Ubicomp's Colonial Impulse

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ABSTRACT
Ubiquitous computing has a grand vision. Even the name of the area identifies its universalizing scope. In this, it follows in a long tradition of projects that attempt to create new models and paradigms that unite disparate, distributed elements into a large conceptual whole. We link concerns in ubiquitous computing into a colonial intellectual tradition and identify the problems that arise in consequence, explore the locatedness of innovation, and discuss strategies for decolonizing ubicomp's research methodology.

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Economics, Human Factors, Standardization, Theory.

INTRODUCTION

We don't think about colonialism much in ubiquitous computing. Ubicomp seems mostly about the future, after all, occasionally about the present, and colonialism seems, if anything, to be about the past. If we do think about it though, we might think about it as tangentially related to some sub-fields that overlap with our own – work on ICT for Development, perhaps, or in cross-cultural computing.

We want to argue here that colonialism is a much more pervasive aspect of ubiquitous computing than we normally give it credit for. In fact, it is entwined with all sorts of aspects of how we think, how we talk, and how we work in ubiquitous computing.

In order to do that, we first have to think about the sort of enterprise that colonialism was (and is). When we think of colonialism, perhaps what we think of most immediately is the era of exploration, expansion, and expropriation, associated particularly with the major European powers during the 18th and 19th centuries. To an extent, then, this construes colonialism as a territorial enterprise; one of us grew up in British classrooms that typically still displayed maps of the world marked by the expansion of a particular pink that indicated the reach of the British Empire. Further consideration of the dependency of industrial capitalism at the time on the colonies both as sources of material and as sites of consumption, might suggest that we think of colonialism as an economic enterprise. Many have seen in this the seeds of contemporary globalization.

Our particular interest here is in a third conception of colonialism: as a knowledge enterprise. Some of colonialism's major institutions, and amongst its lasting legacies, are institutions of knowledge – museums, archives, and libraries.

Consider, for example, the Royal Botanical Gardens at Kew, in southwest London (typically known simply as "Kew Gardens.") Founded as a royal garden in the early 18th century, the gardens occupied an increasingly significant role in the Victorian colonial period as a center of scientific research. Kew acted as a clearinghouse for plants, seeds, cultivation techniques, and botanical knowledge. It supplied seeds, botanical samples, expertise and experts to colonial projects, and it amassed an extensive collection of plants gathered from around the world, on which were based both massive taxonomic projects intended to map and document the plant kingdom, and significant research into the conditions under which different plants could thrive, on which basis agricultural production throughout the empire could be optimized. Kew Gardens was the central hub in a network of botanical gardens that spanned the globe and undertook a large-scale collective project to manage botanical knowledge and agricultural production on a scale hitherto unknown.

To take just one example of the commercial and historical importance of this effort, consider the case of rubber, as documented by Brockway [5]. The rubber tree is native to Latin America, and in the latter part of the 19th century, rubber was a hugely important export for Brazil. The natural monopoly that Latin American countries held on rubber depended on their access to the trees and the ability to cultivate and sustain them effectively. However, in 1876,

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Kew Gardens sponsored a successful effort to smuggle the seeds of the Havea tree from Brazil and began an intensive effort to cultivate them, both at Kew itself and then in Ceylon (Sri Lanka), Singapore, and Malaya, where the effort was spearheaded by a Kew-trained botanist named Henry Ridley. Over several decades of intensive work, Ridley and other Kew scientists not only investigated the conditions under which rubber trees could be effectively grown but discovered new methods of tapping latex and new methods of processing it. Ridley spread both seedlings and the new production methods to plantation owners in Malaya, and it quickly became a major cultivar and a huge export commodity. The impact of this effort was tremendous. At the start of the twentieth century, Latin America produced 98% of the world's rubber; by 1919, 99% came from Southeast Asia.

There are three things to point out about Kew in this story. The first is that, in the context of colonialism, Kew could take as its focus of attention the entire globe. Only Kew, in its imperial context, could manage the movement of major cultivars from one part of the world to another, testing here, adjusting there, orchestrating the global enterprise. The second is that Kew did this through a universalizing scientific gaze that sought to collect, organize, and arrange information (in this case, botanical information) through the manifestation of a single site of coordination (what Callon has called an obligatory passage point [7]). Only in the context of Kew's large-scale enterprise would botanical samples and activities through the world come together and refer to each other. The third is that this universalizing view promotes a notion of scientific progress that is absolutely entwined with national, state, and commercial interests. Kew is a Royal institution, but the role it played in Britain's industrial and commercial development during the colonial period was significant.

