THE CHIME:
POETICALLY TRANSLATING THE DISCRETE DIFFERENCE OF AGNSOTIC SENSORS INTO A SONIFICATION OF THE CITY

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THE CHIME:

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By: Marc De Pape MDes Digital Futures, OCAD University, 2013

ABSTRACT

Inspired by Georg Simmel's notion of the blasé and Mark Weiser's vision for calm technology, this document detailing the application of critical concepts to the realization of a design intention is a critical and creative exploration of computation and the everyday. While paying particular attention to the conceptual underappreciation of acoustic space and place, I outline a case for poetically translating data collected from inherently agnostic sensors through the design, construction and use of an instrument for sensing environmental difference (comprised of 18 sensors measuring 27 data points) and exemplified through a musical sonification. A generative instrument, such as The Chime, takes external impulses and translates them poetically into a form that naturally casts the attention back upon the initial gust. In the built environment such treatment of discrete sensing could help engender what I call acoustic places; place that, even if for a passing moment, might resonate harmonically and reciprocally with the inspiration for its emission.

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ACCOMPANYING MATERIAL

The following accompanying material is available upon request from the Ontario College of Art & Design Library:

DVD: stereo mixes of The Chime's 14 performances in video (MOV) and audio (AIFF) form

Anyone requesting the material may view it in the OCAD Library or pay to have it copied for personal use.

INTRODUCTION

With the majority of the world now living in cities, the intersecting and interdependent systems that converge upon the metropolis are only gaining in complexity. Technology, it seems, is increasingly responsible for helping facilitate the navigation of these urban networks, be it spatially, socially, politically or financially. While network technologies have effectively reduced perceived and real distances and reshaped notions of time, they have done so predominantly in the name of modern efficiency and at the expense of individuality. Of course standards ensure the whole network is reliable and routine, yet on street level, no citizen directly experiences standards and protocols in the everyday. The city is built to work for its citizens, but why must its technology, embedded and mobile, personal and public, merely function? Can it not generate delight? I will argue it can through a process of poetic translation, where discrete digital sensing meets the environment of the everyday. Using the city's many scheduled and improvised impulses and flows as input, sensing can be used to emphasize the characteristic that renders the urban experience so vibrant: *difference*.

The blasé attitude, defined by Georg Simmel (1903) in "The Metropolis and Mental Life" as "an indifference toward the distinction between things" (p. 14), is still to this day a defining characteristic of the urban condition. One only has to look to the pervasive deferral of responsibility for difference recognition, for sensing, away from our innate human faculties on to our extensive and varied technologies. Yet, at the same time, the prevalence of these numerous instruments may be interpreted as sufficient evidence in favour of a greater collective awareness of difference than ever before. Empirically this might be true, however, the way we use these sensing instruments is predominantly in what Simmel describes as the "objective spirit", ensuring that our interactions with difference are reduced to matters of abstract metrics, most often optimized for economic exchange. In other words, sensed difference is overwhelmingly being put to functionally objective use. In addition to dramatically altering some of our most evolved abilities - such as spatial awareness, which can begin to atrophy thanks to an over reliance upon GPS - this goal

driven use of discrete data also contributes to an underdeveloped “subjective spirit”, where sense of self becomes about obtaining (a degree) or acquiring (a new dress) rather than developing or expressing individuality as a fluid and continuous process. In its stead, this objectivity has created “dividuals”, to borrow from Gilles Deleuze, citizens who represent abstract demographics performing normalized behaviour relative to their ascribed lot.

I will argue the predominance of visual concepts of space, and the resultant mapped and modeled abstractions, have marginalized notions of acoustic space. In addition, place has been, for the most part, philosophically ignored in favor of space. This is an observation that, when considered in tandem with the underaprreciation of acoustics, creates a potential conceptual arena I call *acoustic places*: sites that primarily exist to generate change over time, as opposed to feeding the normalization of a static model. Consequently, I argue that one strategy for addressing our contemporary blasé attitude is to engage with the translation process occurring between individuals and their sensing instruments. These objective instruments of engineering and science are incredibly efficient and accurate, producing vast amounts of valuable and empowering data, however, the resulting knowledge is never the direct product of the sensors. The sensors are agnostic. How we translate their output is what ultimately contributes to the “objective spirit”, in the case of engineering and science, or the “subjective spirit” when used in more personally expressive ways. By referring to these sensors as instruments I am intentionally reinforcing their potential for both representation and expression. It is simply a matter of translation. To support this argument, I will be referencing the production and contextual use of a multi-dimensional environmental recorder built with common sensors and inspired by naturally generative instruments such as the wind chime and Aeolian harp. Just as a traditional wind chime translates air currents into sound, I have mapped this system of sensors to the same aim, where the flows of the city become musically sonified.

