

The Future as a Design Problem

Stuart Reeves, Murray Goulden,
Robert Dingwall

Introduction

All designers have to grapple with the unknowability of the future. Objects that are designed here and now will come into use at some future under conditions their creator can neither know nor control.¹ This problem is a special case of a common predicament for human social organization: Every action in the present is also a movement into a future that it helps shape but cannot determine. In many instances, such uncertainty is bounded both by the limited scale of the action and the constraints of formal rules and informal norms that structure social action. However, even the most mundane of acts can unravel if expected outcomes are not met. Garfinkel's ethnomethodological "breaching experiments" demonstrate how quickly social organization disintegrates if assumptions about the stability of the consequences of actions are challenged.²

In cases that designers address, there may be important opportunity costs if expectations are disappointed and the legitimacy of a design is questioned. Individuals, organizations, and nations may all have made significant commitments of material or symbolic resources that could have been applied to other objectives that might have been more productive. Human societies have traditionally developed institutions to try to manage this risk and stabilize (if not control) their future. These range from oracles through insurance to the contemporary fashion for economic modeling. Through such means, the future may be collectively grasped in order to act upon it. Only once the future is stabilized can the designer begin their work to exploit it. However, studies of design have only occasionally addressed this relationship with futures: for example, in urban planning design,³ or in formal anticipatory models of abstract design reasoning.⁴

This article explores the recruitment of the future into design practice and the ways this constrains and shapes what *could* or *should* be designed and its relations to retrospective evaluations of what *should have been* designed. Ubiquitous computing (or "ubicomp") is used as a case study. This is an influential and strongly future-oriented design program—a characteristic that is apparent in the technical and popular literature.⁵ As such ubicom provides

1 Victor Margolin, "Design, the Future and the Human Spirit," *Design Issues* 23, no. 3 (Summer 2007): 4–15.

2 Harold Garfinkel, *Studies in Ethnomethodology* (Cambridge: Polity Press, 1967).

3 Michael Batty, "Limits to Prediction in Science and Design Science," *Design Studies* 1, no. 3 (1980): 153–59.

4 Theodore Zamenopoulos, and Karerina Alexiou, "Towards an Anticipatory View of Design," *Design Studies* 28, no. 4 (2007): 411–36.

5 For example, Adam Greenfield, *Everyware: The Dawning Age of Ubiquitous Computing* (Berkeley, CA: Peachpit Press, 2006).

an exemplary site to investigate the effects of different strategies for stabilizing the future, while also speaking to a much broader category of socio-technical design practices. We distinguish two intertwined approaches: pragmatic projection, which tries to tie the future to the past, and grand vision, which ties the present to the future. We assess their implications and conclude by arguing that the social legitimacy of design futures should be increasingly integral to their construction.

Knowing the Future

Social scientists have long struggled with the paradox that most of their data are historical while purporting to describe the present and project the future. By the time social actions are available for study, they have already passed the moment in which they are enacted. Although a series of investigations have sought to find convincing ways of addressing this problem,⁶ it is typically considered too difficult. Nevertheless, the consideration of possible futures remains unavoidable. In traditional societies, the future is knowable only by gods and those who have access to their messages through oracles or divination. Modernity is accompanied by a cultural shift in understanding that places the future increasingly within the domain of human control, or at least human or machine calculation.⁷ The future at once becomes open and unstable, since it is not regulated by supernatural powers, and therefore is potentially within human capacity to manage and subject to organizational rationality (e.g., planning, modeling, and forecasting).

This potential proves to be illusory, however. Human beings cannot satisfy the conditions necessary to have perfect knowledge of the future.⁸ They depend instead on the socially shared stock of knowledge of what *has* happened in the expectation that what *is to come* will be consistent with this. This stock of knowledge is a knowledge of “typifications”⁹—generalized templates which in their totality form a sort of reference library against which experiences are categorized, and which in turn is modified by experience. What we seem to experience directly as the present moment is, in fact, emergent from the interactions between our immediate sensations and the typifications that make up our stock of knowledge.