How does the example of Kew Gardens help us discern a colonial narrative in the work of ubiquitous computing? To begin, we might point to a series of considerations that undergird both systems of thought:

- They share the notion that knowledge and the bases of innovation are unevenly distributed in the world, and that their goal is to assist the migration of knowledge from centers of power (be they colonial hubs or research laboratories) to places where it is lacking.
- They share the related notion that progress in places where information, knowledge, or technology is lacking is something that should be undertaken by the knowledgeable or powerful on behalf of those others who are to be affected or changed by it.
- They share a belief in universality: that knowledge and representations applied to any particular place or situation can just as easily apply to any other, and that knowledge schemes developed anywhere will work just as well anywhere else. So, for instance, the universal taxonomy of botanical life created at Kew, or the universal accounts of human needs and human activities common to modeling exercises in technology design, are both thought and intended to have power to speak to the details of settings anywhere.
- They share a commitment to reductive representation and hence to quantification and statistical accounts of the world as a tool for comparison, evaluation, understanding, and prediction.
- They share the idea that the *present* in centers of power models in embryo the *future* of other regions, such that the "developed" world is understood as the destiny of and model for the "developing", or that the world at large is destined to become "like" the one under construction in our research laboratories.

It is these ideas that collectively we refer to here as "colonial." While bound up with other considerations, including the broader cultural currents of modernism [6], we use the term "colonial" to invoke a particular dynamic built around historical and geographical specificities and particular configurations of power, technology, and representation. In what follows, we want to examine these ideas in more depth. We want to show how ubicomp's research program, envisioned and portrayed since its founding as a program "for the twenty-first century" [43], nonetheless draws on a considerably older legacy. We then draw out some consequences of this approach, suggest some strategies for escaping it, and sketch the contours of an alternative approach to ubiquitous computing.

KNOWLEDGE AND THE TECHNOLOGY OF EMPIRE

The trend that we identify here is not by any means unique to ubiquitous computing. Indeed, that is exactly the point. We would argue that the discursive regime within which ubiquitous computing formulates its objectives is one whose logic is both pervasive and historically constituted. Examples like Kew Gardens or the British Museum emphasize that the project of empire is thoroughly entwined with a project of knowledge. Knowledge institutions are central to the function of empire, while at the same time dependent upon it.

Critically, knowledge institutions like Kew or the British Museum are not simply repositories of objects; they are also sites of classification, organization, and standardization, and sites from which those classifications and schemes emanate to the rest of the world. They order and organize; they establish standards, references, and categorizations that, though through broad reach, attempt to operate universally, displacing local convention [4].

Political scientist James Scott [36] has noted the role that universalizing schemes have in the operation of statehood. Modernist states regulate and operate through standardization and the imposition of homogenization, from grid-based street layouts to large-scale agricultural planning. Scott lays out a series of examples that illustrate the tension between the universalizing view of modernist statehood and the complex and messy reality "on the ground" that disappears from view in the process of

standardization. Similarly, he points to the way that elements that resist standardization and systematic management therefore become problems, obstacles, or enemies to the processes of large-scale statehood.

Scott's arguments focus on the tropes of modernist rationalism in projects of statehood, and these same tropes have considerable currency in the world of technology design. Take Google, one of the emblematic corporations of the Internet era. Google's avowed mission is to "organize the world's information and make it universally accessible and useful". Terms like "world", "universal," and "useful" have significant strategic power here.

First, it visualizes a single point of entry to the world. If the world is to be rationalized and ordered – or if its information is to be organized – then we must define a single point of entry, a central point from which the whole can be reached and surveyed. Google becomes the central point here (as London was for the British Empire); the place with respect to which everything is organized. Rationality and order flows from the center to the periphery; goods and raw materials flow from the periphery inward.

Indeed, analogizing the flow of information to the flow of raw materials that supported the industrial revolution at the height of European empire turns our attention to a second consideration, which is that of utility. The purpose of this organization is to make information useful – to put it to work, to monetize it, to bring value where there is none, or to enhance what value it might have.

Third, the value to be gained here is "universal" – effective everywhere, and everywhere the same. We could note two things here. First, we might remark on the curious loss of locality that renders Google as "universal" while services like Baidu are uniquely and specifically Chinese, say; and second, we might note that the universal nature of Google's services is challenged by their own practices of localization, customization, and differentiation. To the extent that "universal" is an aspirational claim, it fits into a broader historical pattern that gives the concerns and practices of centers of power a naturalized and privileged status.

