October 2007

Design Research, an Oxymoron?

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Abstract
Why oxymoron?

An oxymoron is a figure of speech that combines two contradictory terms. The word *oxymoron* is of Greek origin. It combines the word *oxy* (=sharp) and *moron* (=dull, stupid, foolish). Thus, *oxymoron* not only names a contradiction in terms, it is an oxymoron as well. Oxymorons may be used for achieving rhetorical effects, as in *working vacation* and *uninvited guest*. They may also result from conceptual sloppiness, as in *extremely average*, *original copy*, or *same difference*. Oxymorons may remain unnoticed when the meanings of the contradictory parts are not distinguished, as in *spendthrift, virtual reality*, and *Artificial Intelligence*. Typically, contradictions of this kind are resolved by taking one term as the inferior attribute of a superior concept. For example, *unbiased opinion* is a kind of opinion, *accurate estimate* is a kind of estimate, and the reply "no comment" is not taken as a comment.

Oxymorons are not mere linguistic oddities. Words are far from neutral bystanders of what happens in the world. They can shape their users' perceptions and direct their actions. For this very reason, and to enhance its academic respectability, the design community has begun to adopt vocabularies from the more established disciplines, without noticing, I suggest, the implicit importation of paradigms that are essentially alien to it. One aim of this essay is to show that *design research* is an oxymoron whose contradictions, because they are not obvious to everyone, can lead its naïve users into thinking of it as a kind of research similar to what reputable scientists do.

Comments
Postprint version.

Manuscript Version

Pages 67-80 in Ralf Michel (Ed.). *Design Research; Essays and Selected Projects*
Zürich: Birkhäuser Verlag, 2007.

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An oxymoron is a figure of speech that combines two contradictory terms. The word *oxymoron* is of Greek origin. It combines the word *oxy* (=sharp) and *moron* (=dull, stupid, foolish). Thus, *oxymoron* not only names a contradiction in terms, it is an oxymoron as well. Oxymorons may be used for achieving rhetorical effects, as in *working vacation* and *uninvited guest*. They may also result from conceptual sloppiness, as in *extremely average*, *original copy,* or *same difference*. Oxymorons may remain unnoticed when the meanings of the contradictory parts are not distinguished, as in *spendthrift*, *virtual reality,* and *Artificial Intelligence*. Typically, contradictions of this kind are resolved by taking one term as the inferior attribute of a superior concept. For example, *unbiased opinion* is a kind of opinion, *accurate estimate* is a kind of estimate, and the reply "no comment" is not taken as a comment.

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What do science researchers (claim they) do?

Science is said to validate propositions that state facts. Research is the process by which this is accomplished, ultimately revealing the nature of what exists from what was observed, starting with simple hypotheses, going to more general theories, and ultimately reaching laws of nature. Since nature does not talk, the process of uncovering its secrets is not an easy matter. Scientists talk among themselves, but their talk is not considered science. Science starts with data – records of observations, measurements or texts – that can decide among competing hypotheses and validate or invalidate theories concerning them.

Why are data essential to research? Experiences are hard to study. Happenings come and go away like thunderstorms and spoken words. Witnessing historical events, watching a game of sports, or being aware of designing something, is not inter-subjectively analysable as such. To be sure that our observations are not entirely subjective, irreproducible illusions, scientists rely on other scientists who, when agreeing on what they see, are willing to conclude that the phenomena of interest existed independent of their subjectivities. Excluding observers' subjectivities from propositions about the observed world is a defining feature of scientific research. However, agreement on what happened can be established only if the phenomena of interest have been observed jointly and records of them are contemporary in order to be compared side by side and examined by many. This is what data are expected to do. They must represent the phenomena of interest, survive the conditions that gave rise to them, and remain sufficiently durable to withstand their analysis. Researchers take great care to assure themselves and others that their

data are reliable in this sense and worthy of their trust, which means assuring everybody that nobody has tampered with them.

This tangible nature of data is also implied in the uncritical use of metaphors that implicitly absolve researchers from the responsibilities for their creation. For example, claiming that data were discovered, found, collected, or sampled entails that they were there to begin with and that the researcher merely picked them up to look at them. This metaphorical description of how data came into the hands of the researcher, and only that, is what makes critical assessments of their representativeness unnecessary, assures researchers of having nothing to do with the data they are analysing, and justifies describing research results as *findings* – as if they were merely uncovered in or extracted from available data. I will return to this point later.