The instrument, which I have named The Chime, is composed of 4 luminosity sensors, 4 IR motion detectors, 4 ultrasonic proximity sensors, 4 microphones (used as meters, not recorders) distributed across eight panels forming the octagonal enclosure that houses a data logging microcontroller. Embedded in the

lid is a digital thermometer, and hanging by thread below the main box, the brain if you will, is a 9 degree inertial measurement unit, or IMU, with X, Y, and Z for each of the embedded accelerometer, gyroscope, and magnetometer. This component is designed to catch the more physical gusts of the environment, winds and other such forceful currents (a fast passing car for example). These 27 data points are then fed into a Processing sketch (either live through wireless serial communication or via comma separated TXT file playback) that relays the processed data via Max For Live to a quadraphonic Ableton Live session, triggering music according to the programmed, or composed rules. These rules are my poetic translations. For instance, the key of the composition can shift either by a half or whole step for every degree above or below the degree ascribed to middle C (for example, I set the composition to 6°C with half step shifts for the recordings in the exhibition). The idea is to deploy The Chime as both a recorder and live performer in a variety of urban milieus where the sensed flows ultimately perform the composition. Just like a traditional wind chime, these performances, based on a fixed number of notes or rules, are unmetered, but not entirely random. The beauty of these instruments rests in their ability to reveal the expressive potential that exists within what may appear repetitive, mundane or banal on the surface, but which in actuality generates incredible difference. If that difference can be amplified, then maybe the blasé can be muted.

I begin with a section titled Critical Intent, which attempts to explain specific conceptual positions that informed my ideation, design and production process. Subsections within Critical Intent discuss public space, the nature of sound in terms of its behaviour and its representation, sensors and the translation process, the role of code, space versus place, routines of the everyday, and the generative from a ubiquitous computing perspective. The next major section addresses my creative process, followed by a section detailing the exemplars that resulted from the intersection of Critical Intent and Process. In the section titled Significance, I delve into a more personal reflection about the project. And finally, I finish with a conclusion, summarizing the project as a whole.

Please note that detailed ideation and production notes are included in appendices A and B respectively, should clarification about specific creative design decisions be needed. These appendicies are particularly useful for illustrating the long process that led me to The Chime and sonification. It should also be noted that sonification is the output this exploration, yet, as a result, it is also the next critical are of inquiry. One which I am keen to undertake in the future. But first…

Figure 1: The Chime in the city

CRITICAL INTENT

DIFFERENCE AS DEFINITION OF PUBLIC

> Hannah Arendt has described public space as the place where we encounter the stranger, a space of friction that breeds tolerance through encountering differences in opinion, social standing, ethnicity, economic background, etc. Yet so many of the applications being developed for iPods, Blackberrys, and mobile phones are oriented toward finding a partner with similar interests and maintaining constant contact with our established social networks or favorite places and things. So looking forward, it would seem one strategy for urban computing would be to reclaim urban space as a place for encountering difference. (Greenfield & Shepard, 2007, p. 39)

With the blasé central to this project, the notion of difference and how it relates to contemporary urbanity is an important topic to broach, for Simmel's concept is over a century old and thus needs to be recontextualized. Simmel (1903) defines difference rather simply: “Man is a creature whose existence is dependent on differences, i.e. his mind is stimulated by the difference between present impressions and those which have preceded” (p. 11). More specifically, the variety of difference brought about by change over time is the variety I wish to explore, and this definition fits.

The Mark Shepard quote that begins this section is taken from the first Situated Technologies pamphlet titled “Urban Computing and its Discontents” suggests that new technologies offer an opportunity for addressing the blasé attitude. However, the majority of applications have interpreted the affordances of these technologies as an opportunity to attract and group the similar in manner reminiscent of Deleuze’s “dividuals”. This is a common criticism of network culture as a whole and not exclusively as it relates to urban experience and notions of public space, a critique articulated quite clearly in the book *Networked Publics*, and in this passage from "Urbane-ing The City":

> Mobile urban friend-finders presume that the chief design problem posed by the city is how to connect to people in a landscape teeming with impersonal others; the city is a static social condition requiring technological solutions in response. Articulating the city as a dense ecology of strangers, veined throughout with invisible networks of friendship and acquaintance, urban computing takes on the function of “curing” anomie. (Williams, Robles, & Dourish, 2008, p. 14)

Though Arendt, as summarized by Shepard, empowers public space by focusing on the inherent potential for difference engagement present in all urban environments, many of the traits that foster this potentially rich variety are the very same that produce the tendency to withdraw found in Simmel's observation of metropolis citizens. Both Simmel and Ardent are clearly addressing the same concern, yet from different perspectives: that of diminishing public space particular to modern urbanity. They are both trying to understand what has become of difference, a characteristic of great importance to the vitality of cities. Simmel attributes this to the financial objectification of social relationships, where the laws of economics govern most urban relationships, rendering individuals essentially anonymous and purely functional. A perfect anecdote demonstrating the extent to which this has taken hold is my attempt to use The Chime at Toronto Dominion Place in downtown Toronto: as soon as I set the tripod on the ground of the plaza, I was told by a security guard that tripods were not allowed on the premise without express written permission from the owner, Cadillac Fairview, no matter the device attached. TD Place has no visible barriers to entry; however, in order to maintain the value of the space it must be protected from any unauthorized documentation. It is here where vision can be deceiving, for the public/private divide is invisible, yet demarcated in terms of intended use. Simmel terms this the “objective spirit”, which tends to subjugate the more expressive “subjective spirit” of the individual:

