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Klaus Krippendorff
University of Pennsylvania, kkrippendorff@asc.upenn.edu

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Abstract
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A Trajectory of Artificiality and New Principles of Design for the Information Age

Klaus Krippendorff
The Annenberg School for Communication
University of Pennsylvania

ABSTRACT
From a likely trajectory of design problems, the paper identifies several design principles that can be expected to inform design in the next century. Underlying them is a shift in emphasis from technological to human considerations or from hardware to information. Along this trajectory design must increasingly afford a diversity of meanings (as opposed to realizing fixed functions), respond to many stake holders (as opposed to catering to serviceable end users), address interactivity and virtuality (as opposed to materiality), support heterarchies, dialogues, or conversations (as opposed to standardizing social practices), rely on a second-order science for design (as opposed to a first-order theorizing, by engineers or ergonomists for example), generate knowledge that opens possibilities for design (as opposed to re-searching a past for previously existing constraints), develop graduate design education programs that continually rearticulate design discourses (as opposed to reproducing design traditions).

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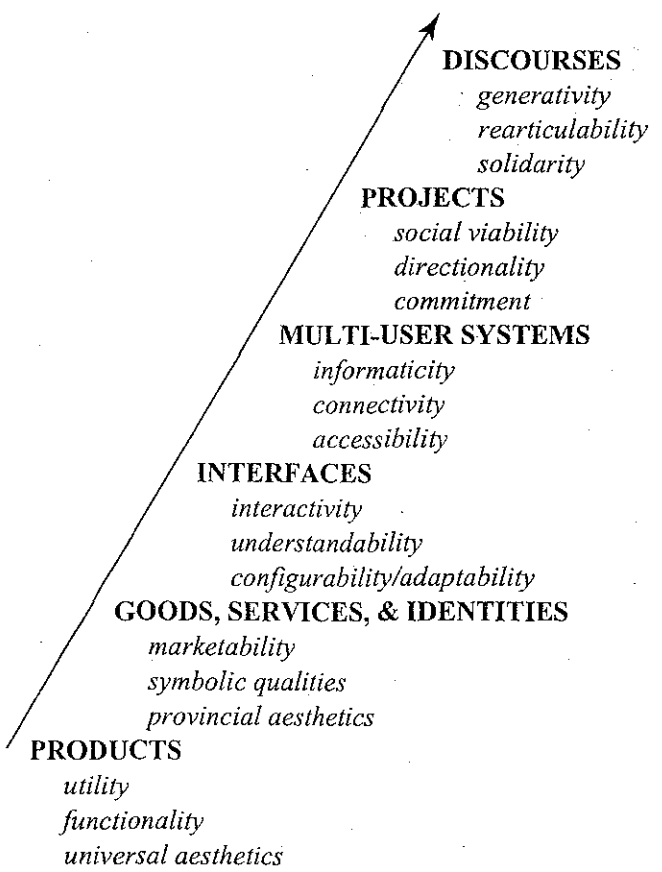
INTRODUCTION
Not even thirty years ago, design meant industrial design: creating functional mass-products that would contribute aesthetically to material culture. Designers of that time elaborated its prototypes: fabrics, furniture, home and industrial appliances, as well as (industrialized) architecture and (reproducible) art. Dominating that time was the 19th century design principle:

Form Follows Function.

This concern for production and functionality still exists in various niches but has been surpassed by very different concerns in a world that is infinitely more complex, more immaterial, and more social in focus, a world in which diverse dis courses reign side by side, and a world afforded by mediating technologies of unprecedented carrying capacities. This world of computation, of information, of electronic networks has seen a tremendous intellectual growth in which Herbert Simonplayed an important role. I will relate the following to changes since Simon's pioneering work on *The Sciences of the Artificial* (1969). Several of his theses have not borne the fruits they deserve. Others have been overcome by unforeseen developments that now pose exciting challenges. Newprinciples of design, a new science for design, and a new kind of activism seems to be emerging. I want to correlate these with a trajectory of artificiality that design should be realizing as it moves on.