Crucially, this reference library also includes a set of typical futures, drawn from personal and received past experience. These expectations are socially shared and capable of gaining acceptance as a legitimate and reliable basis for joint action. By their very nature as typifications, however, these expectations are devoid of the detail that makes any event unique. They are, as Schütz memorably puts it, “empty references to the open horizons.”¹⁰ Only by the concrete conditions of current events are these

6 Barbara Adam, “History of the Future: Paradoxes and Challenges, Rethinking History,” *Journal of Theory and Practice* 14, no. 3 (2010): 361–78.

7 Ibid.; also see Peter L. Bernstein, *Against the Gods: The Remarkable Story of Risk* (New York: John Wiley and Sons, 1996).

8 Alfred Schütz, “Tiresias, or Our Knowledge of Future Events,” *Social Research: An International Quarterly* 26, no. 1 (1959): 71–89.

9 Schütz prefers “typification” to “type” to emphasize the dynamic and enacted character of this stock of knowledge. We may freeze it for analytic convenience, but what we know to be typical is always in a process of emerging from our past experiences, informed from our current engagements with the world, and directed toward our projects for the future; see Kwang-ki Kim and Tim Berard, “Typification in Society and Social Science: The Continuing Relevance of Schütz’s Social Phenomenology,” *Human Studies* 32, no. 3 (2009): 263–89.

10 Schütz, “Tiresias, or Our Knowledge of Future Events.”

references filled in. The consequences of this for design are stark: “whatever has been expected to occur will never occur as it has been expected.”¹¹

Two Strategies for Acting on the Future

In broad terms, we throw into relief two features of possible institutional responses. The first is an investment in research, information, and mensuration that aims to establish ever more detailed knowledge of what has happened with a view to developing a more refined ability to predict what will happen. This strategy was recognized by economist Frank Knight in his early work on uncertainty and the future and has inspired several generations of subsequent intellectual effort.¹² If our predictions fail, it is because computers are insufficiently powerful, data sets are too small, and algorithms are not sophisticated enough. Technical development, undergirded by the increasing power and decreasing costs of computation, will eventually and inevitably fix the problem. We call this form of thinking “pragmatic projection,” in that it attempts to lock down the future by employing detailed knowledge of the past. Pragmatic projection tends to determine what *could* be designed. Alternatively, we can try to bring the future into the present by acting in ways that we expect to be seen as correct from the vantage point of the future we are trying to create. This has been much studied by the sociology of expectations.¹³ By announcing one or more grand visions of the future, we seek to direct present actions in such a way as to make it come to pass as something of a self-fulfilling prophecy, or to paraphrase Alan Kay,¹⁴ to predict the future by inventing it. This institutional response is generally used to determine what should be designed.¹⁵

Recruiting the Future for Design: Ubiquitous Computing as Case Study

Ubiquitous computing (ubicom¹⁶) is a multidisciplinary field concerned with designing, building, and studying computing technologies that have become or will increasingly become embedded into everyday artifacts, ourselves, our homes, and where we work. Ubicomp design work involves innovating technologies and designing novel forms of interaction with these technologies as they seep into our everyday activities. This idea powerfully evokes the notion of an “always on,” “always with you” form of computing that has very much departed from familiar desktop paradigms.

Ubicomp’s wider program encompasses a range of *canonical* socio-technical endeavors that have themselves spawned significant bodies of research. We note some of these: embedded sensors and devices (e.g., computational devices within the fabric of smart homes); context-aware computing, including a substantial focus on

11 Ibid., 287.

12 Frank Knight, *Risk, Uncertainty and Profit* (Boston: Houghton Mifflin, 1921).

13 Nik Brown, Brian Rappert, and Andrew Webster, eds., *Contested Futures: A Sociology of Prospective Techno-science* (Aldershot: Ashgate, 2000). Also see Nik Brown and Mike Michael, “A Sociology of Expectations: Retrospecting Prospects and Prospecting Retrospects,” *Technology Analysis & Strategic Management* 15, no. 1 (2003): 3–18.

14 Deborah Wise, “Experts Speculate on Future Electronic Learning Environment,” *InfoWorld* 4, no. 16 (April 26, 1982): 6.