> The development of modern culture is characterized by the predominance of what one can call the objective spirit over the subjective; that is, in language as well as in law, in the technique of production as well as in art, in science as well as in the objects of domestic environment, there is embodied a sort of spirit (Geist), the daily growth of which is followed only imperfectly and with an even greater lag by the intellectual development of the individual. (Simmel, 1903, p. 18)

What is curious about the misplaced hope that networked technologies can somehow address this objectification and help promote difference is that the solutions are often closed systems that favor self-protectionist homogeneity under the guise of efficient functionality. Be it Blackberry Messenger, the Apple App Store, Sony’s various proprietary formats (Betamax, MiniDisc, Blu-Ray,), or automobile manufacturers who lock-down their engines with special screws requiring non-commercial bits, ownership of a particular device permits an individual to access a very specific type of experience or service (like membership to a club or gym), often highly controlled, or, to use a friendlier expression, expertly designed.

While competition is at the heart of a market system, implying that variety and difference are encouraged for the health of the economy, increasingly this difference is experienced at the exclusion of all others. There is a certain acceptance of uniformity, a willingness to be absorbed, in exchange for functionality: do not ask how how it works, just accept and praise the fact it does. Following the lead of the marketing world, it is no wonder network culture has managed to organize individuals into ever smaller niches; the technological infrastructures, by their very design, encourage consolidation and filtering, at first based on functionality and access, then for reasons foreshadowed by personal stereo (Walkman) use: “The analysis appears to suggest that users negate notions of `difference' in order to inhabit a transcendent and safe space of experience that is characterised as a managed and controlled space which might be referred to as a sonorous envelope (Anzieu, 1989)” (Bull, 2004, p. 114). Consequently, users are not only being restricted access to difference from within a system, but their technological choices have the potential to produce behaviour that resembles that of a blasé attitude.

There is nothing wrong with gravitating towards the comfort of the familiar. Except, when the familiar provides too much comfort, inflexible habits of practice and thought are tacitly encouraged, a condition common to niche group members reinforcing each other's purposefully esoteric point of view: “Given the vast number of possible clusters one can associate with, it becomes easy to find a comfortable niche with people just like oneself, among other individuals whose views merely reinforce one’s own. If the Internet is hardly responsible for this condition, it still can exacerbate it, giving us the illusion that we are connecting with others” (Varnelis, 2008, p. 150). Though the group itself is not inherently problematic, this trend has the potential to compromise the public space, which has traditionally been founded upon ideas of the collective at the expense of private interest. Consequently, the diminishing role of public space could be a byproduct of increased concentration of the like mined, who see acceptance in the closed spaces afforded by internet forums, as opposed to the potential scrutiny of more public options. This is not to suggest that difference should be magnified or amplified in order to reinvigorate public space, for the exaggeration of difference only produces more pronounced divisions; similarity and difference are in reality flip sides to the same coin. This fine line between difference and similarity is the challenge presented to contemporary

urban-inspired designers: how can technology be harnessed to encourage the perception of difference without creating it? This is the opposite of the objective spirit responsible for perpetuating the blasé.

There is nothing in Simmel's observation that suggests difference be put to any particular use, simply the notion that awareness of difference might encourage citizens to forge relationships based on subjective desires as opposed to objective goals. As Edward Relph (1976) observes, the unexceptional is still influential, or, in other words, difference does not have to be pronounced to be of significance: “More usually our experiences of perceptual space are fleeting and unexceptional, and accepted as part of the natural course of things. They are no less important for that, for it is these personal experiences of space that are the basis for much of the meaning that environments and landscapes have for us” (p. 11).

If public space in the 19th century was being threatened by the blasé’s withdrawing tendencies, today, technology has facilitated that withdrawal, taking public discourse out of public space and situating it in various forms of media: "Today, notions of “the public,” “publics,” and “public opinion” are formed more through cable and network news channels, internet blogs, and websites than on the sidewalks, streets, cafes, parks, or shopping arcades of the contemporary city" (Greenfield & Shepard, 2007, p. 39). While the contemporary discourse may appear to be richer because of the increased availability and variety of channels and outlets for anyone to opine, the argument previously made about network technology's tendency to filter out difference still applies. This sort of technologically mediated homogeneity is nothing new, and, as Edward Relph (1976) notes in *Place and Placelessness*, it can have spatial consequences: "In short, mass communication appears to result in a growing uniformity of landscape and a lessening diversity of places by encouraging and transmitting general and standardized tastes and fashions" (p. 92). Not only is public space losing its social relevance as a place where citizens come together to address matters of collective concern, but the differences between public and private spaces are being rendered visually indistinguishable thanks to the blanketing of outdoor space with commercial signage in the form of billboards and screens, making public space harder to identify (as my run in with security also evidences). Or as Manuel Castells (2004) notes: “It is the dissolution of public space under the combined pressures of