A TRAJECTORY OF ARTIFICIALITY
For me, this trajectory begins with the design of products and passes through five major classes of design problems. Each rearticulates the preceding, thus generating a history in progress:



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Products, largely industrial, are designed in view of their *utility, functionality*, and an *aesthetics* that, for reasons of applying to large markets, claims *universality*. In pursuit of these, the responsibility of designers coincides with that of industry which terminates with the end-products of industrial production. Products are conceived for an ideally rational end-user and in disrespect of cultural diversities.

Goods, Services, and (brand, corporate, ...) **Identities** are market and sales driven. Utility and functionality is secondary to recognition, attraction, and consumption. Goods, services and identities are products only in a metaphorical sense for they reside largely in the attitudes, preferences, memories, loyalties, etc. of large populations of people. In developing them, designers are additionally concerned with *marketability*, with *symbolic qualities* that are widely shared within targeted consumer groups, and their work ultimately drives the generalization of commercial/industrial/corporate culture with its diverse or *provincial aesthetics*.

Interfaces. Computers, simulators, and control devices are products in the above sense (and where designers concern themselves with their appearances, they also treat them as such). But more important is to see these non-trivial machines as extensions of the human mind, as amplifying human intelligence. Miniaturization, digitalization, and electronics have made the structure of these intelligent machines nearly incomprehensible to ordinary users , and thus shifted designers attention from internal architecture to the interactive languages through which they could be understood and used. Human-machine *interactivity, understandability* (user-friendliness and self-instruction), (re)*configurability* (programmability by users), and *adaptability* (to users' habits) became new criteria for design. The crown of such one-user-at-a-time interfaces is (the idea of) virtual reality.

Multi-user systems (nets) facilitate the coordination of human practices across space and time, whether these are information systems (e.g. scientific libraries, electronic banks, air plane ticketing), communication networks (e.g. the telephone, internet, WWW, MUDs), or the archaic one-way mass media. Designers of multi-user systems are concerned with their *informaticity, connectivity*, and the social/mutual *accessibility* they can provide to users.

Projects can arise around particular technologies, drive them forward, but above all are embodied in human communicative practices. Efforts to put humans on the moon, to develop a program of graduate education in design for the information age, etc. involve the co-ordination of many people. Projects are always narrated and have a "point" that attracts collaborators and motivates them to move it forward. Projects can never be designed single-mindedly. Designers may launch projects, become concerned with their *social viability*, with their *directionality*, and how *committed* its contributors are in pursuit of them, but no single person can control their fate.

Discourses live in communities of people who collaborate in the production of their community and everything that matters to it. By always already being members of communities, designers can not escape being discursively involved with each other and participate in the growth (or demise) of their communities. The design of discourses focuses on their *generativity* (their capacity to bring forth novel practices), their *rearticulability* (their facility to provide understanding), and on the *solidarity* they create within a community. This workshop is a perfect example of creating an albeit short lived community that accomplishes things discursively.

DESIGN PRINCIPLES

Along this trajectory of design problems, each progressively creates new challenges that need to be met by new social or technical inventions. Each also brings new criteria into the design discourse and calls for new design principles that enable designers to move on. Let me elaborate nine of them as guidelines for future elaboration and immediate research funding decisions:

1. Meaning is the only reality that matters

One of the fundamental insights of product semantics for design is that people never respond to what things are but to what they mean to them. This has lead to the irrefutable axiom of design:

> *Artifacts never survive within a culture without being meaningful to their users.*

I am suggesting that no contemporary design decisions can violate this axiom. Designers who do invariably fail - or design just for themselves and only accidentally for others with compatible understanding. I should say that Simon had no appreciation of the significance of meanings. What mattered to him was an accurately conceived ontogeny, an engineering rationality that everyone had to (or should be trained to) comprehend and enact. Nobody could anticipate the social consequence of computational technology and the complexity of the information we are now facing. His positivism lead to what we now recognize as an authoritarian epistemology which is no longer suitable in information-rich environments. In fact, as soon as we move beyond the engineering of functional products, we need to be concerned with what they can possibly mean to users and with the multiple rationalities that people can bring to bear on them. Consequently: *Form does not follow function but meaning* and *design has to make sense to others*.