But what is research? Fundamentally, it is – just as the English word suggests – *re-search*, a process of *re*peated *search*ing for patterns that are manifest in available data. In other languages, the English *research* may focus on different aspects of scientific work, for example, the German *Forschung* emphasizes vigorous inquiry into truth, but this too involves recurring searches. Scientists are trained to be systematic and careful, systematic by leaving nothing out from what was observed, and careful by going through their data, again and again, until they are sure that what they find is unquestionably evident, not the result of spurious causes or flighty imagination. Re-search involves sorting, rearranging, tabulating, weighting and comparing data in place of the phenomena of interest – much like tangible objects can be handled – but systematically. Processes of scientific research are institutionalised, which encourages researchers to publish their results in the hope that colleagues will confirm their findings, or build on them.

The re-searched patterns are necessarily simpler and more abstract than the data in which they occur. For one thing, re-search findings are stated in language, which cannot but omit what escapes the researcher's vocabulary. But they also ignore details considered irrelevant – irrelevant to the researcher's theory or hypothesis. For example, statistical analyses can extract regression equations, clusters, networks or causal chains from available data. What does not fit these patterns is considered unexplained variation or noise. Pearson's product moment correlation coefficient, for example, measures the degree to which data conform to a linear relationship between two variables. That degree is the ratio of what fits to what fits plus what does not.

What about predictive theories? We can speculate about the future, but data from the future are never presently available. Scientific theories are predictive by generalising patterns found in data that are currently available to data that do not yet exist. (Note that predictions anticipate additional observations, including, but not exclusively, of future phenomena.) For example, when statistical hypotheses are considered, tests of the statistical significance of findings measure the generalisability of patterns found in a sample of data to a population of possible data, of which the sample was a part. Significance is expressed in probabilistic terms, the probability of the continued existence of the observed patterns. This seems entirely unproblematic until we realise that predictions (a) are intrinsically conservative by assuming that the patterns observed in the past will continue to explain future observations, and (b) leave no space for human agency by regarding future observations as necessarily following from past findings.

Finally, re-search is considered applicable to any subject matter. Scientists re-search the working of a machine, just as they study the performance of an economy, a play, or what designers do. Consumer researchers may generalize the performance of one product to all products that came from the same assembly line. Economists derive their predictions by extrapolating past trends

into the future. Likewise, the theories of design that emerge from observations of what designers commonly do account only for what they did, not for how they might redesign the theory they were following. It is well established that scientific forecasts of technological developments are notoriously unsuccessful, largely because design escapes the conservatism of the re-search process – but this foreshadows what will be discussed next.

What do designers do by comparison?

The etymology of design goes back to the Latin *de+signare*, marking out, setting apart, giving significance by assigning it to a use, user, maker or owner. Sixteenth-century English emphasised the purposiveness of design, and because design often involves drawing, or 'marking out', while 17th-century English moved design closer to art. Based on these original meanings, we could say:

Design is making sense of things (to others)

The phrase can be read as 'design is a sense making activity', claiming perception, experience, and perhaps appearance as its fundamental concern, and this reading is quite acceptable. It can also mean that 'the products of design are to make sense to their users', and this interpretation is the central focus of *The Semantic Turn* [1]. It puts the creation of artefacts for future use by others into the centre of all design activities.

For Herbert Simon, writing 38 years earlier, design is both broader and narrower [2]. He suggests:

> '*Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. The intellectual activity that produces material artefacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or a social welfare policy for a state. Design, so construed, is the core of all professional training; it is the principal mark that distinguishes the professions from the sciences. Schools of engineering, as well as schools of architecture, business, education, law, medicine, are all centrally concerned with the process of design.'* (pp. 55–56)

Simon's account could be a starting point, except – and this may be due to the period in which he wrote these lines – he reduces design to rational problem solving, which begins with defining a problem in terms of how something ought to function, proceeds to enumerating alternative solutions to that problem, and ends with methods of selecting the optimal or satisfactory solution from among them. My own experiences lead me to depart from Simon's rational paradigm in two ways. First, I observe that designers, including myself, are motivated in at least three ways, by

- *Challenges*, troublesome conditions, problems, or conflicts that have escaped (re)solution. Challenges arise from the perception of presently undesirable conditions that seem to defy routine improvement. Simon's problem solving would be one example of this.
- *Opportunities* not seen by others to do something, to improve one's own or other people's lives. Opportunities do not imply the presence of problematic conditions, rather, they offer choices to move into something new and exciting without having been a problem at the time.

