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The Conditions of Peak Empiricism in Big Data and Interaction Design

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Abstract

An influx of mechanisms for the collection of large sets of data has prompted widespread consideration of the impact that data analytic methods can have on a number of disciplines. Having an established record of the use of a unique mixture of empirical methods, the work of understanding and designing for user behavior is well situated to take advantage of the advances claimed by "big data" methods. Beyond any straightforward benefit of the use of large sets of data, such an increase in the scale of empirical evidence has far-reaching implications for the work of empirically guided design. We develop the concept of "peak empiricism" to explain the new role that large-scale data comes to play in design, one in which data become more than a simple empirical tool. In providing such an expansive empirical setting for design, big data weakens the subjective conditions necessary for empirical insight, pointing to a more performative approach to the relationship between a designer and his or her work. In this, the work of design is characterized as "thinking with" the data in a partnership that weakens not only any sense of empiricism but also the agentive foundations of a classical view of design work.

Introduction

Empirical research into user requirements and behaviour has been a key element in the work of information and interaction design since the emergence of human-computer interaction and user-centered design research (Carroll, 1997). The rise of mechanisms able to capture large amounts of empirical data regarding user behavior opens the door to new possibilities for research and design (Barakova, Spink, Ruyter, & Noldus, 2013). User trace data (Østerlund, Sawyer, Ribes, Shankar, & Geiger, 2014), physiological data (Van Den Broek, 2013), and other sensor data (Alonso, Hummels, Keyson, & Hekkert, 2013; Terzis, Moridis, & Economides, 2013) all contribute to the generation of large sets of user data. The potential impact of such large sets of data in design can perhaps best be seen in the discourses surrounding the rise of so-called big data. Although big data methods have gained traction in many areas (Callebaut, 2012; Ekbia et al., 2014; Mayer-Schönberger & Cukier, 2013), the ultimate potential for the uses of big data in

understanding users remains unproven (boyd & Crawford, 2012; Marshall, 2012).

Characterized by the volume, variety, and velocity of the data that can be collected (Laney, 2001), "big data" relies on advanced networks of information capture and management. In its size and dynamic nature (Gobble, 2013), big data is reliant on computational modes of analysis (boyd & Crawford, 2012; Manovich, 2012) and allows for the management of previously unavailable levels of complexity (Callebaut, 2012; Mayer-Schönberger & Cukier, 2013). As pointed out by Ekbia et al. (2014), this complexity often exceeds traditional accounts of human cognitive ability (Kraska, 2013; Weinberger, 2012) and, in extreme cases, approaches being simply a form of noise (Wong, Shen, & Chen, 2012).

Laying out a series of cross-cutting "dilemmas" posed by the advent of big data, Ekbia et al. (2014) highlight the epistemic and methodological challenges presented by big data across a number of disciplines. In doing so, they focus on a specifically empirical rendering of epistemology in their discussion of the tension that exists in big data between remaining faithful to appearance or to the phenomenon itself. For us, the epistemic question raised by the use of big data is broader than just a concern over a subjective empirical epistemology and is one which has an impact on a wider field of epistemic and ontological concerns. As such, the central epistemic theme of representation discussed by Ekbia et al. will be given an alternate rendering that we hope will add nuance to their already valuable review and analysis. Although they explicitly note that epistemic approaches attempting to level the distinction between appearance and the phenomenon have found little space in the methods of big data, we hope to show how such an account is necessary, if not inevitable.

In limiting our attention here to the particular epistemic challenges faced in interaction design, we look to provide a discussion of one example of the epistemic effect seen in the rise of big data. The concepts and framings developed here have the possibility of being applied to any number of areas implicated by big data. The applicability of such concepts is particularly seen in areas that are easily encountered as modes of postpositivist research, such as the social sciences (Bernstein, 1983). As in the case of interaction design, in postpositive understandings of science, the influence of the particularly situated perspective and aims of the investigator are readily evident. As developed here, big data comes to challenge this schema in a heretofore unseen manner. In looking at interaction design, we provide explication of one specific cross-section of the wider epistemic issues raised by

Ekbia et al. The application of such conceptual development beyond design is something that we hope to be able to render more generally in the future.

In the case of interaction design, the increase in available empirical data about users and their behavior alters the character of design and the relationship that data have with the goals and intentions of the work of design. Given the opportunities afforded by the developing agenda for large-scale interaction design (Cramer, Rost, Belloni, Bentley, & Chincholle, 2010; Cramer, Rost, Bentley, & Shamma, 2011), it is worthwhile to consider the foundational impact that such reserves of data might have on the work of inter- action design and to begin to rethink interaction design's relationship to empirical data.