Acknowledging meanings as a primary target of design considerations is saying that the diversity of individual (user) conceptions matter as much as if not more than the (techno)logic of the designers and engineers.

2. Design must delegate itself

When developing simple functional products, designers can still be experts in specifying how they have to look and are to

function, much as engineers do. This mono-logical expertise eroded when industrial products came to be considered as marketable goods or services whose values depend on the preferences of potential buyers. The design of goods, services, and various kinds of identities, granted users a voice, however minimal, in what entered the market. But the marketing of combinatorial systems of products enabled users to become local designers in their own right, at home for example. Designing reconfigurable (programmable) computers made it even clearer: In the information age, designers can no longer claim a monopoly on design. Design must be delegated and dispersed with the artifacts it creates. Arranging furniture, composing home pages for the WWW, and programming computers are design activities indeed. The point of design lies in enabling others to do it as well, albeit within the confines of their own resources. Desk top publishing made graphic designers the first victims of this principle. This technology enabled ordinary secretaries to do what graphic artists had done before. Unlike Md.'s who manage to guard their profession by licensing, design can not protect itself that way. Design is a fundamentally human activity. Professional designers can only be ahead of others along a trajectory of artificiality they pursue. In other words, design is not a privilege but a gift to other fellow human beings. It is *the willingness to boldly walk where others have not dared to tread.*

3. Artifacts (are) create(d in) networks of stake holders

The idea of an "end-user" is a myth that originated in our pre-industrial past. Industry appropriated it as a way of limiting its responsibility for its products. Designers who see themselves as user-advocates often react against the single-minded interests of the providers of goods, services, and identities. None of these address what happens after products are brought into circulation. Even the most traditional artifacts not only live different lives - as ideas, prototypes, merchandise, tools, symbols, museum objects, recyclable matter, or public problems - they also typically become a concern of very different kinds of people - investors, engineers, owners, users, bystanders, interests groups, consumer advocates, ecologists, etc., each claiming a different stake in them. Virtually every technology attracts stake holders in its support as well as in its opposition.

At least since the widespread use of computers, stake holders have become far more aware of each other than in previous periods. They organize themselves through various media and are able to coordinate their interests and resistances to what designers propose. While the designers of interfaces therefore can not ignore the stake holders and user cultures that emerge around any idea or technology, the designers of projects are of necessity parts of them. It is only in such networks that designers' ideas can come to fruition.

In additions to the "politics" enacted in networks of stake holders, the design of information age artifacts also tend to draw on vastly different knowledge domains, requiring a kind of interdisciplinary cooperation that was previously unheard of. This suggests the need of a large scale democratization of design decisions and the distribution of responsibilities to all those willing to contribute their conceptual or material resources to the process. In architecture the beginning of this attitude has led to what is called participatory design. The emerging collaborative technologies - from conference systems to concurrent engineering to rapid and distributed modeling - now offer radically new ways of bringing different stake holders into communication with each other, especially including users, even interested bystanders, critical opponents, or eager beneficiaries. Add to this the vast amount of text electronically available, the result of this networking is a totally different environment for designers to practice.

4. Interactivity replaces materiality

Technology resides less in its materiality than in its social uses, in how users make things happen, create artifacts and handle them in the presence of each other. After all, a word ending with -logy denotes knowledge, logic. Simon shifted our attention from the ontology of the natural to the logic of artificial, but failed to see that his very "project" dissolved material products into our dynamic relationships with them. Meanings too are made. They are not a property of surfaces (as presumed by styling) nor inscribed in static symbolisms (as marketers and designers of goods and services like to treat them). Nor are they derivable from ergonomics or the kind of cognitive science that goes for formal logical accounts of operations and stimuli. They are invented and brought to bear by people needing to cope with particular artifacts or achieve something with them.

