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UBIQUITOUS—ALIFE IN TECHNOSPHERE 2.0

The Design, Individuation, and Entanglement of Ubicomp Apps in Urban South East Asia

Jane Prophet and Helen Pritchard

Background

TechnoSphere 2.0 is a re-engineering of a 1990s networked artificial life (ALife) project that used a web interface to enable the design of ALife creatures, who were nicknamed 'beasties.' 'Beasties' were then put into an ALife simulation housed on a PC. TechnoSphere was described at the time using the contemporaneously dominant discourse of interaction, "Most sites out there still only provide information to browse through, our aim with TechnoSphere was to offer a site where users did something (designed a creature) and where their interaction had an effect (each creature affects the digital ecology in the TechnoSphere virtual world" (J. Prophet 2002). The 1990s TechnoSphere was 'launched' as a fully functioning ALife simulation that participants could not easily alter (J. Prophet, Sublime Ecologies and Artistic Endeavors: Artificial Life and Interactivity in the Online Project 1996). It was followed four years later by the production of a real-time 3D version (J. Prophet, TechnoSphere: "Real" Time, "Artificial" Life 2001).

TechnoSphere 2.0 takes contemporary ideas of making and ubiquitous computing much further than the previous version. It comprises a number of interconnected mobile Android applications (apps) allowing people to create creatures in 3D on their mobile devices, take them with them and intra-act with them as the creatures explore both artificial and real world environments. The first app enables users to create their carnivore or herbivore creature by selecting a head, body, wheel, and eye design and then texturing it from a selection of patterns, seeing it from all angles as it spins in realtime 3D as each choice is made or altered (Plate 27.1). Once satisfied, they name the creature; any creature can then be added to a series of Augmented Reality (AR) apps (Plate 27.2).

The AR apps use mobile devices' built-in cameras to capture the live image and overlay it with computer-generated graphics. To achieve this smartphones combine location via GPS data with orientation via compass information and movement via accelerometers and gyroscopes. Fiducial markers, which can be paper diagrams or objects, are used as points of reference that appear in the video image and are overlaid with a virtual object. In the first AR app, a creature can be seen moving around a table or other flat surface like the living room floor, and people can start to interact with it in a shared TechnoSphere world. Participants create the shared world by arranging pre-designed fiducial markers in their gaming environment. Users can make their own fiducial markers to register landmarks, these can be 2D printed paper and can be 3D objects or hand drawn images. These landmarks tether static virtual 3D objects, each of which has specific properties. The virtual objects laid out as part of the navigable environment of the table top include trees, food caches with varying nutritional value and a watering hole. Fiducial markers (colored graphic images printed out on paper) laid on the table are virtual meals, the image is data that causes AR foods to appear in the mobile device screen, displayed on top of the live video of the table top. If it is hungry, the creature can approach and eat the food cache it finds on the table. The next AR app adds obstacles and attractors this table top environment, the virtual creature will be able to navigate around real life obstacles from the users' world. The virtual creature moves within the table top area that is partially controlled by the user, drinking at (or drowning in) the watering hole, eating at food sources, and following drawn pathways.

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The AR environment can be further blended with the real world if users make 3D representations in real space of the virtual objects such as trees and watering hole. These 3D objects can be formed ~~by~~ everyday objects from the users' homes with fiducial markers added, or by users printing pre-designed slice forms on paper or card and assembling them. The creatures will interact with both virtual objects and with those virtual objects' real paper 'twins.' The paper versions of the ALife environment forms are then seen whether or not the AR app is in use, pushing the project further towards Mixed Reality (MR) where the ALife engine is impacted by the gameplay and the participants design choices are meaningful (how a person designs their creature and how they design the landscape affects how a creatures grows and behaves).

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The apparently human-defined graphic world is now tied to an ALife engine, the graphics and the creatures interact dynamically and in real time and the shared world is entangled. Other AR apps use GPS to enable users to take their creatures around with them, tethered to the user via GPS. Humans can walk their creatures round their apartment, into their backyard, or to a public park, tethered via GPS so they scamper within a few feet of the user. This is one way to potentially meet other users and their creatures, if users choose to make themselves visible to others as they stroll.