Finally, the logic of Google's mission statement is also a logic that renders problematic information that refuses to be organized, categorized, or made public. "Information wants to be free," according to the oft-repeated Internet aphorism, which suggests that any constriction in the free flow of information is a problem to be resolved. Christen [8] has explored this in the context of her work on the digital curation of indigenous Australian knowledge, whose owners looked to the digital system to maintain the same kinds of responsible knowledge practices that their own traditions did – not exposing people to information that might bring them ritual harm, ensuring that information sharing is appropriately authorized by the presence of those who have a right to it, and so forth. The idea that information wants to be "proper" is one that mobilizes a quite different logic.

In what follows, we step through four aspects of ubiquitous computing's research practice with a particular focus on the discursive production of future-making, in order to see these logics at work and uncover something of their origins. We will then discuss a series of strategies for an alternative ubicomp that reimagines technologies as sites of human encounter and practice.

DEFICITS OF AGENCY, IMAGINATION, AND CAPACITY

The first consideration, as outlined above, is the way in which a natural migration of innovation is imagined to flow from center to periphery, in the form of research laboratories and the rest of world. To the extent that research centers (including university laboratories) are engaged in anticipatory projects and programs of future-making, the future that they anticipate is a future that others will share in when the technologies in development move out of the laboratory and into the world. In this view, research laboratories are the world in microcosm, and what they have, the rest of the world will want.

This is a familiar argument, and it comes with familiar problems. For example, the rhetorical framing of relations between the industrialized West and the global South in terms of "development" has been extensively critiqued for the kinds of positioning that it produces [e.g. 16, 18, 28]. It invokes an evolutionary relationship in which "developing" regions are understood, first, to lack something that developed regions have, and second, to desire that something, and third, to be on a path to gain it. The path of "development" is, in fact, the historical trajectory of the industrial West; the goal of "development" aid is to assist "developing" regions in their movement along that path and their inevitable evolution into mirrors of those nations offering aid. The ways in which "developing" nations are unlike the "developed" nations, in other words, is formulated as a lack or an absence; the goal of development is to remedy that lack. (Some of these same critiques have also been leveled at development projects in ubicomp and allied research domains [e.g. 20].)

Like the development argument, the innovation argument is a disempowering one. It postulates not only a deficit of technology in the world at large, but also deficits of imagination and agency. In argues that the technologies that people will want tomorrow are ones of which they cannot even conceive, and certainly ones that they cannot create themselves. In fact, projects of future-making are needed in part because people cede to researchers, in this argument, the production of novelty. The standard structure of this argument identifies a problem "over there" (out in the world) or "for them" (those people) and matches it up with a solution that "we" (the researchers) have "here" (in our lab). The world beyond the lab is framed, in this case, as problematic precisely for the way it lacks what we have – both the technology and the power to act with it.

This is not to say that ubicomp researchers are always solving the problems of others; plenty of work focuses on

"scratching the itches" that we ourselves feel as users of technology. Indeed, Xerox PARC, where the ubicomp program originally emerged, is famous for its ethos that researchers should "build what you use and use what you build." Nonetheless, even these programs express the idea that researchers are, in some sense, typical or prototypical people; the problems that we encounter now are the problems that everyone will have soon.

Ironically enough, the problems that arise as consequences of the logic of lack are often quite well known, although operation of the logic itself is less recognized. Let us note, here, five considerations.

The first is that, at one and the same time as the logic of lack establishes a difference between research sites and sites in the world (in terms of the capacities and agencies that those latter sites lack), it also postulates a series of similarities, arguing that those spaces are organized equivalently, operate on the same terms, are populated by the same sorts of people, and so on. For instance, many have noted that the failure of many programs in domestic ubicomp have often been based on models that imagine that domestic spaces operate in similar ways to the office spaces in which the technologies are designed, and that the way to turn an office into a prototype home is to remove the desks and replace them with sofas [e.g. 14, 15, 19]. The way that the different settings are related to each other frequently fails to understand the characteristics of either one.

Second, the logic of lack and its notion of technological migration soon runs us into the problem of getting our innovation from here to there. Indeed, arguably the interest that ubicomp and allied research have expressed in the concept of "living labs" can be seen as an attempt to resolve this very problem. While the notion of "living" brings an attention to daily engagement rather than controlled experimentation, the "lab" remains a place apart from the world and a place where unruly elements of mundane experience can be brought under control [26].