As the hardware of computers exceeds user comprehension, interfaces came to mediate between human cognition and computational processes. We experience the design of human interfaces as the key to the human use of complex artifacts and, in retrospect, this has always been true, even for simple tools. Product semantics concerns itself with such meaningful interactions, with how users make sense of and act on what they face, using compelling metaphors as aid to understanding, and building user instructions into software. Beyond interfaces, the interactivity that makes projects succeed is largely coordinated by compelling narratives, by involving dialogues, which carry the notion of an interface to a higher level, albeit mediating among even more complex human collaborators. Making information systems usable is like making narratives compelling, and means designing - not products - but the affordances of human interactions. Interfaces are interactive gestalts without materiality.

A minor but not unimportant addition: At the dawn of the information age, the small channel capacities then available favored mono-modal artifacts. For example, the telephone reduced multi-channel human communication to voice. But the kind of channel capacities now available allows designers to go back and provide for multi-modal interactive experiences. Virtual reality is trying to recapture these lost territories, albeit clumsily, coordinating interactivity for several

sensory modalities at once, thus approximating the kind of human involvement heretofore known only by being in touch with "real phenomena."

5. Technology thrives in heterarchy, not hierarchy

Simon wrote at the beginning of the computer age. One of the phenomena he explored was the architecture of artificial systems that would succeed in various design environments. To make his point, he considered two watch makers whose assembly collapses into its parts each time they are interrupted in their effort by a telephone order for more watches. Naturally, the one who designs holistically, with all parts organically interconnected, can not compete with the one who assembles sub-assemblies, components of components, etc. until the whole is complete. The latter strategy was also used in the design of ENIAC, the first computer, built at the University of Pennsylvania, which faced a related problem: component failure. Thus, Simon came to celebrate hierarchy and the kind of mono-logical rationality that is typically pursued in the design of highly functional products. This mono/technologic creates the need for integrating diversity into common frameworks, for imposing standards and conventions by a central authority, a government, a leading industry, or a designer.

At least since interfaces became a design concern, the value of hierarchy, of formal (mono-logical) languages and of universal standards has come to be questioned. Simon could not anticipate our current trajectory of artificiality. He could not experience that hierarchical systems of some complexity hardly survive in democratic, market oriented and user-driven cultures. By their very nature, information networks must afford considerable conceptual diversity, enable groups to realize themselves in them, and allow individuals to use information in their own terms. The success of the good old telephone network and now the internet lies precisely in the fact of no restrictions on what can be said. The success of information nets depends on their accessibility to multitudes of users, their substantial openness to different uses, and their lack of proprietary standards. In information rich environments, the projects designers begin to tackle - share wares, educational programs, or corporate design policies - are no longer centrally controllable, governable by a single objective, that is, hierarchically organizable. Design needs to operate with heterarchical conceptions, embrace a great diversity of meanings, and negotiate its possible outcomes with others. Projects need to provide spaces for a multiplicity of rather different if not conflicting stake holders to enter, feel comfortable, and leave their contributions behind. Although traditional designers might decry the loss of control that hierarchies provided, chaos, heterarchy, diversity, and dialogue are the new virtues of the information age.

6. As intervention, design is not informed by re-search

Design intervenes in the present and creates new futures. Scientific research, by contrast, favors history and thrives on constraints. The hyphen in "re-search" is intended to remind us of its etymology: a re-examination of records already there, an extrapolation of past constraints into a future, searching again and again. re-search assumes that the logic of the past will govern the future as well. However, along any trajectory of artificiality, nothing ever truly repeats itself which is one reason why scientific predictions of technological developments have been notoriously flawed. For designers, what is changeable is far more important than what persists. Science fiction, popular myths, and designers' imaginations turn out to be far better predictors of coming technologies than historical facts. Designers would seriously sabotage their own mission by relying too heavily on re-search as a way of justifying the paths they are proposing to take. Re-search results can not recognize newness. They systematically and methodically fossilize history. Generating knowledge that could support design decisions means reversing the familiar process of re-search. Instead of examining the past for generalizations and continuing trends, designers have to search the present for possible ways to move into desirable futures. "Scouting," "way-searching," "trail-blazing," or less metaphorical, "pro-search" may be a better way of naming the kind of empirical inquiries designers need to undertake. This calls for methods of inquiry that are radically different from traditional re-search.