We are proposing an alternate reading of empirically influenced design in response to the conditions set forward by the possibilities emphasized in discourses around big data. What is laid out in this article is a consideration of how the sheer "bigness" of the empirical data that big data claims to offer alters our understanding of design work. Such a stance seeks to continue to build out an understanding of data, information, use, and design as being historically and particularly situated (Day, 2001; Suchman, 2006). It stands in contrast, though not in opposition, to a view of the empirical uses of data in design that sees data as a source of inspiration and representative insight into user behavior (Iqbal, Sturm, Kulyk, Wang, & Terken, 2005; Korn & Bødker, 2012; Kulkarni et al., 2013). Our intention is to chart the developing conceptual terrain that comes with the increase in scale and not to approach either big data or empiricism from an explicitly critical perspective.

In this article, we point to the future possibility of something that we term "peak empiricism," that the scale of big data establishes empirical conditions such that, for considerations of design work, the actual empirical value of any data plateaus. As data become "big," the metaphysical structures established in support of empiricism begin to collapse. The volume, velocity, and variety of the data overwhelm the necessary conditions of empiricism, with peak empiricism pointing to a moment of conceptual exhaustion of the possibilities of empiricism. In this, we examine how designers come to "think with" big data in the work of empirically based design and consider the agentive matrices that come to exert their influence overthe work of design in such an epistemic schema. This presents a challenge to designers and researchers to consider how their individual agentive actions impact design outcomes and how they give away such agency in exchange for the insight given by big data.

The structure of the paper is as follows and is largely dictated by the philosophical tone of the discussion. The first section following this Introduction lays out a general introduction and discussion of the concept of peak empiricism. We then establish our understandings of the questions of both representation in science and the mode of reflective design practice discussed. Building on this explication and placing it in the context of big data, we develop the argument that gives shape to the remainder of the article. It follows from the reflexive conditions of design and empiricism through a reading of the "textured" nature of the situation of design. From there, a consideration of the particular mode of "thinking" found in the work of design points to a reconsideration of the nonagentive character of this thinking. The article closes with a consideration of the conceptual implications for the work of interaction design in an era of big data.

Peak Empiricism

Peak empiricism is a concept that refers to the projected moment at which the sheer scale of large sets of empirical data overwhelm the theoretical conditions that make empiricism possible. In developing this concept, we point to a fundamental consideration of empiricism understood as an epistemic approach that places primary importance on knowledge derived from the senses over that that may be achieved through intuition (Hume, 2011; Locke, 1996). Although the exact role of empiricism in science remains a point of constant contention (Barad, 2007; Bernstein, 1983; Callebaut, 2012; Kuhn, 1996; Popper, 2005), what is vital for understanding peak empiricism is that at its foundation empiricism relies on separating a knowing and sensing subject from the object of investigation. Peak empiricism describes the theoretical moment in which the subjective position of the observer is lost against an outsized engagement with a background of rich empirical data. If Foucault (1994) proffered a theoretical moment of the invention of the subject, then this would proffer the opposite, not in a symmetrical undoing toward any sort of originary position but in an undoing of the subject in the form of a further development of human discourses. With big data, empiricism (as an epistemic strategy) loses its necessary conditions for operation, a loss that forces a re-evaluation of the work of science. In the course of the development of this peak, empiricism remains an invaluable approach for the production of knowledge. However, as will be described, in reaching this peak, the terms of science and the products of scientific investigation are altered.

At present, advances in the collection and analysis of empirical data seem to coincide with similar advances in empirical insight. Putting this in terms of interaction design, with more empirical data concerning use, designers are able to gain better empirical insight into use and thus are able to

design better applications. This increase in the benefit derived from an increased scale of empirical data peaks and levels off as the scale of the amount of data utilized begins to destabilize the subject–object relationship on which empiricism relies. This is not to say that there can be no additional benefit to further increases in the collection and use of empirical data in design, just that any such benefit would not be able to be understood as coming from empirical insight. Instead, any additional insight after the arrival of such an empirical peak would require a different theoretical understanding.

Set against a background of the availability of large sets of data, two main complementary phenomena lead the way toward the conditions of peak empiricism in design. First is the reflexive incorporation of data about users and their behavior into the function of applications. Simple examples of this would be social media or any mode of automated content curation (ranging from search results to online lists of most-read articles). In both cases, the value proposition of an application is derived from the ability to leverage information about users and their behavior as part of the function of the application. Such a reliance on user data points to a double role for data in design; the data serve to provide insight to designers about users as well as functioning as part of the materials of design. As the data both function as empirical evidence concerning user behaviour and are also intimately connected to the use of an application, it becomes difficult to identify the proper “object” of empirical investigation. Because the conditions of use being investigated at one moment both are indicative of the object of design and are the object of design themselves, the proper object of the subject–object relation of empiricism begins to weaken.