Third, the logic of lack systematically denies agency to those who are framed as the potential users of technology, while at the same time celebrating and valorizing the actions of design. By the agency of users, here, we do not simply mean people's abilities to develop solutions of their own, although that is certainly an issue; we also want to include the way that people understand and put technology to use in their own context which serve to structure and give meaning to it. Indeed, we might argue that technologies are always inherently hybrid, encountered and put to use in contexts that go beyond those that designers imagine, and the meanings that technologies take on in the world are ones that arise in the complex, messy, and multi-faceted contexts of everyday practice. If we take seriously the idea of technological practice as one of bricolage, then we must recognize an agency on the part of users that the logic of lack denies.

Fourth, the logic of lack postulates researchers as, essentially, "just plain folks," who, if they exhibit different behaviors, recognize different problems, or evidence different desires from others, do so simply because of their positioning within a world of advanced technologies and techniques. If the research lab is simply a more advanced site, a more developed site, a more evolved site than the rest of the world, such that it may be the place where new ideas develop that will then move out to fill in the gaps elsewhere, then the problems identified in the research lab are the problems that others face or will face, the itches to be scratched in the research lab are itches that will irritate others, and the researchers themselves are proxies for anticipated others in critical ways. Just as development rhetoric imagines the global South desiring to transform itself into a version of the industrialized west, so too are researchers and potential future users connected at points on the spectrum technological evolution.

Fifth, and relatedly, this logic similarly positions anyone else as a proto-user, as someone who, if they don't use our technology yet, will do so soon. Our very language does this; to the extent that empirical inquiry is determined to uncover "user needs," it allows no position other than "user" or "non-user" as the reference point for understanding people and their contexts.

UNIVERSALIZING VS SITUATED KNOWLEDGE

One of the central roles for the knowledge institutions of empire is to produce standardized accounts of the world. The goal is to bring things into alignment, and to create a framework in which objects and processes can be understood and related to each other. That ubiquitous computing has, of necessity, some of the same concerns is clear even from the name of the project – any project that seeks to be ubiquitous or pervasive is engaged in the production of uniformity on some level. Projects in context-aware computing seek to make technologies responsive to the details of particular settings and moments of use, but they do so by organizing those settings and moments into a universalized representational scheme [e.g. 12].

The danger here of course is that universalizing projects reflect particular points of view even as they erase them. To the extent that universalization is about the production of homogenous categories, it is committed to particular points of view with respect to which the specific differences within those categories no longer matter (or must be made not to matter). The process of identifying the universal abstraction that captures the meaning of particular moments, people, practices, and events, is also one that inherently states that, for someone's immediate purposes, other distinctions do not matter.

We turn here to work on feminist epistemology, which a number of recent authors have highlighted as an important destabilizing resource for technology design and analysis [e.g. 3, 41]. The key insight here is that feminism, particularly as a theoretical position, is not primarily about

gender; rather, it is concerned with the operation of patriarchy and the possibility of alternatives. Patriarchy operates through hegemony and homogenization; it takes the positions of dominant groups and adopts them as universal positions, marginalizing alternatives, erasing differences, and obscuring the particularities encoded in the universal. The goal of much feminist theory, then, is to provide resources for revealing the way that specific subject positions are valorized in this process, and in turn to find alternatives that embrace diversity, polyvocality, and difference.

So, for example, the basis of J. K. Gibson-Graham's [22] feminist critique of Marxist political economy is that Marxist analysis exhibits an overriding concern with capitalism that is itself a universalizing discourse that marginalizes or obscures alternative forms of economic life. Perhaps one of the reasons that we have had so little success in displacing capitalism, they argue, is that capitalism isn't actually as successful, universal, or encompassing as we think it is. A feminist critique of political economy, they suggest, would take as its starting point the diversity of forms of economic life in which non-capitalist forms of exchange (e.g. domestic labor, shared child-rearing, and collective voluntary activity) would take their place alongside traditional objects of Marxist inquiry.

Donna Haraway has been particularly prominent in the development of a feminist perspective on science and technology [24]. Latour and Woolgar [27] describe how scientific facts are generated in laboratories through a systematic "deletion of modalities" as particular observations ("the contents of this particular test tube on that table on that day were observed by this person to turn a blueish color") are gradually resolved into universal facts ("copper sulphate is produced through electrolysis of sulfuric acid with copper electrodes"). Haraway argues for a feminist technoscience in which the situated contexts of knowledge production are acknowledged. She argues that objective understanding and actionable knowledge result not from the denial, erasure, or overcoming of partiality but by recogising and embracing it and building a framework for knowing that is build on accountable partialities:

> The moral is simple: only partial perspective promises objective vision. All Western cultural narratives about objectivity are allegories of ideologies governing the relations of what we call mind and body, distance and responsibility. Feminist objectivity is about limited location and situated knowledge, not about transcendence and splitting of subject and object. It allows us to become answerable for what we learn how to see.