privatization of the city and the rise of the space of flows that is a historical oddity. Thus, it is not the past versus the future, but two forms of present that fight each other in the battleground of the emerging metropolitan regions" (pp. 91-92). It is not simply a matter of ownership of the public sphere (both in terms of property and influence), but the significance of site. The "space of flows" (global information technology networks) exists independent of the built form of the city (though certainly the city houses many of its functional components); it is a spatial layer organizing the productive use of the city while simultaneously blurring the distinction between private (both individual and corporate) and public. Here private represents self-interest, and public the collective, and as I have already argued, our network culture prioritizes the former over the later. As Antoine Picon (2008) notes, this divide makes it difficult to understand the contemporary urban experience, and I would add, makes it more difficult to perceive difference: "Another significant challenge, the most important perhaps, is the difficulty in reconciling the hyper-individualistic turn of contemporary life with the construction of a collective narrative in order to make sense of social life" (p. 40).

Hyper-individualism, here understood as the exaggeration of traits for self-interested distinction, does not necessarily reduce the prevalence of the blasé attitude, for exaggerated features are not equivalent to subjective difference. Rather it is objective difference fracturing notions of the public. While Picon argues that this turn is contemporary, and in many ways the emphasis on individual branding - the selling of one's merits for objective purposes - is a recent phenomenon helped by network culture services such as Twitter, Facebook and LinkedIn, this strategy is nothing new, as Simmel (1903) observes: "[...] life is composed more and more of these impersonal cultural elements and existing goods and values which seek to suppress peculiar personal interests and incomparabilities. As a result, in order that this most personal element be saved, extremities and peculiarities and individualizations must be produced and they must be over-exaggerated merely to be brought into the awareness even of the individual himself" (p. 19). What happens when the individual is valued over the collective, the private over the public, and the objective over the subjective? The result, as Simmel observes, is exaggeration in order to manufacture difference for self-awareness. But this is not the kind of difference that empowers public space. This is fractious difference,

selfishly pursued in order to break through the anonymizing power of the metropolis. The quintessential technological manifestation of this strategy is the personal audio player (Walkman, iPod). Here control, the same control over-exaggeration demonstrates, is exerted over the listener's sonic space, rendering it distinct from the absolutely shared soundscape of the city. This exaggerated hyper-individual isolation is the extreme consequence of the blasé. While the headphones alone convey a very clear visual message (leave me alone), the music being amplified is complicit in encouraging withdrawal:

> Music increasingly fills the gap left by the absence of any meaningful sense of the experienced social. Technology is perceived as paradoxically enhancing and increasingly constituting that impoverishment which, for Adorno, contributes to the dependency of the user/listener. Music as such becomes a substitute for community, warmth and social contact. In this isolated world of the listener a need arises to substitute or replace their sense of insecurity with the products of the culture industry, leading to new forms of dependency. (Bull, 2000, p. 129)

Before the advent of recording, music was a social event, transpiring in churches, festivals, and at the piano in the living room. With recording came sound objects, and for the first time music could be owned. While I have no intention of furthering the culture industry analysis put forth in the above quote, it is important to note that music, experienced as a broadcast, performance or emission, is public and thus social (both historically, and in the sense that some attention must be paid to one's physical environment in order to manage its sonic nature). However technology has now enabled music to be used for isolation purposes, paradoxically motivated by the need to foster a greater sense of social significance and subjectivity.

THE IMPOSSIBILITY OF SOUND OBJECTS

Abstraction for possession, the objectification of the transient for purposes of ownership and control, is one of the most problematic characteristics of current media and communication technologies. By its very nature, sound resists material transformation: "In general, one can possess only the 'visible' whereas that which is only audible is already past in the moment of its present and provides no 'property'" (Simmel, 1997, p. 116). Consequently, the ability to record has drastically changed notions of time, and has changed the social significance of events that formerly necessitated performance. It is perhaps for this reason that the speech act is so protected in democratic documents; it is not the visual, that which can be frozen in time,

which carries the greatest power, but the essentially temporal freedom of speech. The reason for this goes beyond the content of that which is spoken and to the nature of sound as vehicle for a message:

> A number of Bach's concertos were produced as a result of such a commission from a prince. Owning musical pieces that were withheld from all others was considered part of the nobility of a house. There is something perverse in this for our sentiments, because hearing is by its very nature supraindividual; what happens in a room must be heard by all who are present there, and the fact that one person receives it does not deprive another of it. (Simmel, 1997, p. 116)

While concerns about responsibility, accountability and veracity abound in studying the content of speech, I am more interested in its temporality. If public space is founded on notions of encountering, debating and reconciling difference for the collective good, with speech as the primary media/mediator, then it follows that public space is structured acoustically. Politically, this visual/audio binary parallels the discussion of the object/thing put forth by Bruno Latour (2005) in "From Realpolitik to Dingpolitik", where he argues contemporary political discourse is more focused on *objects of fact* rather than *things of concern*. Consider the striking similarities between how Simmel has articulated the nature of sound, and Hans Frei and Marc Böhlen's (2010) take on Latour from the sixth Situated Technologies pamphlet, titled "MicroPublicPlaces":