- *Possibilities of introducing variations* into the world that others may not realise or do not dare to consider. From the perspective of evolution, these variations are random mutations, without apparent purpose or plan, and they may prove to be successful or not. Just being different moves many poets, painters, and composers. There is no rational explanation for doing something different, except perhaps personal satisfaction.

To me, rational problem solving is just one way of designing and I do not wish to limit design to what Horst Rittel *et al.* call 'tame problems' [3].

Second and more importantly, the kind of design that occupies my attention is human-centred. If design is to encourage artefacts that are meaningful to others, to users or stakeholders, it must at least acknowledge, if not support, their conceptions and desires. This requires (a) listening to how other people think and justify their actions in worlds they always are in the process of constructing to live in, or (b) inviting the stakeholders of a design to participate actively in the design process. So conceived, design is an essentially social activity, one that cannot be separated or abstracted from the context of people's lives and certainly not be replaced by a deontic logic or algorithms for optimisation, discussed by Simon, which might well be appropriate to engineering design.

Let me suggest five activities that define human-centred design.

- Designers invent or conceive *possible futures*, including its artefacts that they may be able to bring about, imaginable worlds that would not come about naturally. A causally determined world and future, by contrast, would be evidence of nature's work and of the absence (or irrelevance) of design activity. Artefacts are products of human agency. They do not grow on trees. Design is fundamentally tied to conceiving futures that could not come about without human effort.
- Designers need to know *how desirable these futures are* to those who might inhabit them, and whether they afford diverse communities the spaces they require to make a home in them. Desirable futures reside in language, in communication, particularly between designers and the likely inhabitants of these futures. Evidence about understanding these worlds consists of the ability to articulate and rearticulate these futures for designers to take note.
- Designers *experiment with what is variable or could be changed*, in view of the opportunities that variability could open up for them and others. Laws in the natural sciences, by contrast, state what does not vary – cannot be varied or has not been varied. The variability of interest to designers has more to do with people's cultural commitments, habits, and values. Some variabilities are just not recognised, habits and values, some are actively resisted, and some are eagerly embraced. Probably the most important task for designers is to create possibilities that nobody has thought of and would not have considered without rhetorical interventions by a designer. These variables define a space of possible actions, a design space, as Phil Agre calls it [4]. A design space is an artefact, a human creation, not observed in nature.
- Designers *work out realistic paths*, plans to proceed towards desirable futures. By realistic I mean that these paths include sufficient details and take account of currently available technologies and material resources, as well as the abilities of those who might pursue them.
- Designers *make proposals* (of realistic paths) to those who could bring a design to fruition, to the stakeholders of a design. Proposals are stated in language. However, they go beyond mere specifications, suggestions for how to proceed or policies to implement. They must offer their

addressees possibilities to realise their desires and coordinate their actions towards something worthwhile. As such, proposals *must enrol stakeholders into a designer's project.* The ends that designers may have in mind do not need to be the same as the ones that stakeholders pursue – as long as the latter stay involved, at least part of the way. Without a network of supportive and creative stakeholders, a design cannot be realised.

Some of the contradictions between what scientific researchers claim they do and what designers do are as follows.