Just as the "logic of lack" that we described above posits a single inevitable and universal future for those areas into which research technology will migrate, so too here does ubicomp depend on processes of universalization for its operation. Here, though, we have a rather different concern in mind, thinking especially of the representations and coding schemes through which our technologies operate. In particular, we note that even our capacity for producing differentness is to invent a universal logic into which everything can be encoded and through which everything can be understood and aligned. This approach obscures the partiality of the perspective from which certain differences are recognized and others are obscured, and it again promotes a hierarchical distinction between the central position from which a universal view can be generated and those marginal, peripheral sites at which local considerations apply. Drawing on the feminist theorists, we want to ask, what might it mean to take locality, specificity, and plurality not as a problem to be compiled away but as a consideration to be celebrated and retained? What could a ubicomp be that as its very first step abandoned the idea of ubiquity? The question of strategies is one that we will return to later in the paper; for the moment, though, it is perhaps enough to place the search for universal logics of interoperation within the frame of the colonial, and proceed to our next consideration.

CONTROL THROUGH QUANTIFICATION

Projects of categorization, such as those that we have associated with the knowledge institutions of empire, are firmly allied with projects of counting and measurement. If a universalizing logic pervades these efforts, then number is the most universal framework of all.

The etymological root of "statistics" is "state"; it was the progress of statehood that drove the development of statistical analysis. Statistical analysis is in many ways about managing information at scale, and so the vast scale of the colonial enterprise necessitated new forms of measurement as a means to regulation.

This underlying drive to control through quantification can be seen broadly through the application of mathematical and numerical principles and the reduction of aspects of everyday life to forms amenable to statistical analysis. Cartographic practice and the tools of navigation and surveying, for example, which re-render everyday space within a quantized frame, were central to the ages of exploration and colonial expansion; they went hand in hand with the search for new lands, new spaces, and new resources. In a different vein, Cole [9] describes how fingerprinting was developed initially as a tool of the Raj, providing colonial overseers with a means of managing identity in quantitative terms.

Quantification is a universalizing process in the terms we have described above, of course; it renders the elements of the everyday world comparable and trackable. However, it is worth calling out separately given its particular dominance as a logic of control.

Miller [29] uses the term "virtualism" to refer to the way that abstract and particularly mathematical models of the world have a habit of migrating towards centers of power which, operating through them, serve to reorganize the

world in ways that make it compatible with the model. He uses the example of audit in local government, where, because everything must be costable and understood in economic terms, those things that cannot easily be rendered in monetary terms disappear as aspects of institutional work. In the academy, we might think about the ways that measures of research productivity eventually come to shape the research activity that they are meant to measure. In terms of our current discussion, though, a particularly relevant case might be the mathematical models at the heart of macroeconomics, developed initially as a way of understanding the operation of markets. As these become the tools in dominant sites of expert management such as the International Monetary Fund and the World Bank, though, they start to drive projects that begin to remake the world in their image. So, through their Structural Adjustment Programs, the IMF and the World Bank generally required, through the 1970s and 1980s, that loan recipient restructure their economies to open them up to foreign investment, dismantle their welfare states, and generally reconfigure themselves along the lines of pure market capitalism – that is, reorganizing them in such a way that they might better be described by the mathematical models through which those institutions operate.

Lord Kelvin famously commented that, "*When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge of it is of a meager and unsatisfactory kind.*" Ubicomp certainly seems to provide a basis for understanding through quantification. To frame the problem of activity recognition as a data mining problem is a response to exactly this attraction. Indeed, to the extent that "big data" has emerged as a new approach to problems in interactive systems, it postulates an equivalence between the world of numbers and the world of actions such that a solution in the world of numbers is, simultaneously, a solution in the world of actions. Our concern with the difficulty of effecting this translation should be clear by now. But also, in line with our broad concerns here, we question the erasures of context that quantification involves – including of course the contexts of quantification and mathematical reasoning itself [10, 42].

PLOTTING FUTURE PATHS

The formulation of the research laboratory as the site of innovation and future-making, as we have noted, depends on a logic of lack – it refines other spaces in terms of the absence of technologies, opportunities, or activities that are presumed to be able to flow from centers of power and privilege to those less advanced. This is a technologically determinist argument, as we have noted, but it also has the property of conferring upon the research laboratory the responsibility for plotting future paths.

There are two aspects of this consideration that we would like to explore briefly here. The first is how this privileges the perspective of the research laboratory and the second is how it turns our attention away from an investigation of current conditions.