15 We note that while there are exceptions (e.g., Adrian Forty, “Of Cars, Clothes and Carpets: Design Metaphors in Architectural Thought,” *Journal of Design History* 2, no. 1 [1989]; and Jeffrey L. Meikle, “Material Virtues: On the Ideal and the Real in Design History,” *Journal of Design History* 11, no. 3 [1998]: 191–99), the prevailing narrative of design histories tends to be written in a Whiggish fashion that makes the designer’s success seem inevitable. For designers, the future is not a simple matter of “progress.”

16 The terminology itself is often used interchangeably with “pervasive computing” (originating from IBM).

location-tracking systems (e.g., detecting and interpreting a user's "context" through sensor data, inference, sensor fusion); mobility and mobile computing (e.g., wearable and portable devices, mobile phones); and networking (e.g., wireless networking and ad hoc networking design). Increasingly these areas are evolving with newer interests such as "Internet of Things" (IoT) and "big data."

As a design practice, ubicomp can be characterized as a triad of interlocking elements: the technical, the evaluatory, and the theoretic. First, ubicomp design can be expressed through the technical innovation of novel computational systems via exploratory engineering and construction—for example, new software applications and infrastructures, wearable devices, and mobile hardware platforms. In this case design practice is technology-driven, often supported by projected changes in technical capabilities such as miniaturization, increases in computational power, and proliferation of diverse forms of network connectivity. Classic examples of this would be Active Badges, the Tinmith wearable, or the PlaceLab location system.¹⁷ Second, ubicomp design practices encompass the evaluatory, that is, empirical examinations of environments that may benefit from ubicomp technology support or studies of ubicomp systems in use¹⁸—whether through experimental lab-based testing or deployments "in the wild."¹⁹ Third and finally, ubicomp design practice may involve the development of theoretic forms such as design concepts of "seamfulness."²⁰ These may extend to more elaborate conceptual objects such as design frameworks comprising sets of interrelated concepts (e.g., for ubicomp these are often revisions of the grand vision).²¹

Grand vision and pragmatic projection pervade these three aspects of ubicomp design practice. To unpack this, we must first turn to discuss ubicomp's origins. Ubicomp emerged as a novel technological paradigm for a range of researchers during the late 1980s and early 1990s as they sought to rethink and redesign what was then the dominant paradigm (desktop computing) while reacting to an emerging alternative vision (virtual reality). The ubicomp vision surfaced from a program of research being conducted at Xerox PARC's Computer Sciences Lab. The early culmination of this work articulated a vision in terms of key required devices (e.g., tab, pad, and board-size computers) and required infrastructures (e.g., wireless networking) that were coupled with futuristic scenarios (e.g., imagining a world in which these devices, infrastructures, and so on actually existed).²² Compelling fictional scenarios depicted "what it would be like to live in a world full of invisible widgets," indicating that it was not enough to characterize ubicomp *only* in purely technical terms describing required devices, infrastructures, and associated technologies.²³ The inspiration for this socio-technical approach drew strongly on Weiser and others' interdisciplinary interests and a desire to cohere various strands of

- 17 Roy Want et al., "The Active Badge Location System," *ACM Transactions on Information Systems* 10, no. 1 (January 1992): 91–102; Wayne Piekarski and Bruce H. Thomas, "Tinmith-Metro: New Outdoor Techniques for Creating City Models with an Augmented Reality Wearable Computer," in *Proceedings of 5th International Symposium on Wearable Computers* (2001); Anthony LaMarca et al., "PlaceLab: Device Positioning Using Radio Beacons in the Wild," in *Proceedings of Pervasive 2005* (2005), 116–33.
- 18 For example, Peter Tolmie et al., "Unremarkable Computing," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '02)*, ACM, New York, (2002), 399–406.
- 19 For example, Louise Barkhuus and Anind K. Dey, "Location-Based Services for Mobile Telephony: A Study of Users' Privacy Concerns," in *Proceedings of Interact 2003* (2003), 207–12; Yvonne Rogers et al., "Ubi-learning Integrates Indoor and Outdoor Experiences," *Communications of the ACM* 48, no. 1 (January 2005): 55–59.
- 20 Matthew Chalmers and Areti Galani, "Seamful Interweaving: Heterogeneity in the Theory and Design of Interactive Systems," in *Proceedings of the 5th Conference on Designing Interactive Systems (DIS '04)*, ACM, New York (2004), 243–52.
- 21 Yvonne Rogers, "Moving on from Weiser's Vision of Calm Computing: Engaging Ubicomp Experiences," in *Proc. Ubicomp* (New York: Springer, 2006), 404–21.
- 22 Mark Weiser, "The Computer for the Twenty-first Century," *Scientific American* (1991), 94–104.
- 23 Stuart Reeves, "Building the Future with Envisioning," *Interactions* 20, no. 1 (2013): 26–29.