Second, beyond the reflexive difficulties that such an autopoietic setting presents, the sheer scale of the data begins to define the situational conditions of both design and use. In large part because of the pervasive reach of the internet, design (as both a subjective activity and an object) has come to be increasingly intertwined with social structures (Dubberly, 2008; Norman, 2010). In this, the work of design and the empirical data on which it relies both become conditioned and understood in reference to the larger social setting. This, however, is not a one-way movement, with computerization and the work of design also conditioning social forms (Kling & Iacono, 1988).With an increase in the scale of empirical data and the pervasive view of use that it is able to provide, there is a subjective difficulty in disentangling a subject (conditioned by the experiences of big data) and an object (represented in that same data).

Against this weakened theoretical foundation of empiricism, design reveals itself to be less the province of a pointed empiricism than a messier and more engaged mode of everyday experience. As the volume of empirical data increases beyond a certain level (loosely defined by the limits of rational human sense-making ([Kraska, 2013; Weinberger, 2012]), the data no longer provide pointed and specific insight (as in the case of the empirical validation of scientific theory). Instead, data come to give a generalized sense of the larger situation. That is, the specific empirical character of data that might tell us about the relationship between subject and object is overwhelmed by its own volume (and dynamic velocity and variety) and instead comes to provide the general conditions for the work of design. Paradoxically, what this means is that by providing such an expansive empirical setting for the work of interaction design, big data reduces the empiricism of design work, weakening any conception of a narrow subject-object relation in favor of a more embedded approach to the relationship among designers, their work, and any data involved. Instead of just giving insight into the specific usefulness of some feature of an application, big data provides a view into the entire system of use. This perspective is one that includes not only insight into the user and the application, but also a view into the larger social system in which the designer might also be embedded. Such a moment would be considered the peak of the possibilities of big data empirical methods.

This is not to present a critique either of big data or of quantitative or computational methods in general. Neither is this conception of peak empiricism a validation of such methods. Although certain strains of epistemic development have been evident in human–computer interaction design for some time (Bardzell, 2010; Bødker, 2006; Harrison, Sengers, & Tatar, 2011), the conditions put forward by big data ask for a kind of consideration different from considerations motivated by cultural or situational determinations. Similarly, where Ekbia et al. (2014) present an epistemic tension between appearance and phenomena brought on by big data, peak empiricism avoids such binaries by way of a radical consideration of the founding of empiricism as an epistemic technique. In offering a careful look at the theoretical implications that this changed state of affairs has for empiricism and design, an alternate reading of both data and design emerges. The balance of this article will be devoted to laying out the conceptual terrain that engenders such a conception of peak empiricism and the implications for such a shift. This starts with a discussion of representation and scientific theory as understood in relation to the specific mode of reflective design considered.

Realism and Theory in Design

Advocates of big data approaches (Anderson, 2008) tend to discount the importance of scientific theory in guiding empirical work in favor of data-intensive predictive modelling (Callebaut, 2012). Able to function without the need for ideologically based theoretical rumination, the data, as the saying goes, would be able to speak for themselves.

Well before the rise of big data, however, Hacking (1982) put forward a proposition that a belief in scientific realism can be supported by the fact that we are able to do things as the result of our scientific knowledge: We do not have just an epistemic theory about electrons; we are really able to enact a change in our environment with those things we call electrons. It is this effective ability that allows us (the human interlocutor) to talk about something as immediately invisible as electrons in a such way that we assume their realness.

Hacking's sense of realism proves to be extremely useful for discussing design and is, in part, very similar to the epoch-making definition of design given by Simon (1969). For Simon, design is understood as any course "of action aimed at changing existing situations into preferred ones" (p. 55). This definition matches Bacon's definition of experimentation that is used to motivate Hacking's realism: "when by art and the hand of man she is forced out of her natural state, and squeezed and moulded" (as quoted by Hacking, 1982, p. 75). Design, like Hacking's perspective on scientific truth, is focused on what really can be done.

For interaction design, the proof of a realistic atheoretical perspective would come in its ability to achieve workable results using data alone to guide the work of design. If we are able to design, build, and validate successful systems without the use of theory, then that is a demonstration that theory is unnecessary. However, as numerous (and better informed) discussants have pointed out (Callebaut, 2012; Shum, 2013), even in the presence of an overwhelming amount of data that appear to offer deep insight into a phenomena, there exists an entire theoretical scaffolding that supports any analysis. Even if one were to discount theory per se, there nevertheless exists some tacit theoretical presuppositions in any mode of research. Simply by asserting that the measurement of the duration of a task or that user sentiment plays a role in system effectiveness, a theoretical commitment to some epistemic and ontological position is still being made. Such a commitment comes at the level of an assertion of the independence of the subject and object, the validity of sense data over intuition, or even basic questions of realism and relativism.