> An object stands out because of the unshakeable obstinacy of its factuality. It is considered perfect in itself, self-contained, and independent of the bad or good intentions of anyone who makes use of it. The owner of the object is also the owner and master of its properties. In contrast, a thing defies ownership. One can only take part in a thing, as for example one takes part in a court hearing or a soccer game. It is not possible to separate matters of fact - like the weight of a ball - from matters of concern - like the control of that ball. (p. 14)

Objects are much easier to understand because they are concrete and definable; you can point to an object and simply say 'that'. Even beyond the complex subjectivity of language interpretation, speech, music and sound in general are all much more difficult to identify objectively due to their fleeting and ephemeral nature. This is why public space is consistently in the process of being reconstructed and redefined. Change is constant. Hence the selection of sound as primary media, for my project carries more than mere aesthetic considerations, but represents both temporal and spatial concerns as well.

ACOUSTIC SPACE: THE SPACE OF DIFFERENCE

Acoustic space characterizes public space - the space where difference is supposed to be met - yet the question here becomes: how does difference come to be recognized in acoustic space?

It is strange that sound should be the sense upon which democratic and collective ideals are founded, particularly when you consider how the ear operates as embodied sound receptor:

> According to its very nature, the eye cannot take without simultaneously giving, whereas the ear is the egoistic organ pure and simple, which only takes, but does not give; its external formation seems almost to symbolize this, insofar as it seems to be a somewhat passive appendage of the human appearance, and by being the most immovable organ of the human head. (Simmel, 1997, p. 115)

There is a curious assumption at play here: freedom of speech, as a right, does not recognize listening as an essential complementary action to its realization. Does this reflect the aforementioned hyper-individualistic turn of contemporary society, where distinguishing oneself, no matter the level of exaggeration, no matter the volume, is of primary concern? As Kazys Varnelis (2008) notes in his conclusion to *Networked Publics:* "Networked publics are by no means purely democratic spaces in which every voice can be heard. That would be cacophony" (p. 156). Thus it is strange that the most egocentric organ is politically the weakest, and the cacophony of voices, be they on the web or in a crowd, render the ear ineffective. In my youth, I remember being taught that hearing and listening are two very different skills: one is naturally functional and the other is socially learned.

At the same time, Michael Bull (2004) has argued that sound is increasingly being used to foster individual identity and comfort: “Sound, more than any other sense, appears to perform a largely `utopian' function in this desire for proximity and connectedness. Mediated sound reproduction enables consumers to create intimate, manageable, and aestheticised spaces in which they are increasingly able to, and desire to, live” (p. 106). Be it Bluetooth ear pieces, headphones, portable stereos and even the tiny-tinny speakers found in smart phones, citizens increasingly exert sonic control over their urban environment in a very ego-driven attempt to combat the city’s imposed cacophony and carve out some semblance personal space; thanks to

audio technologies, they no longer have to hear or listen to any unwelcome external noises or voices, thus filtering environmental difference in the process. While the ear is the most egocentric sense organ, sound as previously articulated by Simmel, is also immediately popular, in the sense that as soon as it is emitted anyone can hear it. 'Will they listen?' is the big question, that is, if anyone chooses to make a sound at all:

> The interpersonal relationships of people in big cities are characterized by a markedly greater emphasis on the use of the eyes than that of the ears. This can be attributed to the institution of public conveyances. Before buses, railroads and trains became fully established during the nineteenth century, people were never in a position to have to stare at one another for minutes or even hours on end without exchanging a word. (Simmel in Benjamin, 1973, p. 151 from Bull, 2004, p. 136)

Here Bull is quoting Simmel in order to demonstrate a historical precedent for the behaviour he observed in his ethnographic study of personal audio players and their users. However, where the predominant conclusion drawn from such behaviour is that of withdrawal or retreat, both symptoms of a blasé attitude, Bull suggests that such an interpretation is predominantly founded on visual analysis:

> The belief that urban subjects are subjects in retreat has become a core explanatory framework of everyday urban behaviour. Alternatively retreat is perceived as a strategy of coping with an urban environment experienced as being inhabited by 'strangers' and hence dangerous. This is typical of visual explanations of urban behaviour that locate motivation completely in terms of supposed response to the environment. (Bull, 2004, p. 137)

While it is accepted that sonically controlling one's environment, either through voluntary silence or selected soundscape, is a coping strategy, it does not necessarily prove to be a symptom of the blasé. As Brandon LaBelle suggests in *Acoustic Territories*, the use of such technology might in fact be an active response to the dominance of visual culture as opposed to an acceptance of it: "The geographies promulgated by sound then give dynamic space for ducking and diving the writing occurring between body and law, which may support understanding of the intensification of iPod use and the emergence of sound culture as a counter to the semiotic, imagistic, and ocular demands of modern society" (LaBelle, 2010, p. 100). While, not quite saying hello to everyone while walking down the street, it is important to note that sound can and is being strategically used to combat a blasé attitude, even if the visual cues might suggest otherwise. In a way, they are cries for help that ironically go unheard.