related research into a programmatic statement.²⁴ Of the scenarios, Weiser writes: “In addition to showing some of the ways that computers can enter invisibly into people’s lives, [the] scenario points up some of the social issues that embodied virtuality will engender.”²⁵ Although ubicomp as a field has since developed and been continually reinterpreted (e.g., the IoT), it remains strongly oriented by this early statement from Weiser and Xerox PARC (now PARC), a testament to its significance being the very large number of citations for Weiser’s 1991 *Scientific American* article in which the articulation of the vision appears.

PARC’s expression of their ubicomp program as well as its subsequent interpretation, adoption, and growth into an entire field have tended to be articulated in terms of a grand vision constrained by pragmatic projection. By this we mean that the ubicomp program depicts imaginary future socio-technical worlds to be physically realized through orienting present design work with novel (but current-day) technology. At the same time, the program’s expression is embedded within a background of pragmatic projections that rely on the certainty of familiar and apparently stable technological trends like Moore’s Law.

In what ways does this mixture of pragmatic projection and grand vision strategies both support and pose problems for design practice? Drawing on ubicomp as a case study, the following sections present two aspects of the recruitment of the future to design:

- Grand visions reveal a problematic character in the attempt to transform them into action plans;
- Pragmatic projection can constrain future pathways for design.

While presenting this division, we note that pragmatic projection and grand visions necessarily go hand in hand: They are not mutually exclusive ways of working. For instance, grand visions may be translated into pragmatic projection to be organizationally compatible as an immediate or near-term plan of action. This is an issue we will return to later.

Transforming Grand Vision into Action

We have argued that grand visions provide ways to direct actions to bring about the future world depicted by the vision. The ubicomp grand vision has tended to highlight the importance of designing technology for the everyday, since it is always on and always with you. Being concerned with technologies that have the potential to seep into all imaginable aspects of everyday life, the lived experiences of a future ubicomp world become significant directives for technology design. This is apparent in the earliest ubicomp scenarios from Weiser, particularly the Sal scenario,²⁶

24 Mark Weiser, Richard Gold, and John S. Brown, “The Origins of Ubiquitous Computing Research at PARC in the Late 1980s,” *IBM Systems Journal* 38, no. 4 (1999): 693–96.

25 Weiser, “The Computer for the Twenty-first Century.”

26 Ibid.

which describes the everyday routines of a woman named Sal living a recognizably “typical” California lifestyle of the time: She wakes up alone, gets children ready for school, eats breakfast and reads the news, fixes her garage door, drives to work, chats with colleagues as she makes her way to her desk, and collaborates on an assignment with a coworker. The ubiquity of American television and film mean that such lifestyles are familiar even to those inhabiting very different lifeworlds. The familiarity of the scenario is perhaps one way to account for the success of the vision. But while it connects easily with many readers, in being familiar it must at the same time necessarily limit possibility. In Weiser’s scenario these familiar routines are modified and augmented with imagined ubicomp technologies that subtly integrate with the social world of the scenario, such as self-locating garage door manuals; seamless data transfer from Sal’s computational tabs to a virtual office coworker’s device; and windows that also act as ambient displays showing contextual data about their viewpoint (e.g., weather, data trails). Yet at the same time the ambitions of these augmentations are bound to the familiarity of the scene.