But design is only partly about assembling parts into new and progressively more sophisticated artifacts, which largely is what Simon had in mind. It also amounts to interventions into networks of ongoing user practices that change the social fabric of many people's lives. Some technologies merely replace old practices by new ones. Others expand or limit the horizon of human experience. All affect how peoples live together. I am suggesting that the commitment to the re-search of a positivist science - which generates observer- and user-independent knowledge of past events - prevents us from coming to grips with the consequences of informed actions in the minds of stake holders as well as on the technological developments they help to bring about. We need a very different kind of paradigm of inquiry, perhaps along the line of Donald Schon's *Reflexive Practitioner*, certainly one that acknowledges the dynamics any design activity sets in motion.

7. A science for design must be a second-order science

Designing artifacts with as well as for use by others implies knowledge of these others' understanding. In an information age, designers must either have this understanding or systematically acquire it. However, this understanding is not the kind of understanding we need to assemble functional products, the kind of knowledge that Simon extensively elaborated, or what is needed to design information systems, which Simon began to make available. It is designers' understanding of users' understanding, an understanding of understanding, or second-order understanding for short. Second-order understanding assumes that others' understanding is potentially different from ones own. By contrast, first-order understanding, the kind of understanding that engineers need and the natural sciences have provided us for thousands of

years, completely ignores the conceptualizations that (other) humans bring to it. First-order understanding is mono-logic, second-order understanding is multi-logic (dialogic or interactive). Second-order understanding radically breaks with the widely shared illusion that scientists could take a Gods-eye view of the world and that all humans, conveniently excluding scientist, are biased, have distorted perceptions, limited capacities, and therefore can not see the true nature of things. Second-order understanding also is dynamic in that it accounts for the possibility that artifacts change their meanings in use, that new artifacts always intervene in their users' understanding, and that we too change our understanding in the process of designing artifacts with and for others. Interfaces can hardly be developed with first-order knowledge (unless the designer can impose his or her conceptions on every user). In human communication, messages are sent in the anticipation of their receiver's understanding. Thus, information always bridges two kinds of understanding and creates a dynamic interweaving of these understandings. Projects can not possibly grow in first-order understanding. A second-order science generates a wholly new kind of knowledge which is central to design in an information age.

8. Graduate design education must redesign design

To see graduate education as an institutionalized way of preparing designers for better paying jobs would not be worth the effort. To offer graduates an understanding of existing trends, for example what the information society is all about, or to familiarize them with the latest technology would not be enough. Walking on a trajectory of artificiality that is paved by its artifacts means pursuing a vision that is ahead of its time and rearticulating at each step what design is or could be. I suggest that graduate education should create designers that are capable of critically examining and re-designing the intellectual infrastructure of their design community. This calls for developing design methodologies, enhancing the conceptual tools for design practices, and creating new opportunities for design as a profession. Design education would be a natural place for designers with a Ph.D., but far more important is their creative contribution to design scholarship. Although Simon never envisioned design as moving along a trajectory of artificiality through and into rather different worlds, his writing prepared designers to embrace at least the world of computers. He could be considered a model of the kind of scholars a graduate program in design should have educated 25 years ago.