ACOUSTIC ABSTRACTION

> The first is that everything, but everything, is spatially distributed, down to the smallest monad [...] Second, there is no such thing as a boundary. All spaces are porous to a greater or lesser degree [...] Third, every space is in constant motion. There is no static and stabilized space, though there are plenty of attempts to make space static and stable [...] Fourth, there is no one kind of space. Space comes in many guises: points, planes, parabolas; blots, blurs and blackouts. (Thrift N. , 2006a, pp. 140-141)

In his eloquent book *Space and Place*, Yi-Fu Tuan (2001) does a beautiful job of describing how space and place are experienced from a human perspective. However, in the process he reinforces and normalizes the dominant power of our visual faculties: “Taste, smell, skin sensitivity, and hearing cannot individually (nor perhaps even together) make us aware of a spacious external world inhabited by objects. In combination with the "spatializing" faculties of sight and touch, however, these essentially nondistancing senses greatly enrich our apprehension of the world's spatial and geometrical character” (p. 12). It is troubling that Tuan considers only sight and touch as spatializing faculty. Even more troubling is the notion that sound is "nondistancing" considering that sound *must* travel across distances to be heard. As the personal audio player clearly demonstrates, sound can have a dramatic effect on social distancing, for the sonorous envelope created by these devices affects both perceived space and distance. Even without technological mediation, our ears provide more than just access to acoustics for the purpose of reinforcing the visual. Ears help our bodies maintain balance and contribute greatly to our sense of direction, both of which are further evidence that sound is just as "spatializing" as touch and vision. In fact, all of our senses work in concert to construct systematic impressions of space; any representation of space that isolates one particular sense is thus incomplete.

In "There Are No Visual Media", W.J.T. Mitchell (2005) rightfully argues for the abolition of the term "visual media" because all media are inherently multi-sensorial experiences. In the course of his argument, he references Bishop Berkeley's *New Theory of Vision*, which "argued that vision is not a purely optical process, but involves a 'visual language requiring the coordination of optical and tactile impressions in order to construct a coherent, stable visual field" (p. 402). Mitchell goes on to explain that Berkeley's conclusion was based on the behaviour of recovering cataract surgery patients who needed to employ touch

in order to properly spatialize objects in their environment. Mitchell also references Marshall McLuhan in the article, explaining that:

> McLuhan was happy to use terms such as 'visual' and 'tactile media', but his surprising claim (which has been mostly been forgotten or ignored) was that television, usually taken to be the paradigmatically visual medium, is actually a *tactile* medium: 'The TV image... is an extension of touch' (p. 354), in contrast to the printed word which, in McLuhan's view, was the closest that any medium has come to isolating the visual sense. (Mitchell, There Are No Visual Media, 2005, p. 261)

While it is interesting that McLuhan associates television with tactility, complementing both Tuan and Bishop Berkeley's arguments for the pairing vision and touch, I would like to pick up on the notion that the printed word is the quintessential visual medium. In the first chapter to McLuhan's *Laws of Media* (1988), titled "Proteus Bound: The Genesis of Visual Space", he and Eric McLuhan articulate the power of the written word, going so far as to conclude that the alphabet is responsible for all contemporary and historical notions of visual space:

> Visual space is a man-made artifact, whereas acoustic space is a natural environmental form. Visual space is space as created and perceived by the eyes *when they are abstracted or separated from the activity of the other senses.* With respect to its properties, this space is a continuous, connected, homogeneous (uniform), and static container. Visual space is man-made in the basic sense that it is abstracted from the interplay with other senses and their specific modes. This abstraction occurs by the agency of the phonetic alphabet alone: it does not occur in any culture lacking the phonetic alphabet. The alphabet is the hidden ground of the figure of visual space. (original emphasis McLuhan, p. 22)

The visual concepts of figure and ground are, according to McLuhan (1988), the product of abstracting speech into letters and phonemes, where “the sound and sign of the phonetic alphabet are in no dynamic relation or interplay; one simply *stands* for the other. Both are abstracted from all meaning or relation” (p. 18). While this eloquently articulates how the timeless abstraction and division of a speech act is meaningless without the complementary symbols, more importantly it explains how sound cannot be static from a phenomenological perspective. It is impossible. Beyond any notion of exactly how small of a smallest interval by which to atomize a sound event in order to define its essential element - and no, pitch will not suffice because of the complexity of noise and the reflective properties of all waveforms - sound is understood through undulation, or more simply change. Time is sound's essential element, which makes it very difficult to abstract. Or as Michael Bull (2000) summarizes rather succinctly: "Vision thus attempts to

impose order upon flux by attempting to fix objects, whilst sound is transitory" (p. 118). This aligns with McLuhan's proclamation that "acoustic space is a natural environmental form", for change over time, or difference, is one of life's great certainties.

MAPS: IMMEDIATE ANACHRONISMS

Returning to the urban, noted Marxist spatial theorist Henri Lefebvre (1991) draws one potential political conclusion to McLuhan's analysis when he states "The ideologies which have to be destroyed for our immediate purposes are those which promote (abstract) spatiality and segmented representations of space" (p. 90). And there is no better example of the visual abstraction of space than the map.