Barad (2007) specifically critiques Hacking's attempts to avoid the kind of representational thinking associated with theoretical science as not going far enough:

> despite Hacking's best intentions to leave representationalist beliefs behind [as those that might constitute a theoretical position], his entire realism takes on board one of representationalism's fundamental metaphysical assumptions: the view that the world is composed of individual entities with separately determinate properties. (p. 55)

Focusing on how any realistic approach to the world is constituted by a combined understanding of ontology and epistemology, Barad (2007) claims that "different intra-actions produce different phenomena" (p. 58) and that "one can't simply bracket (or ignore) certain issues without taking responsibility and being accountable for the constitutive effects of these exclusions" (p. 58). In looking at one aspect of a design over another, or in establishing one "preferred" situation over another, a constitutive action is taking place.

In this, we can see how it might be impossible to disentangle the agentive intention behind the work of design from the empirical assessment of the conditions of use or the assessment criteria for the design itself. After all, the perspective from which the success or failure of a design is judged is developed alongside the design itself. One is completely dependent on the other, as has been demonstrated by the coevolution of problem and solution spaces in design (Dorst & Cross, 2001). Design is a generative activity that does not rely on previously decided types but instead introduces new types. This generative work requires a reflective approach and a reconsideration of the new territory opened up (Schön, 1992).

Such coevolution of problem and solution spaces provides design work a certain air of contingency, even when a specific design problem is under consideration (Cross, 1997; Dorst & Cross, 2001). This picture of contingency in design is heightened by the integration of the concerns of specific designs into a wider field of social action (Norman, 2010). In this, contingent social practices are determined by related practices and so on. When focusing specifically on empirically informed design, the reach of this situational contingency is expanded to include whatever particular determinations (social, ethical, or value-driven) have been imputed into the mechanism of data collection.

Whatever network of values is involved, the reflective work of interaction design is dependent on having an empirical understanding of the conditions of use. Design work relies on being able to understand and reflect on the effect that a designer's work may have on such conditions. In the necessity for a material involvement with the object of design (as material for design), it is not

enough for a designer simply to intuit either the form or the validity of any design. It is only through empirical support that she or he is able to found the work as design. This empiricism can come in the form of user research done in advance or in the form of post hoc analysis, in either formal or informal ways. For both, there is a concern for gaining an accurate and realistic understanding of users and their situation, with such empirical reckoning providing a basis for the condition and legitimization of design decisions. Based on this understanding of the work of design, we will now turn to a consideration of the impact of big data.

Big Data in Design

From the position of a reflexive view of empiricism and design developed in the previous section, we can start to consider the presumption that representations in empiricism might "serve a mediating function between independently existing entities" (Barad, 2007, p. 47). Just as Barad (2007) describes physicist Bohr's argument that scientific practices should be understood as interactions among component parts of nature and that our ability to understand the world hinges on our taking account of the fact that our knowledgemaking practices are social-material enactments that contribute to, and are a part of, the phenomena we describe (p. 26), so too should we understand the notion of big data as being copresent with the phenomena that the data describe. It is not just that in designing applications we have a tremendous amount of user data to work with, but, rather, it is that users and designers are both copresent with each other and with any data that are in play. In large part, such a consideration continues an argument developed by Day (2001) in his critique of the conduit metaphor for understanding information: Information is not seamlessly passed from subject to subject. The selective nature of its conveyance and the material and organizational work that goes into the construction of such a conveyance provides (and is provided by) an ideological scaffolding of power relations and values that coexist with any information that is passed along. Data, the object of design, and the work of design all exist together. It is their interaction that forms the totalized phenomena of design and use. The data of big data are as situational as the setting of use and the work of design.

In this entangled view of data, design, and use, the stable relations between subject and object as the necessary foundation of empirical evaluation become weakened, just as positivist conceptions of the situation of design are weakened in the study of the conditions of use in interactive systems (Suchman, 2006). This weakening of subjective relations in the work of design is particularly seen in the overlapping roles of data as both source of empirical insight

and material for design as described earlier. The effect of this weakening of the metaphysical distinction of the subject and object is exacerbated in the case of big data by the numerous dynamic relations that are formed in such a largescale collection of data.