9. Design takes place in languaging

Simon taught us, correctly I would add, that the cognition of living organisms actually is quite simple. What makes their behavior appear to be so complex, is the complexity they face in their environment. I must note that such a statement occurs in language and implicates us, humans, in ways Simon hardly realized. Not only have contemporary artifacts increasingly become language-like - they are recombinable into numerous forms, change their meanings in the contexts of their use, can be rearticulated by different users, and be reproduced in different environments - the very environmental complexity that Simon talked of and we face indeed is the complexity of our languaging (which is not merely using a vocabulary instrumentally, but living in communication with others). Product semantics is one approach to design that capitalizes on the recognition that distinctions within and among artifacts are drawn in language, that the qualities we attribute to artifacts start with those available in language, and that designers cooperate with each other and with clients in a language they can handle. Language enables designers to receive specifications, to make presentations to clients, to argue the virtues of particular design solutions, and to empirically inquire into the social roles that artifacts acquire within a culture. 99% of all design occurs in talk and it is amazing that we seem to know as little of our languaging as fish are said to know of water. This is not to down play the role played by other modes of interaction. Visual perception, tactile experiences, emotions, and kinesthetic senses of our bodily being with artifacts undoubtedly are central to design. But even in this workshop, 99% of what happens is talking, gesturing, projecting slides, and a written version of the contributions, this paper included, will be on the World Wide Web, printed in book form, and we all are convinced this will set the switches for the shape of design in an information age.

I am suggesting that the road toward an information society is paved by our own languaging, by our developing adequate discourses by which we generate the opportunities we desire and conceptualize all the artifacts we need to realize to move on. Design discourse is what keeps the community of designers together. Design discourse generates artifacts whose meanings matter. Design discourse provides the ground on which institutions can thrive (even those we might not wish not to nourish). Design discourse enables the education of designers, the teaching of design principles, the formulation of design methods, the public celebration of exemplars, as well as the construction of guiding futures. Designing a discourse probably is the most human way of designing worlds, including ourselves, for it embraces all its speakers in proportion to their willingness to contribute to the process. A design discourse contains all the principles of design.

I take these loosely worded design principles not merely as responding to the information technologies we know, but as initiating a process by which we can critically examine and conceptualize design and the history of artifacts to come.

RECOMMENDATIONS

When funding design efforts or scholarly work towards new information technologies, NSF should give preference to proposals whose investigators:

1. ... *respond to the multiplicity of meanings* different stake holders or users may bring to a technology and resist the temptation of universalizing their own techno-logic.

2. ... *delegate* to users *as many design decisions as possible*, develop frameworks or languages that encourage unanticipated uses, and avoid designs that leave others no interpretative spaces.

3. ... commit themselves to *work as partners with stake holders* who quite naturally organize themselves around any proposal or idea and/or to create multi-disciplinary teams for realizing a proposal within networks of such stake holders - as opposed to providing ideal users with designer's solutions to designer's problems.

4. ... *focus on human interactivity*, on the design of *interfaces*, and on treating artifacts primarily as reproducible gestalts in ongoing, multi-modal, and language-like interactive practices and only secondarily as industrial and marketable products. The reality of information "products" resides in human interaction or communication.

5. ... *favor heterarchy* over hierarchy in information designs, favor *open* non-proprietary software *architectures* over the creation of inflexible standards (in the service of a dominant stake holder), and allow artifacts to develop lives of their own in contrast to attempts to prescribe or control their use.

6. ... *engage in "pro-search"* (the systematic creation of presently possible paths towards desirable futures) rather than traditional re-search (the systematic extrapolation of past constraints and their projection into a future).

7. ... *contribute to a second-order science of the artificial*, to an understanding of others' (stake holders') understanding of artifacts, to conceptions of reality that embed others' reality constructions in that of the investigators - in opposition to a first-order science that limits itself to orthodox and monological world constructions outside the (first-order) scientist and treats information as unrelated to human concerns.

8. ... *encourage educational technologies* and programs *that drive a trajectory of artificiality into the future* by making scholarly contributions to design discourse, conducting second-order inquiries into possible design practices, developing new interdisciplinary design methods, and testing the viability of critical appraisal techniques, claims, and arguments. In an information age, the new generation of design graduates have to be capable of continuously rearticulating (redesigning) design as a visionary profession, as a knowledge based institution, and as a generative social practice. Traditional (art)historical approaches to design research and education shed light only on a past.

9. ... are aware of their own *languaging* and constructively intervene into the *interactions between language use, perception of reality, and the coordination of design practices*, examine how different forms of languaging create (or close) alternative trajectories of artificiality, and critically evaluate the viability of alternative professional design discourses.