- Simon already recognised that the disciplines of the sciences are concerned with what exists whereas the disciplines of design are concerned with what, in his words, 'ought to be' [2]. In terms of this essay, whereas scientific theories are based only on what existed and could be observed prior to an analysis, design concerns artefacts that are not yet in use and could not have been observed, for which data are constitutively lacking, and experiences can at best be anticipated.
- Whereas predictive theories that arise from scientific research conserve the status quo – constitutively assuming that the forces that operated in the past continue into the future – designers need to break with the determinisms of the past, proposing novel and untested paths into alternative futures, especially by involving the stakeholders' creativity in realising a design.
- Whereas researchers in the natural sciences privilege causal explanations, which excludes them as originators or contributors of the phenomena they observe, designers intend to affect something by their own actions, something that could not result from natural causes, thus defying the causal explanations of scientific discourse.
- Whereas scientists celebrate generalisations, abstract theories or general laws, supported by evidence in the form of observational data, designers suggest courses of action that must ultimately work in all of their necessary details and in the future. Artefacts never work in the abstract. This contradiction is also manifest in scientists' preference for abstract mathematical explanations, and designers' preference for images, figurative models and prototypes.
- Whereas researchers theorise invariancies, treating unexplained variations as undesirable noise, designers are concerned with variabilities, conditions that could be changed by design. Something analogue to Werner Heisenberg's uncertainty principle applies to this incompatibility. By focusing on what exists, researchers cannot possibly observe what could but has not yet been altered; by focusing on what could be altered, designers have no reason to care for why something had stayed the same. For these reasons scientific theories are not particularly interesting to designers – unless the theory describes something that designers do not care to change or need to build on.
- Whereas researchers are concerned with the truth of their propositions, established by observational evidence, designers are concerned with the plausibility and compellingness of their proposals, which resides in stakeholders' ability to rearticulate them in the context of the futures they desire and various paths to reach them.
- Whereas scientific researchers 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 dimensions related to their designs.

- Whereas theories in science describe nature as unable to understand how it is being investigated, theories of design address the activities of designers who can understand not only what they are doing but also theories about what they are doing. As Wolfgang Jonas notes: 'Any theory of designing has to include the generation of theories of designing' as followed by its practitioners … and 'explain its own emergence …its own change.' [5], p. 184. Thus, a research-based theory of designing could never keep up with the changes that designers introduce into their own subject matter.

Obviously, design and research are incommensurable in conception. They pursue unlike epistemologies, at least in regard to the above. "Design research" is an oxymoron without question. As a subspecies of research, design research suppresses design.

As re-search stifles design, what inquiries could improve design practices?

Unquestionably, design re-search cannot support what designers need to practise. But what would be a more appropriate alternative? How and into what should designers inquire? *The Semantic Turn* (p. 209ff) proposes a *science **for** design*, which is meant to support what designers need to do to make their claims compelling [1]. A science for design is distinct from a 'science of design, …that body of work which attempts to improve our understanding of design through "scientific" (i.e. systematic and reliable) methods of investigation' [6], p. 96. The latter is exemplified by the scholarship of art historians, sociologists of design, or theorists of technology, all of whom generalise dominant features of design, historical trends, psychological predispositions, or socio-cultural contingencies. Observing from outside the process, a science of design depicts designers as being causally determined by forces not under their control, and can contribute little to the practice of designing. A science for design is also not to be confused with a 'design science … an explicitly organised, rational and wholly systematic approach to design; not just the utilisation of scientific knowledge of artefacts, but design in some sense a scientific activity itself' [6]. A science for design raises questions from within the practices of design. I will spell out some of them.

First and fundamentally, designers *create possibilities*. Possibilities relate to what humans *can* do. Possibilities are not part of and cannot be observed in a nature void of humans. A science for design must nurture ways that enlarge the design space within which designers act. Some of these ways are psychological, freeing oneself from blind spots and cognitive traps. Some are social, making use of conceptions held by others, when brainstorming, for instance. Some are technological, expanding a design space combinatorially, using computers, to generate alternatives that easily escape cognition. Some are perspectival, approaching a design from multiple disciplinary perspectives, and some are morphological, suggesting transformations into alternative representations with different qualities. All of these ways expand the range of choices available to designers (before narrowing them to a workable proposal). Re-search, as discussed above, is driven by extracting certainties from diverse data. Design, by contrast, thrives on uncertainty that designers can create and handle.