The beasties made as part of TechnoSphere 2.0 individuate through entangled relations of GPS, hardware, software, human, and nonhumans in the city. The 1990s web based version of TechnoSphere was populated by creatures that were autonomous, behaving according to rules embedded in algorithms of the ALife engine that defined each creature and its environment, but that did not enable human users and their interactions to permeate the ALife system. By contrast TechnoSphere 2.0 takes that ALife engine as a starting point but then adds features that allow for human activity to become coupled to it. The inputs from human participants can then affect both the creatures and their environment, concretizing previously un-realized potentials of their ALife creature and their milieu. For example, by adding a watering hole or food sources on the AR table top app, a human user creates the conditions for a creature to carry out actions such as eating or drinking, creating navigable paths for the creature to follow or paths along which to race with another creature. Whether, or to what extent a creature will take advantage of these human interventions will always depend on the creature's ALife engine.

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Previous papers on ubiquitous computing research tend to focus on the exploration of future prototypes of technology and how such technology is part of everyday experience, or as Bell and Dourish state "on the future just around the corner" (Bell 2007, 134). We investigate the

tools of ALife and ubiquitous computing (ubicomp) as they develop together in the present-
day, emerging, into previously undiscovered relationships and discuss what Ulrik Ekman has
described as the potentialities of ubicomp "whose actualization we are not yet sure" (Ekman
2011, 1). We present our engagements with the project TechnoSphere 2.0 by analyzing the
ongoing process of designing and developing a series of ~~mobile game applications for Android~~
~~(apps)~~ that form part of this ubiquitous ALife project. Jane McGonigal argues that ubicomp
game design "formulates hypotheses about the value and feasibility of ubiquitous computing"
(McGonigal 2007, 92), positioning prototype games as experiments to suggest that testing these
prototypes via so-called playtests "provide citable proof of these hypotheses" (McGonigal 2007,
92), about ubicomp futures. We note that our project, like many in the ubicomp literature,
is currently a prototype, developed as part of our method of using practice-based research to
design processes for artificial life.

Our augmented reality mobile apps can be seen as experiments through which we test
hypotheses that mixed reality opens up the possibilities for more affective experiences. Our
use of the term mixed reality here recognizes a blending of the material and immaterial, as
entanglements of humans and nonhumans. However, our methodology differs from many cited — , comma
by McGonigal inasmuch as our goal is to produce a game that goes beyond prototype and
playtest phase. The underlying premise of both the TechnoSphere 2.0 project and this chapter
is that the process of making *matters*, that the materialization of an ubiquitous ALife project is
a process of unveiling hidden potentials, what ~~Gilles~~ Simondon refers to as moving from the — Gilbert
abstract to the concrete (Simondon 1980, 16). This is a movement through which a "series of
problems" is resolved (Simondon 1980, 14). Drawing on the work of Isabelle Stengers we
describe this process as one of *making*. Stengers outlines the figure~~s~~ of the "Maker" to express
the creative process and assert that although the makers' values "pass into the world" (Stengers — maker's
2010, 295), the explanation of the values themselves does not fully explain what is made. For
Stengers, makers themselves cannot fully explain what is made, even though they "explain
themselves through the making process" (Stengers 2010, 295). Drawing on Simondon, Stengers
also uses 'making' to describe the process of 'transduction.' (Stengers 2010, 291). Transduction,
in Simondon's theory of individuation, describes the process through which entities become
individuated in a milieu/setting (Simondon 1992), ~~A~~ a process that as Elizabeth Grosz notes ~~as~~ — is
one in which "activity generates itself" and "objects and practices produce themselves" through
their relations (Grosz 2012, 43). For both Stengers and Simondon, transduction describes the
process through which entities emerge, importantly this is not an emergence *into* a context,
environment or milieu that is then changed by them, rather entities emerge *with* their context,
into an environment of individuation, what Stengers calls the "causality of coupling" (Stengers
2010, 259). Rather than conflating ideas of ubiquity and ALife with a sense of universality we
situate the practice of making TechnoSphere 2.0 in the environment of SE Asia to unveil the
complexities of ALife entities in a particular ubicomp environment. The process of making a
design or an app occurs in specific contexts and we note that the concept of ubiquity as a
seamless technologically connected, or universal, domain is flawed and that at present networks — comma
are not ubiquitous.