If, as Dourish and Bell [14] argue, technology-oriented research is frequently framed in the "proximate future," a world of technological abundance or opportunity that can be perceived just around the corner, then we might ask, whence and how does that inevitability arise? What does it take to say, "we will soon be in a situation where X becomes a problem," where X is anything from synchronizing data across the many devices that "we" will all be carrying to making our devices interact seamlessly with the complex digital fixed infrastructures which we might encounter in the course of everyday life? Indeed, what is it about this life that makes it "everyday"? "Everyday life," indeed, has been a major focus of attention for many in ubicomp, in an attempt to understand how technology operates outside of the laboratory and outside of the office and workplace settings that characterized much early research in interactive technologies (and indeed in Weiser's early accounts of ubiquitous computing) [e.g. 1]. The term "everyday" is rhetorically fascinating here, suggesting simultaneously the significance and casualness of ubicomp research, while at the same time erasing the question of just whose "day" is being reimagined.

The privilege of perspective granted to research laboratories is accompanied by its own negative dual, which is the angst of relevance. This concern manifests itself not least in panel discussions at our conferences, where we debate whether we are really "making an impact," and consider how research programs should best be directed in order to be "relevant to the needs of industry," for example.

The second consideration here is that the overwhelming concern with the possibilities of the future tends to overrule a consideration of the present. As noted in the discussion around the prevalence of "implications for design" as an aspect of ethnographic practice in ubicomp, the idea that the measure of ethnographic work is what promise it can offer for the future implies concomitantly that we are uninterested (or, certainly, less interested) in what it might tell us about the present [13].

We see again here an analogy with the rhetoric of international development. Ferguson [18] has suggested that development is what he calls an "anti-politics machine," arguing essentially that the rhetorical structure of aid and development is so firmly fixed on the sorts of things that might be changed through investment and volunteer action that it renders invisible the question of the historical and political circumstances in which development aid came to be needed in the first place. Ironically, then, an activity that is founded at least in part on considerations of social justice rules those very same questions of out its own scope. Analogously, we might argue that the overriding question, "What might we build tomorrow?" blinds us to questions of our ongoing responsibilities for what we built yesterday.

STRATEGIES

Implicit in our message so far is that the colonial impulse in ubicomp, as in other areas of technological research, is a problem; it might be worth taking a moment here to explain just what sort of a problem it is.

First, and perhaps most obviously, it is an *ethical* problem. It is an approach that elevates a particular, narrow, and partial perspective to a position of central importance, and then reframes other perspectives in relation to the dominant view. It is an approach that marginalizes alternative voices, that denies the agency and independent rationality of others, and that is blind to its own blinders. To this extent, our call echoes that of others who have sought new approaches as means to "decolonize methodologies" [35, 38].

Second, it is a *pragmatic* problem. Leaving aside for a moment the power relations at the heart of the colonial perspective (a somewhat ridiculous idea), we can focus too on the inherent problems of the colonial approach's loss of perspective. The problem is not simply that a colonial perspective in inherently partial, reflecting the perspective of a dominant group; it is that it is implicitly partial, unrecognizingly narrow, and unreflectively local. In line with Donna Haraway's call for a polyvocal science, then, we are not suggesting that partiality needs to be eliminated, but rather that it needs to be recognized and understood as part of our project.

Third, it is a *conceptual* problem. We believe that ubicomp is fundamentally a conceptual project, one that begins from a reconfiguration of technology, space, and action. While it operates through technological innovation, those technological innovations are not ends in themselves, but means towards the broader conceptual goal. (This is not to dismiss technological innovation as secondary; indeed, quite the opposite. This is why, for example, the original work of Weiser and his colleagues remains important, despite the fact that it is technologically obsolete; more broadly, it is why contributions achieved through technological innovation can and should outlast the technological innovation itself.) The limitations of the colonial perspective are not simply limits to technological innovation (although they may be that too, as we have detailed above), but they are most certainly limits to the conceptual understandings that we might gain through the development, deployment, and examination of technological innovations.

If we accept this perspective as a problem, then what should we do about it? We broadly sketch some strategies here.