As laid out in Derrida's (1981) concept of dissemination, meanings depend on other meanings, and, applying this reasoning to large sets of data, insights derived from the data can also be seen to "radiate backwards" (p. 355). Considered at a fundamental level, this kind of movement "is defined (thought) by the operation and is at the same time defining (thinking) as far as the rules and effects of the operation are concerned" (Derrida, 1981, p. 355). As will be detailed, this provides an active sense to the role that the data play in design. This characterization of data and the way that data are actively *thought with* in the process of design is reinforced by the continually renewing "velocity" of big data. As it becomes synonymous with understanding use, function, and design, empirical data— as in Derrida's dissemination— always point elsewhere.

The Texture and Scope of the Experience of Design

Highlighting the network of meanings that develops within and without big data in design, it is not only the epistemological character of data that comes under question but also the ontological role that data have. Looking to understand the "ontological dimension of scientific practice" (p. 42), Barad (2007) asks "[d]oes the full 'texture' of nature get through, or is it partially obliterated or distorted in the process?" (p. 42). To an extent, this question mirrors that set up by Ekbia et al. (2014) in their discussion of van Fraassen's (2008) *Appearance-from-reality* criterion in relation to the scientific image presented by big data. The distinction for us, however, is that the question is not one that starts with a competition between appearance and reality but starts instead with the proposition (developed in different ways by Barad, 2007, and Day, 2001) of a type of enacted (or phenomenological) unity of the epistemic and ontological work of science. Such questioning not only builds on the critique of a reductionist view described in the previous section, but also addresses the kind of world-making function that data come to have in support of the work of design. As copresent with the work of design, how is big data experienced?

Where other modes of empiricism used to inform the work of design extract particular nuggets of knowledge based on a selective criterion (as in the case of usability testing or the development of specific design requirements), big data has the possibility of opening up a different mode of empirical reflection. With the potential to offer a broadbased, dynamic, and multilevel view of a phenomenon (Callebaut, 2012), big data presents a particular texture to the understanding of use.

Instead of having the chance to understand use either in a constrained, targeted, and laboratory fashion or in a local and ethnographic manner, big data offers a different perspective. This is not one that is just a third way between quantitative and qualitative approaches, but one that presents a different configuration entirely. Exploring the online behavior of users in a social media platform, for example, is a different proposition with big data. A designer does not come to understand just one facet of use or just the use of a single user but sees the dynamic and varied conditions of use across the entire ecosystem of use. The variety and dynamic connections that are illustrated across a wide network provide a different texture to the experience of data. In that these networks of relation connect with and play an intimate role both in everyday life (as in the case of a social network for users or in providing the materials with which designers engage), such texture comes across not just as empirical representation but as a phenomenon itself.

This contrast between the experiential textures offered by big data and traditional empiricist methods is best understood through Gadamer's (2004) subtle German language distinction between two types of experience, *Erlebnis* and *Erfahrung* (Weinsheimer & Marshall, 2004). For Gadamer, *Erlebnis* refers to the kinds of pointed experience that we are able to isolate in some fashion. This is the kind of experience that people consciously have of a vacation, a movie, or any other memorable occurrence. *Erfahrung*, on the other hand, provides a more overarching sense of experience, as what we undergo as we experience the cultural traditions with which we grow up. In this way, *Erfahrung* provides the background against which other experiences are set.

This distinction highlights one of the effects of big data. Traditional modes of empiricism supported by small sets of data provide a pointed (and often theoretically directed) view of a phenomenon that can be understood in the manner of *Erlebnis*. That is, designers and researchers are able to have a particular experience of the data and what the data tell them about the phenomenon in question. With big data, however, the empirical story provided is not such that it necessarily gives particular and immediate insight. Instead, the size, heterogeneity, and dynamism of the data give an overarching sense of experience more along the lines of *Erfahrung* and play a constitutive role in the experience of a designer. That big data is able to provide depth and can be investigated along a dynamic range of levels give data this constitutive character.