We position TechnoSphere 2.0 as a feminist technoscience project, a work that challenges
critically any distinction or separation of 'basic' and 'applied' science. Writers on philosophy,
science and technology studies (STS), and feminist technoscience studies, have variously
argued that there is no pure science, rather it is "entangled in societal interests, and can be held — comma
as politically and ethically accountable, as the technological practices and interventions to which
it may give rise" (Asberg 2010, 299). A feminist approach to technoscience treats the tools of

science, such as ALife, as socioculturally embedded and politically and ethically accountable. Historically the discourses of feminist technoscience demand that we attend to material-discursive configurations (Suchman 2007a; Haraway 1997), building on the feminist science studies of the 1970s and 1980s and the ecofeminisms and cyborg studies of the 1990s (Hird 2009). These feminist technoscience engagements share a commitment to "processes of materialization and the entanglement of discourse and materiality" (Asberg 2010, 302). comma

The term 'interaction' is commonly found in discussions of ALife. In those contexts, interaction assumes that there are separate individual agents, which in our case might be human and ALife creatures, and that separation between entities precedes and accompanies their interaction. Taking a feminist approach to the technoscience of ALife we use Barad's term 'intra-action' to suggest something different, that agency in ALife is a "matter of intra-acting; it is an enactment, not something that someone or something has" (Barad 2007, 178). As we have stated elsewhere, "Intra-action works as a counterpoint to the model of interaction, common within ALife and biological experiments, where it signifies the 'interaction' of separate individual 'bounded' agencies that exist apriori, and precede their interactions. For instance, interaction might signal a bounded human subject who is transformed through chemical interactions or produced through cultural relations. Instead intra-action signifies the materialization of agencies conventionally called 'subjects' and 'objects,' 'bodies' and 'environment' through relational intra-actions. Intra-action assumes that distinct bounded agencies do not precede this relating but that they emerge *through* their intra-actions" (Prophet and Pritchard ~~in press~~). 2015/

Another part of Barad's agential realism that has influenced our thinking about ubiquitous ALife is her theory that different entities interweave and entangle, in an ongoing process of intra-action, resulting in the production of new entities that in turn, entangle with others. These intra-acting entanglements differ from interacting components commonly described in theories of autopoiesis and autonomy that we will discuss later. Such entanglements are also distinct from a blended mass. "Entanglement does not mean that what are entangled cannot be differentiated, discussed or remedied, only that the different entangled strands cannot be adequately dealt with in isolation, as if they were unrelated to the others" (Hammarström 2012, 43). An intra-active understanding of entanglement also demands that individual strands are not understood as self-subsistent entities therefore they differ from the separate and bounded agents common to ALife. In summary, entanglement proposes that individual entities are understood as continuously and co-constitutionally refigured in, and through, their mutual interdependence (Hammarström 2012). and

The reconfiguring of boundaries in ALife through technological innovation, including ubicomp, stretches beyond modern practices of the twentieth and twenty-first century, and as Isabelle Stengers describes, the story of artifice and life is a "timeless story that transcends modern practices" (Stengers 2010, 207). Indeed, from the selective breeding of tulips, highlighted by the peak of tulip mania in 1637 (Schama 1987), to Vaucanson's defecating Duck of 1738, described by Jessica Riskin (Riskin 2003, 119), to Steve Grand's 1990's 'Creatures' where Norns learnt language, ALife has repeatedly reconfigured ours and caused us to reconsider the boundaries of the living and the artificial. However, despite the openness to engaging with the systems currently being designed (Aicardi 2010), ALife theories have remained bound to ontologies which privilege the opposition of life and artifice, inanimate and animate material, nature and culture. Writers on ALife and complex systems emphasize connection, interaction, and causality between anything that can be defined as a single agent, and in many cases between agents and their environment. As many artificial life researchers (Waldrop 1992; Langton 1999), back practices/