Avoid the rhetoric of center and periphery. The colonial impulse, as we have illustrated, speaks in terms of centers of innovation from which new ideas, new technologies and new understandings flow out into the world. This language and way of understanding research practice reinforces the perspectives against which we have been arguing here. Now, it is most certainly the case that some objects are designed in one place and used in others; iPhones, for example, are "designed by Apple in California" (as Apple product packaging attests) and are put to use all over the world. However, to see this as an unproblematic flow of technology from a center of innovation to peripheral sites of use is to miss the way that many of the innovations surrounding the iPhone are innovations of manufacturing processes rather than design, which originate in different places; that the iPhone incorporates ideas that emerge in all sorts of places, including in the daily practices that people the world over engage in with their phones; that the iPhone, as a cultural object, means different things in different places and at different times; that the innovation strategy around the device is itself in dialogue with related devices, related processes, and related services in many places; that the iPhone is adopted everywhere differently into local conventions of practice that make it meaningful; and so on. It is not simply that "innovation arises at the margins" – it is that the very rhetorical distinction between center and periphery, never mind the elevation of the center to a privileged position, is a misstatement. More broadly, we might suggest that the rhetoric of center and periphery is also a rhetoric of design and use, and we would ally ourselves with others who have questioned this conventional understanding of design/use relations, from Participatory Design onwards [e.g. 23, 30, 35]. One concern that this strategy identifies is the way that we think about research labs as prototypical environments for technology design, and the extent to which they anticipate the future conditions that others will encounter or desire.

Engage with people in their own terms. We might most easily summarize this with the slogan: ban the word "user." As soon as we frame someone as a user (or a potential user, or a non-user), we automatically place their position with respect to our technology or our service ahead of their own concerns. Similarly, as we analyze settings of work and identify the absence of solutions, approaches, methods, and technologies that we have available, we again frame the relevance of these settings in terms of their current or potential future patterns of technology consumption (technologies, moreover, that we simultaneously position ourselves to provide.) Elsewhere, Dourish has argued that ethnographic work, for example, should not be evaluated in terms of its stated "implications for design" not least for just this reason, that is, that to frame the report in terms of opportunities for technological solutions is to place our own concerns ahead of those of our ethnographic partners (who might in other modes of empirical research be referred to as "subjects" – a term that should resonate differently in light of the argument we have developed here.) In general, simply by avoiding the term "user" we begin to think more broadly and more realistically about the contexts of technological encounter and the limits of our claims.

Recognize the historical specificities of sites of technology production and use. Technological systems – including not only physical devices but also practices, standards, and classifications – aspire to universality. Indeed, the problems

of the term "user" as documented above are not least the problems of attempting to erase, ignore, or transcend the specifics of technological encounters. However, these specifics are critically important to the emergence of technologies in use.

Bowker and Star [4] provide several examples of this phenomenon in their work on infrastructures. For instance, they detail the way that the International Classification of Diseases, developed by the World Health Organization and an evolution of a system originally developed by French authorities, was criticized for focusing especially on diseases of the global North, and ignoring or underrepresenting tropical diseases.

As we noted earlier, Suchman [39] has argued the importance of the locatedness of design – that is, that it happens in particular geographical, institutional, commercial, and historical settings. Given that design is first and foremost an act of imagination, we need to be attentive to the way that the imagination does not only give shape to technological design, but is shaped by it at the same time [2]. Technological practice has often regarded this as a problem to be resolved through a search for universal principles and decontextualizing generalizations, but if we regard design practice as inherently located, then we recognize that these decontextualizations do not eliminate local commitments and assumptions, but obscure them. This calls for a different response – not to seek universals in order to eliminate historical and geographical specificities, but rather to acknowledge and account for them.

Seek solutions that resolve local details without translating everything into the global. That is, where possible, we should seek mechanisms for coordination that do not presume a global authority. The question of coordination without centralization is the core concern that Galloway explores in *Protocol* [21] and indeed to the extent that protocol – in both the networking sense and the diplomatic – speaks to a set of mutual expectations without demanding a common implementation, it provides an instructive case of the way that alternative approaches can interoperate without agreeing on implementation. Nonetheless, protocol (in the networking sense at least) is itself also deeply centralizing, organizationally if not geographically; it requires everyone to commit to doing things the same way (commitments which themselves are often shaped by historical and geographical specificities, above.) This centralizing tendency is particularly illustrated by accounts of the political processes over both the definition and management of standards and infrastructure (such as Mueller's account of ICANN [29] or by those of the debates at work in the standardization process, e.g. [25].)

More broadly, it is important that we find ways for different systems to interoperate, coordinate, and co-exist without positing or requiring the existence of central agreements or universal encodings. While certain forms of coordinated action may be impossible to achieve with this degree of autonomy, what we need to recognize is that this is a value judgement rather than a purely technical consideration; the question in many cases is whether efficiency or autonomy is a more desirable goal. Global registration mechanisms, universal IDs, and reliance on singular infrastructures are indicators of a commitment to the global; for instance, it is often instructive to examine whether a system can continue to operate on local networks disconnected from global infrastructures, or on ad hoc networks, as a means to uncover such dependencies.