Designers must be non-dogmatic and anti-authoritarian in order to *question the 'findings' of scientific re-search.* Blindly accepting scientific authority means surrendering to what existed in the past. Undoubtedly, there are limits to what design can accomplish. For example, I would be hesitant to invest in a proposal for a perpetual motion machine. It violates the second law of thermodynamics. But even laws of nature are human artefacts. They may have withstood the test

of time, but we can never know whether the findings of the natural sciences are valid in the time frame of a design. The history of design is full of examples where scientists claimed impossibilities that designers managed to circumvent or prove wrong. Scientists once assured us that it was impossible for humans to fly and now we do. Engineers calculated that the steel wheels of locomotives on steel tracks would not have enough traction to pull a train, and they were wrong. In the 1950s, IBM researchers are reputed to have concluded that the world would need no more than five computers. This did not discourage Steve Wozniak and Steve Jobs, working in a California garage, to develop the first personal computer. In effect, designers need to question prevailing ontological beliefs. Being afraid of undermining common convictions makes for timid designs. Proposing what everyone knows or already uses is not design at all.

Designers must *vigorously examine their own methods.* Design science, as Cross defines it, institutes design methods, supposed to be scientific, and hence unquestionable [6]. Legitimising some practices and delegitimising others is the mark of a discipline. Disciplines discipline their disciples. Design, however, is an *undiscipline*, one that should be able to question anything and be allowed to try everything – provided its products are useful, work, and benefit others. But it should especially apply to itself.

Designers must inquire into how to *create variables*, things that can be altered by design. They need to learn to create what scientists mostly abhor: changes that cannot be explained by natural causes. Variability, the ability to vary something, is an exclusively human ability. Just as JJ Gibson's 'affordances' [7], variability is a relational concept, relating human agency to the environment; to what can be done with something. As already mentioned, inquiries into variables render knowledge of what exists less relevant than the options that variations open up. There are physical constraints, of course. Artefacts may 'object' to how they are treated by falling apart or just not doing what their users had in mind for them. When invariancies are social or cultural, designers need to explore what it takes to unfreeze cherished habits or convictions, or to get people to learn something new. Inquiries into variability require interactions with people, not more observations. They differ from ethnographic fieldwork of what users do, market research of user preferences, and ergonomic studies of the efficiency of human interfaces with technology. The latter describe what people do, not what they *can* do.

Above all, designers *participate in stakeholder networks* and need to know how to support such networks and energise them with *compelling proposals.* I have already suggested that design must remain undisciplined but it cannot be totally free when it intends to succeed. For designers, success means enrolling stakeholders into the project of their design. This is what keeps design responsive to the conceptions, desires and capabilities of others, and it 'disciplines' the necessarily unruly design professionals – but not from within the profession. Unable to rely on data from a desirable future and without actual experiences of what is being proposed, designers need to know what makes their proposals compelling. Elsewhere, I have outlined several approaches to this effect [1]. I cannot reiterate them here except to say that designers need to inquire into the conceptual abilities of diverse stakeholders through processes of exchanging narratives with them about possible futures. Consequently, because design becomes real in communication with others, inquiries into what makes a proposal compelling are inquiries into how people understand and act on narratives pertaining to desirable worlds. Some scholars have suggested that design is an ethical enterprise. If designers realise that they cannot go alone, cannot force their conceptions onto others, and that whatever they propose must resonate with stakeholder conceptions [8], the questions that designers need to ask are implicitly ethical. The

only ethical principle I would add is to avoid monopolising design in a profession and instead delegate the practice to as many stakeholders as possible. Design is a basic human activity to which everyone should have access. Professional designers must not usurp the ability of other stakeholders to design their own futures. Proposals for designs may fail for all kinds of reasons, and systematically studying why they failed is an important source of changing design practices from within.

I suppose most of these suggestions for inquiries in preparation of design activity do not conform to what traditional designers do when they say they do research. Let me mention three traditional kinds and explore their value.

First, *surveying useful ideas* for how a particular problem might be solved. Genrich Altshuller *et al.* surveyed some 200,000 patents and found 77% utilised something already existing within the inventor's field [9]. 18% imported ideas from other areas. 4% realised new concepts, and only 1% pioneered landmark inventions. The problem of the first 95% is to find something that already exists but elsewhere. While surveys of this kind might prevent reinventions or enable designers to creatively deviate from what is already known, they do not say anything about how these ideas could be utilised and are, hence, not about design practices.