and more recently literary theorists and philosophers (Hayles 2010; Stengers 2010) have stated, ALife is a process of making that extends the idea that artifacts are made, bottom-up, through complex relations rather than in a top-down environment (Stengers 2010, 256). We suggest that ubicomp coupled with ALife is another instance of making where human and nonhuman agents intra-act, bottom-up, in complex environments. As we discuss later on in the chapter through the example of TechnoSphere 2.0, the coupling of ALife and ubicomp/ redefines practices that constitute ubicomp, unveiling previously un-realized potentials of the city. Our focus on making brings recognition to the ways in which ubiquitous-ALife is "bound up with practices" (Gabrys 2014). This shifts the focus from the users and devices to a practice-based approach that recognizes their entanglements. The making of software "stays with the trouble" (Potts and Haraway 2010, 322) of working on a project, from which we are not able to disentangle and that seems to always be in the process of becoming. As the TechnoSphere 2.0 beasties emerge, we cannot predict how they will concretize new relations with GPS, hardware, software, human, and nonhumans in the city of Hong Kong in South East (SE) Asia.

SE Asian Milieu or Setting

Ubiquity has also often been conflated with a sense of universality, as Dourish and Mainwaring note when they link ubicomp to colonial intellectual tradition, "[e]ven the name of the area identifies its universalizing scope" (Dourish 2012, 133), though such universality has been countered by discussions of embodied experience coupled to specific social and cultural settings in the real environment (Bolter 2003, 114–40). Our focus is on designing TechnoSphere 2.0 for a ubicomp that is already here, while acknowledging that this continues to be a shifting structure that is emerging with the technical, urban, and creative milieu of, in our case, Hong Kong. Given that the urban SE Asian location of Hong Kong has influenced our understanding of ubicomp and the way we design, as part of our team develop apps from there, it is perhaps especially important that we remain mindful of what Dourish and Mainwaring term the "third conception of colonialism: as a knowledge enterprise" in which they include ubicomp.

We will address, as far as space allows, the "central conundrum posed by the fact that Weiser's vision of the future is, by this point, not only an old one, but also a very American one" (Bell 2007, 133). Our small team is spread from Europe to Australia, with a base in Hong Kong. As Eric Zimmerman has observed, "Games reflect cultural values . . . the internal structures of a game rules—forms of interaction, material forms" (Salen 2004, 516). The designs for the TechnoSphere 2.0 game apps have been made "in dialogue with the larger cultural values of the community for which the game is designed" (516), and their materialities, emerging simultaneously with the milieu. Our practice-based research in Hong Kong revealed the propensity for socializing to take place outside the home in the city, public spaces like malls and parks being the place that people spend the majority of their non-work time. The practices of walking through public space in Hong Kong, while simultaneously 'being online,' are the modi operandi of most people, of almost all ages. As we move through Hong Kong by mass transit or on foot we are streaming media, chatting via mobile text apps and playing games, and this is one of the most dominant forms of experience in the city. Like Bell and Dourish who write about ubicomp in the SE Asian locations of Singapore and Korea, our location has prompted subtle but important shifts in our thinking about ubicomp and the design of our apps. It has been noted that "[t]he use of mobile phone in public places was particularly found to be impacted by cultural norms and tradition" (Chen 2014, 2), and our focus on location-based experiences has been informed by close observations of how we use smartphones in Hong

Kong, "[u]nlike young people in developed countries who grew up using PCs, Asia's youth have grown up using mobile devices" (McGregor 2012, 10). China has three times as many mobile subscribers as the United States, 89 percent of these one billion consumers have a mobile device and two-thirds of Chinese mobile subscribers surveyed, own a smartphone (ETC 2014, 17). Much research has used a comparative model to compare mobile phone use between North America and SE Asia ~~countries~~ including Hong Kong (such as Ji 2010, Sia 2009). Often these studies cite the key differences between North American, Australian, or other non-Asian groups and SE Asia groups as individual, knowledge seeking versus data gathering, collective connection and group conformity. These types of comparisons risk Chinese users being positioned as 'others,' re-inscribing a caricature of Chinese culture. In the design of TechnoSphere 2.0 we have been less interested in using the process to perpetuate a notion of a generalized 'Chinese user' and instead we aimed to understand the specific practices of mobile phone use in Hong Kong. Through a nuanced approach to mobile phone use we hoped to consider what "possibilities for new practices" (Gabrys 2014) it might offer. For example, we believe that mobile device practices in Hong Kong enable the significant extension of mobile leisure and gaming experiences into open and public spaces.