I began this project exploring wayfinding and global positioning systems, two topics that seem to be most frequently represented through mapping, often without question as to whether or not the form is appropriate to the content. Having come to my studies from four years producing content for a museum, I brought wayfinding and mapping with me as residual design problems left to be addressed. However, I struggled to find an angle with which to approach the challenge. Then I came across this pointed statement from the article "Entering a risky territory: space in the age of digital navigation" by November, Comacho-Hubner and Latour (2010): "The very idea of a time separated from a space (as if a fourth dimension had to be added to the three of `commonsense', as if living in a Euclidian space was commonsense!) comes from dreaming over a map too long" (p. 596). This summed up my reservations rather succinctly.

Prior to my studies, I had plied my craft in time-based arts, primarily video and music, with some site-specific interactive installations. What they all had in common was time. Though I possess visual sensibilities, I have never considered myself a visual practitioner. Consequently, I added narrative to my wayfinding studies in order to qualify my particular approach while simultaneously bringing some of my previous expertise to the subject. In reading Michel de Certeau's *The Practice of Everyday Life* (1984), I found an even better conceptual frame for my take on wayfinding: *the tour*. With this term de Certeau describes a specific type of spatial navigation, one based more on corporeal experience than the factual,

knowledge based navigation encouraged by maps. These two strategies attempt to address the same issue, one where "description oscillates between the terms of an alternative: either *seeing* (the knowledge of an order of places) or *going* (spatializing actions)" (p. 119). Maps are seen, whereas tours are acted.

Much of *The Practice of Everyday Life* addresses the power structures of everyday life, focusing on macro-level impositions called *strategies* (such as laws) and micro-level creations called *tactics* (such as *la perruque*: stealing a little time for personal-interests while on the clock). The city is the stage upon which these strategies and tactics play out. For de Certeau, modernism's strategic abstraction and modeling of everyday life in the name of efficiency devalued the tactical way in which those actually living within everyday life navigate it. Hence his rather stern reprimand of efficient mapping:

> In order to give an account of these practices, I have resorted to the category of "trajectory." It was intended to suggest a temporal movement through space, that is the unity of a diachronic *succession* of points through which it passes, and not the *figure* that these points form on a space that is supposed to be synchronic or achronic. Indeed, this "representation" is insufficient, precisely because a trajectory is drawn, and time and movement are then reduced to a line that can be seized as a whole by the eye and read in a single moment, as one projects onto a map the path taken by someone walking through the city. However useful this "flattening out" may be, it transforms the *temporal* articulation of places into a *spatial* sequence of points. A graph takes the place of an operation. A reversible sign (one that can be read in both directions, once it is projected onto a map) is substituted for a practice in dissociable from particular moments and "opportunities," and thus irreversible (one cannot go backward in time, or have another chance at missed opportunities). It is thus a mark *in place of* acts, a relic in place of performances: it is only their remainder, the sign of their erasure. Such a projection postulates that it is possible to take the one (the mark) for the other (operations articulated on occasions). This is *quid pro quo* typical of the reductions which a functionalist administration of space must take in order to be effective. (de Certeau, 1984, p. 35)

I have found no better critique of functional abstraction than the above, and find the use of the term trajectory to be a particular brilliant inclusion. For it is one thing to argue that maps, and visual space in general, impose stasis on that which is always in flux (a fundamental characteristic that immediately renders any map an anachronism the moment it is completed), but it is particularly astute to observe that even when mapping tries to address change it fails to properly articulate the sequence of events. And when they do, they simply designate directional significance with a mark, another abstraction as damaging to overall meaning as each letter of the alphabet.

This is a stinging critique, and one that applies to contemporary practices. As Kazys Varnelis and Mark Tuters (2006) note: "Broadly speaking, locative-media projects can be categorized under one of two types of mapping, either annotative— virtually tagging the world—or phenomenological—tracing the action of the subject in the world" (p. 359). While the multitude of traceable dimensions afforded by mobile networked technology certainly increases the fidelity and significance of the data being mapped, they still have a tendency to reduce all input to a mark (though that is diminishing thanks to the variety of data able to be collected and situated at any given moment). Fortunately, as Antoine Picon (2008) recounts in "Towards a City of Events": "Recent developments in urban mapping have followed this line and considered events as landmarks that can define our contemporary city as much as monuments do" (p. 38). Much like considering the fall of the Berlin Wall as an event rather than as a geographic feature redefines the significance of all prior and future maps of the city, a narrative form of wayfinding, a tour if you will, offers a form of mapping that takes into account the trajectory of the place, giving equal meaning to the journey as the destination. While my work does not take the form of a traditional guided tour through the city, nor a tour of the artistic variety such as the walks produced by Janet Cardiff and George Bures Miller, the use of generative sound parallels the experience of a tour: every step or gesture is, to use de Certeau terms, a rhetorical impulse propelling the chosen trajectory onward.