As we saw with our prior discussion of Schütz,²⁷ future typifications are filled in and made concrete *only* when this projected future becomes the present moment. In line with this, we argue that a key character of grand visions is that they cannot be unproblematically and straightforwardly transformed into concrete design actions. This is a problem of translation. Ubicomp largely emerged within particular communities (computer scientists and related technologists) for whom technical building work is typically a primary mode. For such a community, the natural response to the ubicomp vision was thus a deeply—and perhaps desperately²⁸—practical one, that is, “how can we design and engineer this vision?” As a result, when taken as a strategic plan that can be used to direct present practical actions, the plan, like all plans, is inevitably found to be incomplete.²⁹ Ubicomp’s future scenarios as plans to action thus appear both mis- or over-predictive (typically optimistically) and gloss the nature of technological capacities. Interpretations of Weiser’s scenario and its academic progeny, through realization in practical action, have found that the nature of future visions brush over huge design and technical challenges that have remained largely unexplicated, and subsequently can transform into intractable problems.

We take as a signature instance that of context awareness within ubicomp research and the associated “context gap” that has since been a source of difficulty for design in its technical, evaluator, and theoretic expressions.³⁰ Weiser’s character Sal interacts with a range of systems that are keenly (and seamlessly) context-aware. For instance, Sal’s remote coworker Joe shares a document with her, which she subsequently transfers onto her live board via

27 Schütz, “Tiresias, or Our Knowledge of Future Events.”

28 Julian Bleecker, *Design Fiction: A Short Essay on Design, Science, Fact and Fiction* (San Francisco, CA: Near Future Laboratory, 2009).

29 Lucy Suchman, *Plans and Situated Actions: The Problem of Human-machine Communication* (Cambridge: Cambridge University Press, 1987).

30 Louise Barkhuus, *The Context Gap: An Essential Challenge to Context-Aware Computing*, thesis, IT University of Copenhagen, 2004.

gestures with a computational tab. But how does Sal's tab "know" this is the right behavior? The practical design transformation of this idea has been to develop ever more sophisticated theoretical definitions of context and technical implementations of context-aware systems to support imagined situations like this.³¹ Thus, although in retrospect it may be clear Weiser is providing a vision of the kind of relationship to everyday life computing could have, this grand vision has been mapped to practical engineering challenges to design and build successful context-aware systems that record, model, and represent contextual information with ever-increasing sophistication. In spite of decades of work, a representational view of context awareness has been seen as largely failing to bear fruit within ubicomp, due to the mismatch between "a sensor-derived technical representation of a context, and the social perception of a context" that is an inherent technological limitation.³² Researchers have advocated radically different understandings based on practices³³; however, the representational view continues to hold sway.

A second, related aspect of the problem of grand vision directing design actions is praxeological. Drawing on Schütz again, it is impossible to know concretely what future everyday "mundane" actions will entail practically. These are everyday problems that we continually encounter and resolve as a matter of routine. Garfinkel empirically characterizes this as "normal natural troubles" which are unavoidably meshed with any engagement in practical action in the world.³⁴ The unspoken order and organization of this was exposed by Garfinkel's breaching experiments. The significance of normal natural troubles for design has been documented within a long tradition of ethnomethodologically informed ethnographies of social praxis.³⁵ In consonance with this view, Redström speaks in terms of a form of mundane "complexity" facing designers, which "to a significant extent comes as a result of people making their own interpretations when incorporating objects in their lifeworlds and their everyday practices."³⁶ Normal natural troubles are necessarily excluded from grand visions, just as they are from all design work, because they only emerge in the lived moment from the interplay between the experience and the experiencer's typifications. This has contributed to the problems encountered in transforming grand vision to directed actions.

Running through both problems of translation and praxeology is the unevenness of the vision's grandeur. To have organizational value—that is, to recruit others—a vision must accord with their future typifications as much as it challenges them. A grand vision presents a new territory: to not lose travelers requires that some elements are held static as recognizable landmarks. Accordingly, ubicomp's *vision* is restricted to technological developments.

31 For example, Anind K. Dey, "Understanding and Using Context," *Personal and Ubiquitous Computing* 5, no. 1 (February 2001): 4–7.

32 Barkhuus, *The Context Gap*.

33 Paul Dourish, "What We Talk About When We Talk About Context," *Personal and Ubiquitous Computing* 8, no. 1 (2004): 9–30.

34 Garfinkel, *Studies in Ethnomethodology*.

35 For example, see Andy Crabtree, Mark Rouncefield, and Peter Tolmie, *Doing Design Ethnography* (New York: Springer, 2012).

36 Johan Redström, "Towards User Design? On the Shift from Object to User as the Subject of Design," *Design Studies* 27, no. 2 (2006): 123–39.