Earlier colonial ubicomp models assumed that what was then the present state of the art in centres of power would be models for the future of ubicomp in other regions. However, leapfrogging technologies—those technologies that accelerate development by skipping over what is currently considered inferior technologies and move directly to more advanced ones, (Brezis 1983, 1216) in this case mobile phones that bypass the need for fixed lines—have disproved this colonial model. Hong Kong's ubicomp infrastructure in 2014 is notably different from that of the U.S. and Europe. Hong Kong's ubicomp infrastructure also differs significantly from the rest of China as Hong Kong's telecommunications industry is totally privately owned and faces no restriction on foreign investment. Unlike the U.S. and Europe, the fixed line technological infrastructure of Hong Kong is one that goes into condensed high rise apartment buildings, connecting large numbers of residents, and results in relatively rapid penetration of services as opposed to the rolling out of cable between single dwellings that are often far apart, which is common in many parts of the U.S. and Europe, and relatively expensive and slower to penetrate as a result. Of more significance is the way that smartphones have been taken up in Hong Kong. With 96 percent of residents using their smartphone to go online every day, Hong Kong has the highest mobile Internet usage rate in the Asia Pacific region. Hong Kong's subway system, the Mass Transit Railway (MTR), carries phone signals and smartphone use is almost universal. Authorities have been forced to use signs and constant audio warnings to passengers urging people to look up from their phones to avoid injury on escalators and Hong Kong is considering removing some seats from metro trains to create more room for commuters to interact with their devices (phys.org 2014).

The density of Hong Kong's population, resulting in crowded living conditions results in a widespread lack of privacy at home and a concurrent use of air conditioned malls and busy street markets for socializing, doing homework, strolling, and, especially, eating out. This urban behavior is an intrinsic part of Hong Kong's ubicomp environment and the use of public parks in Hong Kong is also different from the U.S. with widespread use by people of all ages. Elders populate the parks in the early mornings doing tai chi and other exercises, on Sunday's most of Hong Kong's nearly 271,000 foreign domestic workers, almost all women, gather in parks and public places to socialize. Parks are very safe and in summer it is common for people to stroll and jog at night when the heat of the day has reduced. As public spaces in Hong Kong are largely seen as safe places for activity, day and night, a variety of ubicomp games and apps may be enabled. One of our app designs reflects the use of some of Hong Kong's parks as spaces where hundreds of dogs and their owners meet on Sundays and chat and play. In our design for TechnoSphere's "Walk In the Park" people go to the park to exercise their TechnoSphere 2.0 creature, rather than their canine companion, and as they walk through the park so does the creature. A TechnoSphere creature is tethered to its human by GPS and can share the human's fitness data from mobile apps such as MyFitness, which we connect to from the TechnoSphere 2.0 app. Through this linking the human's fitness impacts the activities and ALife of the creature. In addition, designing our "Walk In the Park" app to blend with the practices of humans and nonhuman animals has lead us to design for visibility or privacy when walking with a TechnoSphere 2.0 creature (see Plate 27.3). If visibility is selected, then your virtual creature will be visible to other people in the park, who are also using the app. TechnoSphere creatures (and humans) might meet and interact as a result.

It is important to discuss Hong Kong in relation to China, as any ubicomp app designed in this Special Administrative Region of China is likely to cross the border to Mainland China which has an estimated 618 million Internet users. China's Internet use in 2012 was still lower (44.1 percent), than Europe and America. While many regions in China, in contrast to Hong Kong, have restricted broadband infrastructure "the ubiquitous mobile phone and 3G/4G services have significantly altered access to the Internet. Pew Research (2014) reported that approximately 79 percent of China's Internet users now access the Web through a mobile device (Pew 2014) which suggests that this is a 'leapfrogging' ubicomp environment that is developing quickly. However, while many of Asia's youth use their mobile devices there is a significant group with very different behavior that get online from home. These are known as the 'Zhai', China's stay-at-home consumers, equivalent to Japan's Otaku. They "represent a large and growing consumer segment, [. . .] half of Chinese consumers. They prefer to pursue their interests—shopping, social networking, and surfing the Internet—from the comfort of their own homes" (McGregor 2012). The online activity of the Zhai depends on 90 percent coverage of broadband networks in so-called tier 1 and tier 2 cities. In China, it is estimated that by 2015, wireline broadband subscribers "will be outnumbered by wireless broadband subscribers" (McGregor 2012).