By providing a robust account of either a small-scale phenomenon (at a great level of detail) or a large-scale phenomenon (with an expansive view), the kind of (mainly) quantitative approach that is

characterized in big data begins to turn away from its positivist roots and offer a different mode of experience. This follows a version of Kittler's differentiation of those technologies that create a mere representation of a phenomenon (writing, for example) versus those that provide an imprinted record of nature (audio recording, photography). There, the different modes of technology point to different ontological and epistemic (and for Kittler, political) implications (Krämer, 2006). Here, however, the representational, quantitative view of a phenomenon comes to take on the texture of qualitative data when considered at the scale and depth of big data. This shift from particulate and representational points of data to an engaged form of interpretive and phenomenological being with takes place in a manner initially explicated by Simon (1969) in his assertion "that we often find quite different inner environments accomplishing identical or similar goals in identical or similar outer environments." For Simon, this "[q]uasi independence [of the inner environment] from the outer environment may be maintained by various forms of passive insulation" (p. 8). In the case of the turn in big data, this insulation of the representative quantitative interior to the qualitative exterior is one that is achieved through the sheer scale and dimensionality of the data in question, a fact disrupts a straightforward use of Simon's consideration of an interior-exterior divide, rendering it more metaphorical than anything else. Big data occupies a unique space in the way that data, in most ways, function internally as positivist data, providing an explicit *Erlebnis*. At the same time, however, the external environment relates to the sheer size, dynamism, and variety of the data in an interpretive fashion, sustaining an overarching *Erfahrung*. The internal representation is, for purposes of external function, received as a phenomenal occurrence, one to be confronted as phenomenological object.

This kind of phenomenological picture of big data is readily seen in the kind of filtering, manipulation, and multilevel analysis that such a large set of data provides. The ability to examine a set of data in a multidimensional fashion according to a variety of perspectives that each leverages the dynamic presentation of a phenomenon in the data gives an experiential realism to insights drawn from big data. As Husserl (1982) put it in discussing "mere 'modes of appearance'," "*a core of 'what is actually presented'* is apprehended as being surrounded by a horizon of *'co-givenness'* " (p. 94). In the possibility for a dynamic engagement with "the horizon of *'co-givenness'* " that exist at the edge of the appearance of an object, big data offers the possibility for this phenomenological appearance within the confines of an empirically derived system.

This is demonstrated in the work of interaction design in the way in which data concerning individual users get compressed into the designer's understanding of the impact of the application as a whole.

The data are specific and explicit *(Erlebnis)* when considered on the basis on an individual user, but, taken together, the data provide the overarching situation of the application *(Erfahrung)*. In this, designers come to live with the application and to understand it in a manner that points beyond what is explicitly found in data. Such data are not something that can be understood in either a piecemeal or an isolated fashion; they are only able to be thought of as a part of the work of design itself. Instead of considering the empirical characteristics of big data in their work, designers begin to *think with* the data as the data come to play the role of the background against which designers interpret their work. Much in the manner described by Schön (1992), this background of data (as *Erfahrung*) provides both the field within which designers reflectively engage with the materials of design and (as applications take on more social and ubiquitous functions) the materials for design itself. For the designer, this field provides the conditions for the work. The next section builds on this in order to discuss designers' relation to the field and how they "think with" the data in their work.

Thinking Design with Big Data (and without Empiricism)

As big data begins to take on this dual character of both material for design and empirical representation of the outcome of the work of design, a moment of peak empiricism is approached. In this, the traditional empirical character of the (empirical) data begins, as used in the work of design, to fall away. Instead of functioning to mediate the relationship between subject (the designers) and object (the function of the application), the data take on an environmental character, providing scaffold for the situation, goals, and intent of the design. The humanist model of empiricism gives way to a posthumanist paradigm of a broader network of relations. Big data, in its own empirical nature, serves to undermine the metaphysical relation of subject and object on which empiricism relies. This changes the nature of the work of design, turning it from one in which designers empirically evaluate the situation of use through data to one in which *thinking with* the data becomes the central focus of design work[1].

Critiquing the traditionally understood relation between "knower and known" (p. 133), we can use Barad's (2007) performative approach to provide an initial entry to understand the situation of big data:

[1] 1Although this is given particular rendering in terms of the domain of design, a similar account could be given in the social sciences. The work of social science research would thus be cast also as a mode of "thinking with" the available set of big data generated from a particular area. These data would provide a measure of the historical horizon of a hermeneutic mode of scientific work (Bernstein, 1983). As noted in the Introduction, the concept of peak empiricism is perhaps suitable for any area of the human sciences beyond that of design, which is used here for its development.

[u]nlike representationalism, which positions us above or outside the world we allegedly merely reflect on, a performative account insists on understanding thinking, observing, and theorizing as practices of engagement with, and as part of, the world in which we have our being. (p. 133)

When applied to the question of knowledge in design, however, this understanding of performance goes beyond the epistemic questions of "thinking, observing, and theorizing." To design with big data is not just to understand, but to alter explicitly any situation that is understood. Developing a performative account of knowledge, Barad's account begins to make a link between Hacking's functional epistemic orientation and the world-making *Erfahrung* of the data. For this vision of design, the epistemic uses of empirical data are more than epistemic: they are active in the way that the data are *thought with*. Such "thinking with" is founded neither on epistemic rumination nor on an isolated sense of practice. Thinking with data engages both the paradigmatic mode of general theoretical background and the situated *Erfahrung* conditioned by big data, each of which support a kind of actively reflective and engaged design practice that includes both the designer and what is to be designed in a single system.