The pattern of life imagined by the technologists driving ubicomp is largely the social world that is familiar to them—California in the late 1980s. The Sal scenario assumes the lived experiences of suburban West Coast life will not change while computer technology will. It does not, for example, encompass the notion that technological innovation will liberate people from the nine to five working day (as was largely projected in mid-twentieth-century future visions).³⁷ For a modern audience, the failure of such a predicted transformation to materialize may strip similar scenarios of legitimacy. In lending the scenario familiarity, the conservatism of nontechnical elements lends plausibility to the grand vision. Recruiting the actors—individuals or organizations—who might realize the vision comes at the expense of the integration of technology and the social world it inhabits.

A third and final matter we address is how the organization of these present, practical actions is important. In the translation between grand vision and practical action, the vision is deployed so as to configure a particular organization of categories, subdivisions, and specialisms that are implied by the vision. For instance, various areas of ubicomp's work have been canonically established as definitive subfields of research, subfields that have been categorically fixed by directly attempting to realize the grand vision. These areas are shaped strongly by the inspiration of PARC's original work on ubicomp and Weiser's foundational scenarios. By way of example, we return again to context awareness as a key feature of ubicomp design thinking. Weiser's Sal scenario has been employed quite explicitly by technology designers to subdivide the future design space into specific areas of endeavor (outlined earlier). Once these canonical areas have been identified, they generally remain self-sustaining, reproducing their own justifications and further requirements while the original rationale for the inspiration is lost. For instance, for the Sal scenario to be made a reality, the development of context-aware computing is required to service the sorts of technologies Sal interacts with: "As she walks into the building, the machines in her office prepare to log her in but do not complete the sequence until she actually enters her office."³⁸ Of course, this presumes the existence of an office rather than an open-plan hot desk, but the categories of possibility have already been fixed. This becomes a problem in that design's focus can come to be disconnected from the situations that are sought to be addressed. For ubicomp, context-aware computing as a pursuit in and of itself has come to displace the vision's original core concern for designing technologies that addressed everyday life (which, incidentally, could—not should—be supported by sensing systems that attempted to infer "context"). Thus the organization of practical actions directed by the problems inferred from the vision results in their realization as canonical subfields that tend to supplant or obscure the vision.

37 For example, Herman Kahn and Anthony J. Wiener, *The Year 2000: A Framework for Speculation on the Next Thirty-three Years* (New York: Macmillan, 1967).

38 Weiser, "The Computer for the Twenty-first Century."

Of course, none of this is to say that a single grand vision may exist to the exclusion of others: There can be many of them at play in any given organization, just as in society at large. Thus around the time of the ubicomp vision PARC also sustained a parallel notion of the paperless office.³⁹ This was inherited from prior articulations of the office of the future.

Pragmatic Projection in Ubicomp Design

Transforming grand visions into actions necessarily implies an ordering to those actions, that is, a planned pathway. Here is where pragmatic projection comes into play, 'drawing a line' from past to future.

Pragmatic projection relies on the construction of a singular, predictable pathway into the future that is predicated on historical developments and perceived trends. By anchoring a practical program of development within a demonstrable heritage, pragmatic projection provides a powerful means of organizational mobilization. Within ubicomp, this heritage has been found in Moore's Law, which plots a historical trend of exponential growth in transistor counts and chip performance. By evoking a law-like property, the perceived implications of Moore's law are used as a way to recruit the future to ubicomp design via a preordained pathway toward enabling technologies that are sufficiently powerful, small, and cheap so as to make the realization of Weiser's grand vision almost inevitable. Given past trends, the future pathway means increases in storage space (e.g., hard disk size, solid-state device size, and volatile RAM) and processor speeds and miniaturization as a matter of future fact. Cheaper, more powerful integrated chips and storage systems will then suggest the possibility of embedding computing power in unlikely places, potentially everywhere,⁴⁰ similar in many ways to the rhetoric around the recent IoT. It is largely assumed this linear pathway reveals self-evident possibilities that will appear attractive to various stakeholders in future public and private sectors.