Embrace polyvocality, diversity and multiple perspectives. Finally, here, to take the previous consideration one step further, we might ask how a more explicit polyvocality – not simply the interoperation of different autonomous elements, but even the incorporation of radically different perspectives, might be introduced. How might two systems operate simultaneously in which fundamentally different considerations are at work?

One interesting development in this area is work in database technologies which looks beyond traditional schema-based systems in favor of alternatives in which schemas can be thought of not so much as metadata that defines the structure of objects but as approaches by which data can be interpreted [32]. Here, one can think of using different schemas to look at the same data in different ways and understand it according to different organizations. Similar approaches have been applied in programming languages, where particular language constructs can be construed as local ways of registering software systems [11]. "Registration" is a term borrowed from Brian Cantwell Smith's explorations in the metaphysical foundations of computation [37]. The underlying idea is that for an object to be perceived as a certain kind of object is not purely an achievement of the object, nor purely of the perceiver, but is an achievement that is contingent, particular, and relational. A useful exercise, then, is to analyze a design for the ways that it draws equivalences between objects and manages the processes of translation, since those translations are typically points at which alternatives are eliminated rather than maintained.

What this points to is the idea that multiple perspectives can be simultaneously present even when not directly compatible. As in the considerations of partiality and locatedness discussed above, it opens up the possibility that we might make all structural elements matters of description rather than matters of configuration, and as such, place them on similar footings without privileging any one point-of-view. To regard this as a direct technical translation of the sorts of concerns that theorists like Haraway have proposed is clearly reductionist in the extreme and simplifies those ideas to the point of absurdity; on the other hand, it does suggest that the fundamental commitment to building effective technical objects does not require the sorts of representational absolutes that we are generally familiar with in conventional systems

development. What, we would then ask, would be a ubicomp that not only incorporated but celebrated polyvocality, ambiguity, partiality, and contingency?

It would be a good start.

A ROLE FOR SOCIAL SCIENCE AND CRITICAL THEORY

Some have argued that ubiquitous computing's interdisciplinary agenda is framed by a set of aligned concerns with sensors, systems, and users, a position that argues that the role of social science within the ubicomp program is contained in that third component. Social science (and the arts and humanities, to the extent that they have a role to play at all) should help us understand users – what they want and what they do.

In line with other recent discussions (e.g. [14]), this paper attempts to demonstrate an alternative role for contributions from the social sciences and humanities. We believe that the object of analysis for these disciplines is not simply ubiquitous computing in the form of devices, technologies, services, practices, and problems, but also "ubiquitous computing" in the sense of the program, discipline, and research practice. Our concern here exemplifies this approach.

In a paper on projects of future-making in industrial research laboratories, Lucy Suchman [40] reflects on an observation, heard on the radio one evening, that "the future arrives sooner here [in Silicon Valley]":

> [These statements] position the speaker in an identifiable territory, indexically referencing the interviewee's location as the Silicon Valley and in turn, of course, performing the existence of that place once again through this naming of it. And in their positing of a singular, universal future, they re- iterate, as well, a past in the form of a diffusionist model of change. Described by Fabian (1983) in *Time and the Other* as a form of temporal distancing, this "involves placing chronologically contemporary and spatially distant peoples along a temporal trajectory, such that the record of humanity across the globe is progressively ordered in historical time" (p. 13). The kind of spatial and temporal distancing enacted in a statement such as this is also, in this sense, a colonizing move.

The formulation of a temporal trajectory in the way that Suchman (and Fabian [17]) describe here is very familiar in ubicomp practice, as it is in other areas of technological research. It is a powerful discursive move. Similarly, the force attributed to that trajectory suggests an inevitability of technological development that makes its logic hard to escape. However, we feel that it is critically important that, as researchers, developers, and practitioners, we attempt to understand the kinds of discursive work being undertaken here and the kinds of institutional and intellectual legacies to which our work is heir.

This is not simply about plotting new paths – our goal is not a call for a "new" in that sense, since revolutionary rhetoric and the enshrining of "new" as the central value of intellectual enterprise is, in part, the problem we have been tackling. We are perhaps less concerned with the shock of new as with the equally shocking nature of the old. Our goal is as much to recognize what path we have been following as to forge a new one, and similarly, we hope that such a recognition can help us understand what ubicomp is now, and how it came to be quite where it is. This is not a vision of the future, then, but a call for new acuity in our vision of the present.

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