The Activity of Thinking

In engaging with big data in the work of design, what comes to supersede any kind of imminent practicality is an even more fundamental approach to conceptual development in design. Looking to understand the influence of peak empirical data in design, it is important to remember Bødker's (1998) definition of design as focused on "the creation of something new" (p. 108). Here, any data pertaining to the conditions of use serve to provide the space within which the possibilities of any system can be seen. The data do not so much compel any particular design decision as open the possibility for certain products of design to be developed.

Heidegger (1998) provides some insight into this relation between thinking and acting as he argues that "changing the world in the manner intended requires beforehand that thinking be changed" (p. 338). In this sense, "thinking" comes to play a constitutive role in the enactment of any real change, both in the possibility of creation through design and in recognition in use. This relation between thinking and the possibility of change resonates with Barad's (2007) consideration of the relationship between "knower and known" (p.133) and counters Hacking's (1983) reaffirmation of Marx's (1978) formulation of the importance of changing the world rather than thinking it. Here, Heidegger not only links thinking to a mode of epistemic practice but establishes it as the fundamental condition for action of any kind, epistemic or productive. For both designers and user the field of action laid

out by big data comes to be a shared space of possibility. The data provide an immediate and reflective basis against which the continuing activity of design (and use) functions. It is in the engagement of such a field of data that the work of design is understood to take place as "thinking."

Thinking as the General Condition of Design

Thought, as a mode of performance (intuitive and reflective), becomes the general condition of design under peak empiricism. Explicitly, this is not to reduce the thinking of design to a kind of interpretive and representational thought as found in interpretive research or the consideration of specific theory. Instead, we look to a more foundational understanding of what both thinking and design are, establishing thought as a constitutive act (as design is already generally understood to be).

In characterizing this kind of constitutive thinking-with, Heidegger's (1968) conception of the withdrawal of what is thought—of the escape of thinking from an immediacy of presence—begins to help us separate the forward-looking work of thinking as it is found in design from considerations of the explicitly present conditions as in the actual conditions represented in big data. As he formulates it in somewhat esoteric terms, the "event of withdrawal [of what is thought] could be what is most present in all our present, and so indefinitely exceed the actuality of everything actual" (p. 9). In this, design, as it *thinks with* the data, is not concerned with what is present but is instead engaged with a more fundamental concern for "the presence of what is present" (p. 244). That is, it is concerned with what constitutes what comes to be. Building upon Heidegger in this way, a performative act of design as thinking with the situation established by the data brings on an active account of those conditions that make design possible. For Heidegger, the withdrawal of thinking "is an event" (1968, p. 9) that comes as "the essential occurrence of beyng2 itself" (2012, p. 8). This echoes both Simon (1969) and Bødker (1998) in considering design as being concerned with a change that brings about something new: Design is not concerned with what is present; it is concerned with a basic mode of presenc*ing*.

Viewed through the lens of a Derridean ethics (Critchley, 2014), design is the event in which thinking answers a call for responsibility from the alterity given by the data. Such responsibility to those conditions that are yet to come forces the work of design away from the present. This thinking takes on the tenor of an original ethics of "human dwelling thought upon the horizon of the truth of Being" (p. 15). Design, when given over to the domain of large-scale empirical data, is to be understood as a "designing" rather than "design." The active and performative work of thinking

provides a basic account of design as something eventful, singular, and, as will continue to be developed, extrasubjective. The thinking of design takes place as an intuitive and emergent event constituted by the historical conditions set forward by the designer and the field of data together.

This formulation of the constitutive value of thinking is not without difficulties. In acknowledging Barad's critique of Hacking's assumption of individual entities, is there any support for understanding a singular and eventful occurrence—one that distinguishes itself from any other, as event? This critique pushes us to again remember Derrida's consideration of dissemination, which exhorts us to face the presentness of any event of thinking in a more radical way. This leads not toward a certainty of thinking (what it is and how it functions) but away from certainty. Such a fundamental consideration of the network of interpretive valences at work in the determination of basic concepts and an acknowledgement of their social and historical determinations points to a weakening of metaphysics (Vattimo & Zabala, 2011) beyond even the subject and object or empiricism. For the concrete work of design, this introduces a measure of doubt regarding the empirical appraisal of any solution. It highlights the question of the individual responsibility involved in the work of design and the role that the designer plays in bearing this responsibility. The question of the conditions of the agentive founding of design is considered in the next section.