Returning to our example of context-awareness from the perspective of pragmatic projection, the projected capabilities of future technologies have been employed to support the design and implementation of ever more sophisticated representational models of context. Pragmatic projection encourages this perspective. This is because the representational view appears susceptible and, indeed, tractable to the future emergence of ever faster, smaller, and more sophisticated sensor and computational technologies underpinned by extrapolating Moore's Law.

Yet treating Moore's Law as a natural law instead of a social, organizational, and business achievement is problematic. For instance, software (via 'bloat') tends to absorb forecast hardware advances, once again for various social, organizational and commercial reasons. More broadly, employing projections that rely on

39 Abigail J. Sellen and Richard Harper, *The Myth of the Paperless Office* (Cambridge, MA: MIT Press, 2002).

40 Greenfield, *Everyware*.

only one element (such as hardware in Moore's Law) can result in a fixation that blinds designers to the full range of possibilities. The pragmatic projection approach, based on the trajectory of the past, straightforwardly rolls ubicomp technologies forward into the future in a singular manner without necessarily considering a range of pressing questions regarding the incremental dynamism of social worlds, let alone acknowledging the possibility of radical "black swan" events. Bleecker calls these "up and to the right" futures,⁴¹ which, tied to their linear pathway, systematically exclude a range of design possibilities. The focus from which pragmatic projection draws its capacity to operationalize resources undermines its ultimate goal. As events proceed and extrapolations from the past fail to reflect the new present, the project appears increasingly archaic, and its organizational strength diminishes accordingly. The result is future visions that quickly unravel.

Although we have conceptually distinguished grand vision and pragmatic projection, the foregoing account demonstrates how they are inseparable in practice. Drawing on the pragmatic projection of Moore's Law, ubicomp has been transformed into fixed sets of linear sub-pathways along which the grand vision is pursued. The net result of these tensions is that dissonance is observed between the intended pathways of grand visions and pragmatic projections, and the present reality, with this incongruence often being recognized as an unattainable future. For instance, Bell and Dourish argue that Weiser's future is effectively "yesterday's vision of the future";⁴² as they state, "ubiquitous computing is already here; it simply has not taken the form that we originally envisaged." To demonstrate this, Bell and Dourish use case studies of Singapore and Korea, depicting them as instances where the immanence of the ubicomp program has been overlooked. This argument still tends to frame the ubicomp research program in terms of a success/failure comparison to the present—albeit one achieved earlier than realized. While this argument is interesting, it is parallel to our discussion. Instead, we sought to examine strategies deployed to recruit the future to ubicomp's design practices as we find them (technical, evaluatory and theoretic).

Lessons from Ubicomp Design Practice: Resolving the Future as Matter of Social Legitimation

Grand visions and pragmatic projections remain important forms with which notions of "the future" are recruited into the technology design process. We have used ubiquitous computing as an exemplary case to illustrate this, highlighting how these two methods have combined to mobilize a vast collective effort to realize Weiser's vision. The constraints that make these methods organizationally useful also impose limitations on their effectiveness. As

41 Bleecker, *Design Fiction*.

42 Genevieve Bell and Paul Dourish, "Yesterday's Tomorrows: Notes on Ubiquitous Computing's Dominant Vision," *Personal and Ubiquitous Computing* 11, no. 2 (2007): 133–43.

we argued, grand visions—which direct present design actions—tend to assume a fixed societal context into which technical futures are imagined. Pragmatic projections—which causally link past technological trends to future designs—tend to assume a single linear, usually technical pathway into the future. In concluding, we examine how these strategies may be supplemented with new considerations around social legitimation.

As they are combined currently, the grand visions/pragmatic projections approach remains very brittle for design practice, evidenced in two ways by the programmatic implementation of the ubicomp vision. First, it has fixated on Weiser's past vision of the future while ignoring the technological realities of the present day (as argued by Bell and Dourish),⁴³ and second, it has established inflexible sets of canonical subfields that themselves fixate on intractable tasks such as context awareness. This brittleness closes down a range of alternative possibilities: either through offering little consideration for changes in societal organization (e.g., the lifestyle depicted in the Sal scenario) or in not questioning whether technological pathways that appear inevitable are or should be so (e.g., ubicomp's canonical set of subfields). This design approach can thus be highly vulnerable to uncertainty.