Second, designers often start by trying to *understand how an artefact is to function*. Indeed, designers tend to spend much time exploring what they are asked to do, for example, by taking the current version of a product apart, observing how it is used in different situations, visiting the manufacturer, talking to sales representatives etc. Louis Sullivan's widely cited slogan *form follows function* abbreviates the common but naïve belief that the form of a product that designers need to find automatically follows from a thorough understanding of its function. However, understanding is not what re-search can provide, and deep understanding does not automatically lead to ideal forms. In fact, that deeper understanding of how something needs to work can limit a designer's attention to the cosmetics of what already exists – a rather minimal design contribution. Sometimes, starting naively or from scratch can prevent one from being boxed into what clients and users expect designers to deliver.

Third, there is one area where re-search in the sense described above can make valuable contributions and that is by *pretesting a design*. In the context of designers having to make proposals to those who matter, we need to realise that proposals are linguistic constructions whose compellingness usually depends on extralinguistic devices: sketches, models, diagrams and demonstrations, but they can also be enhanced by empirical evidence that a design works as claimed. Approximations to that future evidence may be obtained by observing prototypes in action, how targeted users respond to and benefit from a design. Valuable as this kind of re-search is, it can be conducted only after a design is at least provisionally complete. Pretesting is necessarily limited to parts of a stakeholder network, perceived bottlenecks, typically users. Pretests merely approximate the ultimate realisation of a design.

Hiding design in the process of scientific inquiries

What researchers claim they do is not the whole story and what is missing reveals their blind spots. Let me discuss two and end by suggesting a less delusionary epistemology for scientific inquiry, including research design.

First, the *metaphorical language* of the accepted accounts of scientific research *prevents acknowledgements of the researchers' agency*. As above noted, researchers speak of research results as findings, discoveries, or truths – as if the phenomena they describe had been there to begin with, theories were hiding themselves in the data, laws would govern nature, making the task of scientific research one of uncovering what is behind the observable surface of nature. But patterns must be recognised before their pervasiveness can be tested. Re-cognition – cognising something again – implicates a long history of the researchers' conceptions. Researchers' conceptual involvement cannot be avoided by delegating pattern recognition to mechanical devices, to systematic analyses or statistical tests. Such mechanisms, meant to assure objectivity, are always designed by someone and, hence, are representative of its designers' conceptual repertoire, and what they indicate must be re-cognisable as well.

It follows that re-search results are not the properties of data alone, as claimed, but of how the data fit a researcher's conceptual and linguistic vocabulary. The difference between outstanding and normal scientists lies in the former's ability to ask interesting questions, generate relevant data, and describe their implications in convincing terms. This is not to suggest that research results are subjective, but that so-called findings are the product of interactions between the data and their treatment. Privileging the properties of data at the expense of the researchers' role as the creators of hypotheses, proponents of theories, and designers of systems of analysis denies human agency in the products of science. The skilful design of research by scientists thus becomes the victim of the epistemological commitment to objectivity, the illusion of being able to observe without an observer [10] or to re-search without the cognitive and linguistic histories of the researchers.

Second, in order to preserve the abstract-objectivist [11] or representational [12] conception of scientific (propositional) language, the accepted accounts of scientific research deny or *omit the context in which re-search takes place*. This may be demonstrated with Bruno Latour and Steve Woolgar's (1986) five-stage model of scientific discoveries [13], schematically stated as follows:

(1) *document*
(2) *document* $\rightarrow$ *object*
(3) *document* | *object*
(4) *document* $\leftarrow$ *object*
(5) *'deny (or forget about) stages 1–3'*

Based on ethnographic studies of scientific practices in research laboratories, astronomical observatories and other scientific enterprises, Latour and Woolgar noted that virtually all research starts with *(1) document*s: the literature of the discipline in which problems are identified as legitimate targets of investigation; lucrative requests for research proposals; or puzzling gaps in research results published by colleagues.

