someone makes a promise to someone else, a relationship is created. When someone customizes his computer, he designs a world he can work in. Selecting clothes to wear is to identify oneself in the world of others. Design is indispensably human, if not a basic human right. I would venture to say that, in everyday life, scientific propositions are not taken for their truths but for what they enable, what one can do with them. Preventing people from designing their world, whether by requiring them to wear a uniform, putting them on an assembly line, or forcing them to merely look at the world, the prisoners in Plato's Cave or television addicts, robs them of what is essentially human.

Second-order cybernetics, defined as *the cybernetics of participating in systems under continuous reconstruction by its constituents*, is necessarily cognizant of what its discourse shapes—by design or evolution—and sees its contributions to be essentially participatory and inevitably social. It elevates design to be a narrative that is more embracing as that of science, a way of realizing oneself in coordination with others. It favors democratic practices (circularities) where God's eye views (top-down hierarchies) dominated. It creates alternatives (variety and information) that can motivate others to participate in the practices of cybernetics. It applies cybernetic principles (parts of the discourse of cybernetics) to how cyberneticians engage each other in conversations. And finally, by rendering constructions of worlds relative to one's own engagement with others, it causes individual or cultural differences to be cherished rather than ignored.

It seems to me that the cybernetics of design and the design of cybernetics are worthwhile projects to be enrolled in as one of its stakeholders.

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Title
The Cybernetics of Design, and the Design of Cybernetics

Structured Abstract
- The **purpose** of the paper is to connect two discourses, the discourse of cybernetics and of design
- The **design/methodology/approach** taken is a comparative analysis of relevant definitions, concepts, and entailments in both discourse, and an integration of these into a cybernetically informed concept of human-centered design, on the one hand, and a design informed concept of second-order cybernetics, on the other hand. In the course of this conceptual exploration, the distinction between science and design is explored with cybernetics located in the dialectic between the two. Technology-centered design is distinguished from human-centered design, and several axioms of the latter are stated and discussed
- The **findings** of this paper consist of recommendations to think and do things differently. In particular, a generalization of interface is suggested in replacement of the notion of products; a concept of meaning is developed to substitute for the meaninglessness of physical properties; a theory of stakeholder networks is discussed to replace the deceptive notion of THE user; and above all, it is suggested that designers, in order to design something that affords being used by others, engage in second-order understanding
- **What is new about the paper?** The paper makes several radical suggestions that face likely rejection by traditionalists but acceptance by cyberneticians and designers attempting to make a contribution to contemporary information society

Outline
- Cybernetics in the dialectic between science and design
- Second-order cybernetics and human-centeredness
- Human-centered design
- The design of cybernetics

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Conceptual, critical, and constructive

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Short Biography of the Author
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