The Weakening of Agency in Design

The kind of radical weakening that is heralded in thinking about peak empiricism points to a fundamental reconsideration of the relation between empirical data and the way data function in design. This is particularly the case when looking at the agentive role of the data. As the empirical data move from a traditional empirical role (as *Erlebnis*) to one that provides overarching support for a basic understanding of the situation of design (*Erfahrung)*, data's role in dictating the work of design is highlighted. In reworking the subject–object relation of empiricism in favour of a flattened ontology, big data forcefully presses the question of what it is to "think" as part of the work of design. Furthermore, big data calls into question how it remains possible to maintain a theoretical individuation of the subject and locus of individual action in the face of a weakened metaphysics. Under the conditions of peak empiricism, empirical data come to be explicitly understood as a necessary partner in the work of design, as material and situation. In this partnership, the *thinking* of design takes on the form of a nondiscrete matrix of activity constituting a field of mutual agency shared between designers and the data with which they work.

In moving past the dictates of a traditional scientific epistemology, in peak empiricism, what a designer (as agent) *does* is bound up with the way in which she or he *thinks* with the data. No longer are data simply a tool utilized for some effect (as Hacking might have it); data become a fundamental component of the kind of thinking that goes on in the work of design. This thinking is, as with both design and big data, linked to a fundamental view of progress and movement. Just as design is focused on what is new, so is big data, in its velocity, oriented toward action. Instead of relying only on an active sense of agency on the part of the designer, as data are *thought with* in the work of design, they come to take on an agentive and active role, revealing the posthuman orientation of big data design. In Barad's (2007) eyes, "[r]efusing the anthropocentrisms of humanism and antihumanism, *posthumanism* marks the practice of accounting for the boundary-making practices by which the 'human' and its others are differentially delineated and defined" (p. 136). As in the performative approach she takes to epistemology, both "knower and known" (p. 133) have responsibility for what is. The "doing" of design (the thinking) is characterized by its eventful happening that instantiates any participants and is not characterized by any a priori and precisely located doer.

This reframing of the conditions of design presents an important shift. Following Latour (2005), the work of design can no longer be characterized as either a social or a material technical practice. The introduction of big data to design continues the progressive character of design but without the arbitrary distinction between social need and technological possibility. Instead, design takes place, as event, within a broader field of material action. In this, the thinking with the data of design directs the instantiation of both the newness of design based on a shared matrix of social need and technological possibility. Diluting these boundaries, the use of big data in design forces a reconsideration of the relationship between effective design and the intention of design and the relationship between agency and structure.

In proposing "a posthumanist account of performativity that challenges the positioning of materiality as either a given or a mere effect of human agency," (p. 183), Barad (2007) reinforces a sense of agentive change. Radicalizing the concept of agency, she allows that "materiality is an active factor in processes of materialization" (p. 183). In this light, perhaps even the terms of any such discussion concerning big data and peak empiricism in design should be reconsidered. Instead of thinking of design as a mode of technoscientific practice (even as its objects are largely technological), perhaps we should, following Heidegger's (1977) consideration of the common origin

of the terms *techne* and *poiesis*, reinvigorate our understanding of the work of design as being properly poetical and approach the work of design as a mode of revealing that does not force its own point of view forward but nurtures and draws out what is there in the data, allowing it to reveal itself. In doing so, we would weaken the concept of agency in design and complicate the relation between designers, their work, and the user.

Conclusion

Contrary to what an increase in the availability of empirical data would initially seem to offer, big data does not carry along an unlimited increase in empirical certainty about the situation of use. Nor does big data offer designers consistently increasing empirical insight into how best to approach any design problems. Instead, with its outsized scale and dynamic dimensionality, big data exhausts the possibilities of empirical insight and brings about a debasing of the direct sensuous link between subject and object which is the foundational theoretical position of empiricism. In harnessing the insight that it offers, big data presses for a new understanding of design as an event of thinking with the data. More than anything, this moment of peak empiricism points to a future where designers trade some sense of agency for the power and reach that big data offers. This presents a kind of miniature Faustian bargain for the designer: gain the insight offered by the data but lose some measure of agency in the deal. Such a trade-off presses us to consider carefully the goals of the work of design and attend to the ways in which our intentions might be reshaped in the face of such vast data resources. This is not to warn off any serious considerations of big data in favor of a thoroughly humanistic view of the work of design, nor is it to capitulate to an overwhelming empiricism of data. Instead, it is to encourage a realistic and nuanced understanding of the new position faced by both empiricism and design and to knowingly, if not carefully, step toward their future.

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