A key aspect of the fragility and brittleness of design futures is that of a lack of wider social legitimation. Grand visions and pragmatic projections may already serve a purpose in providing an accountability to work within an organization itself, such as between disparate strands of technical development in the case of ubicomp's origins.⁴⁴ Beyond this, however, design futures must be seen as legitimate by communities wider than those seeking to practically enact research programs like ubicomp. Through this process of wider public (community) legitimation, those enacting technology programs gain a "social license to operate."⁴⁵ Gaining this means that design futures can be prospectively and retrospectively accounted for as a shared interest across contrasting and maybe conflicting communities of practice rather than narrowly representing the interests of only one small group of stakeholders (such as investors and technologists working in Silicon Valley).

We would suggest that such social legitimation is a precondition for the development of better futures. In closing we briefly offer pointers toward emerging ways in which grand vision and pragmatic projection may be enhanced and lead to greater legitimation, specifically through the use of participatory approaches and the use of fiction. First, participatory approaches are well known to technology design and have also seeped into ubicomp,⁴⁶ yet participatory approaches to constructing future socio-technical visions themselves are scarce; where this has been touched on, experts are assumed greater accuracy of prediction (e.g., see the Delphi application of Mankoff, Rode, and Faste).⁴⁷

43 Ibid.

44 Reeves, "Building the Future with Envisioning."

45 Neil Gunningham, Robert A. Kagan, and Dorothy Thornton, "Social License and Environmental Protection: Why Businesses Go Beyond Compliance," *Law and Social Inquiry* 29, no. 2 (2004): 307–41.

46 For example, Eva Hornecker et al., "UbiComp in Opportunity Spaces: Challenges for Participatory Design," in *Proceedings of the Ninth Conference on Participatory Design (PDC '06)*, (ACM Press, 2006), vol. 1, 47–56.

47 Jennifer Mankoff, Jennifer A. Rode, and Haakon Faste, "Looking Past Yesterday's Tomorrow: Using Futures Studies Methods to Extend the Research Horizon," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*, (ACM Press, 2013), 1629–38.

Although nonexperts are no wiser about future states,⁴⁸ increased participation can bring with it organizational accountability and generate greater social legitimacy than expertise-based predictive activity. Second, we point to approaches that purposefully incorporate fiction as part of a design practice, particularly to create futures that do not follow the familiar shapes of corporate planning/foresight exercises. The use of fiction in design has been discussed at length by Bleecker and Sterling,⁴⁹ and it is reflected in the “speculative design” of Dunne and Raby.⁵⁰ In effect, fiction is a device that extends both the range of typifications of the future available to members of a particular society, “to problematize, reframe or interrogate otherwise taken for granted expectations,”⁵¹ and the range of contributors to discussions about these futures. Finally, in combination, participatory approaches that leverage design fictions could lead to decision making about diverse visions and projections that in retrospect can be seen to have been considered as legitimately engaged with public participation at the time, instead of being the production of relatively limited groups of stakeholders. Practically, this means that designers need to consider the design of the social circumstances of legitimacy into which their products will be deployed as much as they need to consider the design of the artifact as a product itself.

Data Access Statement: All data accompanying this publication are directly available within the publication.

Stuart Reeves is an EPSRC senior research fellow at the Mixed Reality Lab, in the School of Computer Science, University of Nottingham, UK.

Murray Goulden is a research fellow at University of Nottingham.

Robert Dingwall is a consulting sociologist and part-time professor of Sociology at Nottingham Trent University.

Acknowledgments

This work was funded by EPSRC (grants EP/K025848/1 and EP/G060762/1) and by RCUK through the Horizon Digital Economy Research grant (EP/G065802/1 and EP/M02315X/1). It also draws on work carried out under EPSRC grant EP/G060495/1.

48 Redström, “Towards User Design?”

49 Bleecker, *Design Fiction*; Bruce Sterling, “Design Fiction,” *Interactions* 16, no. 3 (2009): 20–24.

50 Anthony Dunne and Fiona Raby, *Speculative Everything: Design, Fiction, and Social Dreaming* (Cambridge, MA: MIT Press, 2013).

51 Cynthia Selin, “On Not Forgetting Futures,” *Journal of Responsible Innovation* 1, no. 1 (2014): 103–08.