In a second step, such verbal matter gives rise to and defines an object of investigation: *(2) document→object*. In statistics, this step means identifying a population that can be sampled with suitable instruments. In physics, it nowadays means building very expensive apparatus to run theory-informed experiments that yield novel observations. In psychology, experiments with subjects are typical. They induce individual behaviours pertaining to a research question that might not occur in everyday life. Public opinion researchers design surveys and interview schedules through which publics are constructed that are of interest to candidates for political office or policy makers in government [14]. This step generates data that would not exist

otherwise. Researchers do not merely stumble upon data. Data are made, which prompts Herminia Alfonso to call them '*poieta*' [15]. Scientific literature is full of how-to books on the design of experiments, of measuring instruments, of questionnaires, of coding instructions, and of transcription conventions. Even when data are produced by a process not controlled by the scientist, recognising them as data makes all the difference.

The third step involves separating the data from what caused them: *(3) document | object*. To justify this split, a variety of devices are in use, for example, for preventing experimenter biases from polluting the data, relying on objective measuring instruments, or admitting data to an analysis only when their inter-coder agreement is high. While such devices assure that the data are reproducible, that the method of generating them is not affected by spurious causes, none of these precautions can change the fact that the data could not exist without the application of a design that generates these data.

The fourth step inverses the original direction of the causality: *(4) document←object*, now treating the data as selecting among hypotheses or judging the validity of a theory of interest to the researcher. This is the step that researchers in the sciences treat methodologically, and it also is the step described above as the re-search process.

The fifths and final step, *(5) 'deny (or forget about) stages 1–3,'* leaves step (4), re-search, as the accepted way of describing scientific research, effectively supporting the claim that research results represent phenomena existing in nature. Woolgar 1993 suggests [16]:

> *'Step (5) rewrites history so as to give the discovered object its ontological foundation. …Construing the prior existence of the object entails the portrayal of the observer as passive rather than active. We thus see the rhetorical importance of the antecedence of the object in the way it implicates a particular conception of the agent (as)… merely peripheral and transitory. It is as if observers merely stumble upon a pre-existing scene.'* (p. 69)

One might be lenient and argue that steps (1) to (3) take less time or are easier to perform than step (4). However, ignoring the design phase of scientific research and the agency of the researcher/observer is no oversight. It is necessary to preserve the idea of representation, the belief that research probes reality the way it is. I take this the primary motivation of step (5).

Suppose we were to ignore the devious step (5) instead of (1) to (3). What difference would this make? Obviously, it would acknowledge the history of the re-search process. More importantly, it would require a significant shift in the epistemology of science from a representational enterprise to a constructive one. I want to build on Heisenberg's famous assertion: 'What we observe is not nature itself, but nature exposed to our method of questioning.' Our method of questioning points to the discourse in which we construct our worlds and ask our questions about these worlds. The answers we obtain reveal nothing other than whether our own actions, taken in view of our constructions, are afforded or fail to be afforded by whatever resides outside of us. Consequently, scientific work does not reveal what exists (in perpetuity or in fact), but what our constructions of the world had enabled us to do – the data we were able to generate to test the hypotheses we designed. While this brings science and design closer to each other, the past tense in the last sentence is of utmost importance in distinguishing between the two. Science articulates the constructions that worked so far. Design articulates constructions that might work in the future – but not without human intervention.

Conclusion

Re-search as practised today cannot possibly serve as a model for generating knowledge about design or to improve design. In fact, relying on re-search, being necessarily conservative, would condemn design to elaborations of the past. Even my modest suggestion to acknowledge scientists as designers of research processes does not go far enough.

Inquiries that could inform design practices would have to start by acknowledging the simple fact that design is concerned with how we may want to live in future worlds. At any one moment in time, these futures reside in narratives that are sufficiently compelling to coordinate the stakeholders in these futures and encourage them to do their best to make them real. Whereas science concerns conceptions that worked so far, design concerns what could work in the future, a future that is more interesting than what we know today. A design is always a proposal, a conjecture. Whether it delivers what it promises, whether it will work in the foreseeable future, cannot be known until it ceases to be a design and becomes part of its users' history. At any one moment in time, the viability of a design depends on its stakeholders' conceptions, commitments and resources, which can be studied in order to inform design decisions. This is what inquiries in support of design need to do. They must not become entrapped by a debilitating oxymoron.

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