It is common to think of GPS and movement through urban spaces when designing and discussing ubicomp games, but our design of TechnoSphere 2.0's table top AR app, described in detail later, allows people to create ALife creatures in their apartments, has been influenced by Zhai users and geared for play in smaller-scale domestic space. If calm technology is about the peripheries of attention (Weiser and Brown, 1997) and a greater sense of choice such as when to, if ever, focus on a game, then a calm ALife creature is one that does not make the attention-seeking demands of that older handheld pet, the Tamogotchi. At the same time many toys are literally in our peripheral vision, visible to us even when not in active play. The TechnoSphere 2.0 table top app can 'disappear' but home users have the choice of making their own physical objects that can literally sit in the periphery for use by a TechnoSphere ALife creature that will autonomously live but that is enhanced through intra-action. Hong Kong and China both report significant increases in pet ownership, especially of small animals that are easier to accommodate in high-density living. We approach the TechnoSphere 2.0 creature as another nonhuman companion that traverses the city and resides in small domestic spaces with humans. that

Our approach to the design of ubicomp apps is influenced by our local infrastructure, Hong Kong, which has its own particular characteristics. As Dourish and Bell note "an infrastructure is an infrastructure only from the perspective of specific peoples and technologies" (Dourish

2011, 37). As much research has demonstrated, cultural differences in mobile phone use have been reported in several studies (Ishii 2006, 97), for example, youth in different countries "differ culturally in their personal relationship patterns, creating different media trends" (Chen Y 2014, 2) We would also argue that the new relations that these trends form lead to the invention of different ubicomp technics and the unveiling of its other potentials.

Entanglements of Ubiquitous-ALife: from Autopoiesis to Co-Making

TechnoSphere 2.0 can be seen as an example of the emergence of ubiquitous-ALife with the environment of Hong Kong. TechnoSphere 2.0 creatures do not just become through the intra-actions of the 'TechnoSphere ALife engine' and the network (as they did in the 1990s version), but they also mutate and are contingent on the form, matter, and energy of urban technical environments. In TechnoSphere 2.0 the city's cellular structures, such as 4G data connections, mobile screens, and AR apps, allow TechnoSphere 2.0 participants to walk with their creature through the urban environment. The AR and MR of these walks demand that participants navigate relationally between physical and simulated spaces and objects. Rather than an ambient or pervasive vision of ubicomp, AR makes us aware of the technological structures, "AR art [. . .] wants to perform a reve(a)ling as part of its enactment. Neither the body nor the media disappear, but instead, they reappear as vectors for the expression and experience of art as both must be present in order to access AR art's invisible visualities" (Gould 2014, 26). The embodied experience of AR depends on physically moving the mobile screen to see objects within the live video image of the user's local physical environment, fed in through the mobile device's camera. As people alter their posture and movement, to better interact with their creature via AR, they configure public spaces differently which in turn configure the ALife creature differently. For example, the creature's need for food, exercise, or play may result in practices that configure different spaces in the city for different uses. Our design has been informed by the well documented practice of domestic workers who gather in their thousands on Sundays in Hong Kong. The workers (who are predominantly women) temporarily take over open (not necessarily public) spaces in significant ways. Subways and walls, designed to channel perpetual movement, become picnic areas as women gather and eat, talk and dance connecting with friends and family. These activities are often organized via mobile devices (Smales 2011). Open spaces in Hong Kong accommodate people using them in different ways, and are not policed in the ways that public spaces have been for gamers in North America. The TechnoSphere 2.0 design builds on the reappropriation of space that is already taking place in the city; this allows people, especially women, to engage with open spaces in ways we cannot fully predict, though we can be confident that the wider community will be accommodating.

In TechnoSphere 2.0, ALife and ubicomp are always already part of an entangled making that implicates humans and nonhumans. Like many working in the discipline of artificial life, modelling biological organisms and other systems using computing, both 1990s TechnoSphere and TechnoSphere 2.0 have been influenced by the work of Humberto Maturana and Francisco Varela who have written widely about the autonomy of biological systems. Their work, in particular their theory of autopoiesis, which preceded their writing on artificial life, has had significant impact on a wide range of disciplines that in turn influence current ubicomp thinking and practices. Autopoiesis describes the self-producing nature of bounded metabolic activity and one of their criteria for autopoiesis is that the system has an identifiable boundary. For Varela, autonomous systems that are also autopoietic, typically living systems, depend on those systems having organizational closure, "a topological boundary, and the processes that define them occur in a physical-like space, actual or simulated in a computer" (Varela 1981, 15). Varela goes on to argue that many systems that others have described as autopoietic are, instead, autonomous because they do not have topological boundaries, using as examples insect societies, human systems like institutions and animal societies. In each case he notes that the unity's boundaries are not topological and/or that the interactions within these 'wrongly categorized' autopoietic systems are not about the production of components, concluding "that these proposals are category mistakes: they confuse autopoiesis with autonomy. Instead, I suggest taking the lessons offered by the autonomy of living systems and convert them into an operational characterization of autonomy in general, living and otherwise. Autonomous systems, then, are mechanistic (dynamic) systems defined by their organization" (Varela 1981, 15). While drawing this important distinction between autopoiesis and autonomy, Varela nevertheless reaffirms the importance of organizational closure, stating once again "[w]hat is common to all autonomous systems is that they are organizationally closed" (Varela 1981, 15). Varela's perspective on autonomy has been criticized for this emphasis on closure and the secondary role that system-environment interactions play in his definition and constitution of autonomous systems. Artificial life researchers such as Barandiaran suggest "[i]ntroducing ideas from complexity theory and thermodynamics [. . .] [and a] ~~a~~ more specific notion of autonomy as a recursively self-maintaining far-from-equilibrium and thermodynamically open system. The interactive side of autonomy is essential in the definition: Autonomous systems must interact continuously to assure the necessary flow of matter and energy for their self-maintenance" (Barandiaran 2004, 515). Specific concerns about the acceptance of organizational closure implied by a wider adoption of autopoiesis, outside of the biological sciences, have been raised by researchers from a wide range of disciplines (Hayles 2010, 174; Parisi 2013; Loc 564; Stengers 2010, 447). Therefore rather than use the term "autopoietic" to describe the TechnoSphere 2.0 ALife project, we use the term "autonomous" meaning that the process is not organizationally closed but is dynamic, including human agents, autonomous ALife and inhuman networks of data in keeping with its ubicomp entanglements. In TechnoSphere 2.0 the creature's ALife boundary is extended beyond the ALife software running on the app, to include feedback from the location of the mobile device running the app, such as GPS locations, walking routes, and movements. In this example of causal coupling, creatures behave and evolve *with* human practices in a partially bounded, autonomous system.

In TechnoSphere 2.0 the entanglement of humans, mobile phone networks, ALife creatures, and practice becomes apparent, for example, when eating at a restaurant. "Nothing in Hong Kong is more satisfying than flooding friends with photos of our food" (Chen 2012)—the practices of taking photographs of food are popular in Hong Kong and are part of a growing global trend that has prompted camera manufacturers like Nikon, Olympus, Sony, and Fuji to develop cameras with a "food" mode setting. When TechnoSphere 2.0 practices activate creatures during dinner, creatures appear on the dinner table visible through AR. Human users can feed their creatures by accessing data from the restaurant's menu, sharing an affective experience with them. Human users are probably eating dinner, listening to music, and watching other screens as well as the artificial creature that they can see on their real table top via AR, making intra-acting with TechnoSphere 2.0 an entangled or 'polyaesthetic' experience. To engage with these creatures and their environment, humans need to use "multiple senses, and not only the senses of sight, hearing, and touch but proprioception as well" (Engberg 2014, 6). Human participants, looking at the screen and maneuvering physical objects on the table top AR, or navigating as they walk Hong Kong's streets while watching their creature run alongside in AR, need to, as Jay Bolter and Maria Engberg say, "occupy two locations at once" (Ibid). Locations in which different potentialities are enabled through their relational couplings.

Ubiquitous Couplings

In TechnoSphere 2.0, public places, technical structures and ALife become configured relationally through a process of entanglement. Designing for ubiquitous-ALife as entangled is very different to a design of 'interaction' as it engages with emergence through difference rather than opposition. As Lucy Suchman outlines, since Donna Haraway's eruption with the cyborg manifesto, feminist scholars have embraced "the inseparability of subjects and objects, 'natural' bodies and 'artificial' augmentations" (Suchman 2007, 140). Coupled with this has been a focus on the importance of the emergent milieu or what we might call the mattering processes (Kavka 2008; cited in Blackman 2012, 173). Classical models of causality might describe the new configurations of public places, ubicomp and ALife as a series of linear deterministic relations, whereby objects designed and 'used' by humans simply "do their thing" (Barad 2007, 130). However the ontological commitments of Karen Barad, Isabelle Stengers, and Gilbert Simondon suggest that ALife allows us to see alternate forms of causality and individuation within ubicomp which are neither linear nor circular, but transductive, coupled, and entangled. This coupling takes place through the process of intra-action, the mutual constitution of entangled agencies (Barad 2007, 33). That is in contrast to the commonly held model of interaction which assumes that there are separate individual agencies that precede their interaction. We suggest that the ontology of entities emerges through what Stengers might term their relational couplings, including couplings with practices and apparatuses of production as exemplified by Barad. Barad's elaboration on the complexity of emergence is not dissimilar to Simondon's conception of individuation.

To expand a little on how these theories differ from the aforementioned autopoietic theory, in autopoiesis a unity is a network of discrete components ~~produces components~~ that continuously regenerate the network devoid from any milieu. Here the operation of regeneration is distinct "from any relationship to a milieu, for there is no "milieu" (Stengers 2010, 259). Autopoietic theory is based on an analysis of ways that "living systems address and engage with the domains in which they operate" implying that that there is an easily determined boundary between living system and domain. This differs from the theories of Simondon, Stengers, and Barad, where the context emerges simultaneously with the individuation of the entity. Ideas of a 'unity' and a 'domain' in Varela's autopoietic theory might, at first glance, suggest that autopoiesis is not open, nor radically open, as previously discussed. As Whitaker has noted, this demonstrates "the difference between the open/closed dichotomy as it is employed comma in first-order cybernetics versus autopoietic theory" (Whitaker 1997, 6). However, writing about autopoiesis, Varela's mentor Maturana addresses his own use of the term 'closure' and ties its use to the system's organization, he then emphasizes that, structurally, autopoietic systems "operate as materially and energetically open systems (in continuous material and energetic interchange with their medium)" (Maturana, Autopoiesis: Reproduction, Heredity, and Evolution, 1980, 54). In contrast to Varela and Maturana's theories of interchange and regeneration with a medium, Simondon, Barad, and Stengers emphasize processes in which there is continual change and becoming for both entity and milieu. Diffractively viewed, Barad, Stengers, and Simondon's philosophy of ubiquitous-ALife does not exist in a continuous stable form but instead emerges into an already constituted field that alters both itself and other active elements in the field (Venn 2010, 139 cited in Blackman 2012, 173) albeit that for Barad the constituted field is itself always in a process of intra-actions. The important point is the recognition that the "milieu or setting operates as the technical actualizations of a potentiality" (Blackman 2012) within ubiquitous-ALife.

Conclusion

TechnoSphere 2.0 is constantly emerging as humans move around the city of Hong Kong with their mobile devices shadowed by any TechnoSphere 2.0 creature that lives on their device. Couplings of ALife and ubicomp become part of an entangled making between humans and nonhumans that extend the idea that artifacts are made through complex relations rather than in a top-down environment. TechnoSphere 2.0 is one example of what Stengers calls the new practical relationship between artifact and its maker. This is a relationship of making, of transduction, in which creativity and invention are unhinged from 'humans.' The making process is no longer "the logic of an inventor or a creator, but the logic of the invention of processes, objects and practices that produce themselves." A process of making enabled by the milieu that "generates the creative leap from the past and present of the pre-individual to the unknown future" (Grosz 2012, 43). The couplings of ALife and ubicomp in TechnoSphere 2.0 allow its participants to partially "see" an emergence in which they are entangled. As this ubicomp concretizes, adopting a particular structure, it "brings about the emergence of both individual and milieu" (Simondon 1992, 301). When TechnoSphere 2.0 becomes more widely available and we undertake playtests, one series of questions that we will ask is, not the 'age old' question of how to prepare the conditions for artificial creatures to "await breath" (Stengers 2010, 207) but instead *what* do these new relational couplings enable?

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