AGNOSTIC SENSORS

> There are data of the greatest relevance today, furthermore, that it would be very difficult, if not impossible, to map at all. For example, where, how, and by whom, and to what purpose is information stored and processed? How is computer technology deployed and whom does it serve? We know enough in this area to suspect the existence of a space peculiar to information science, but not enough to describe that space, much less to claim close acquaintanceship with it. (Lefebvre, 1991, p. 86)

The above passage is from Henri Lefebvre's *The Production of Space*, published in 1974. Though the mapping of the "space peculiar to information science" has made significant strides since - one only has to look at the growing adoption and demand for information visualization and visual analytic tools - the larger concerns posited have not been answered, even with the greater volume and resolution of data at our disposal. Maybe this is a result of our reliance upon abstraction, both visual and logical, where the input

methods contributing to this space (engineered sensors of natural phenomena and points of manual technological interaction, such as a bank machine) are poorly equipped to understand intent. This is not to say that profound patterns of behaviour cannot emerge, and that natural phenomena cannot be modeled so as to better understand their behaviour for projection purposes: “The world is reconfigured as a global trading zone in which network forms, which strive for co-ordination, are replaced by flow forms which strive for observation and projection” (Thrift, 2006b, p. 590). Rather, it is simply important to remember that all these input methods are essentially agnostic. Agnostic in the sense that they respond to environmental stimuli and phenomena yet ascribe no meaning to the perceived change. Following the religious metaphor further: they lack a doctrine by which to evaluate what they have sensed. They respond according to their programmed biases (sensitivity to phenomena) and pass no judgment upon the collected data. Code provides judgement, evaluation, and meaning. Code is the doctrine.

Data is a new natural resource (unnatural as it may be), and like all natural resources, the question becomes one of intended use, as opposed to nature. What is interesting in the context of difference and the blasé, and an observation which supports my agnostic characterization, is the fundamental reduction being performed whenever data is collected: no matter how complex the phenomena, in the end, it exists as a collection of binary bits. Thus it is imperative to maintain the contextual threads that connect recorded sensor data with that which it is tuned, otherwise, any observed or sensed difference gets lost in the binary reduction. Today, the vast majority of applications favour using data to abstract, map, and/or model for the purposes of prediction, with finance and weather being the most prominent examples, though elections and sports are not too far behind with both arguably producing data more frequently than, say, hurricanes (there are certainly more games and votes globally per year than violent storms, though storms likely last longer and produce a greater quantity of data). This is all to say that data may be the first infinite resource at our disposal. However, like the application of most resources, the ends do not justify the means, or in this context, the predictions should not obscure the intentions.

Let us return to the agnosticism of input methods, sensors in particular. As I have already implied, all input methods are biased by design. Luminosity sensors are biased towards the measurement of light frequency and intensity. Compasses are sensitive to magnetic fields. This biasing is a reflection of functional optimization more so than a matter of stance or opinion; it is a quantitative as opposed to qualitative biasing. One could argue that the clock was the first mechanically engineered sensor, abstracting the smooth cycle of days into a logically stepped series of discrete points. Much in the same way the alphabet dissected the continuity of the spoken word, where prior to its invention words were wholly indivisible entities that had be communicated totally uninterrupted in order to be understood, the clock has done the same to time: "With the advent of modernity time has vanished from social space. It is recorded solely on measuring-instruments, on clocks, that are as isolated and functionally specialized as this time itself" (Lefebvre, 1991, p. 95).

Clock time became a measure of functional productivity across very specific intervals, as opposed to social patterns of time, which were largely built on qualitative observations relating to such patterns as season or daylight where the precision of the reading bore little consequence to the intended outcome. This is what I mean by agnostic and biased: clocks have no direct link to increased productivity, yet are its optimized measuring instruments. The significance of the instrument becomes a matter of translation found in the analytic parameters that determine points of discrete difference (a clock is still valuable outside realms of efficient optimization, such as timing in sports or cooking, where the very same measured intervals have a different ascribed significance). These parameters are imposed by humans, yet administered today most prominently by computer code.

POETIC TRANSLATION

With the introduction of this sensor/data/code relationship, I would like to articulate how a more figurative use of data, through code, might help distinguish difference in a manner that might defuse a blasé attitude. To begin, it is important to note that while the human body is equipped with incredibly sophisticated

sensing apparatuses, it is still limited, both in terms of types of sensing and more importantly in terms of reach:

> Our primitive senses no longer suffice for critical intellectual navigation in an age of synthetic design. Magnetic flux, infrared waves, ultra-sonic sound are just a few of the worlds closed to our primitive sensory organs. Beyond expanding our own sensory perception ranges, sensors change our temporal orientations. They do not tire, do not blink and do not need rest. Combined with mesh-works they can span large distances to become all perceiving. (Frei & Böhlen, 2010, p. 20)

Rather than have sensing exist in biased isolation, finely tuned to a single variable, sensing has evolved to maintain its functional ability to measure while also integrating itself into the complex systems of the lived world from which it extracts data, thanks to advancements in networking capabilities. This is important because without the thread back to the original context from to evaluate the data, all sensing lacks significance and quickly becomes conjecture:

> Noise. Noises. Rumours. When rhythms are lived and blend into another, they are difficult to make out. Noise, when chaotic, has no rhythm. Yet, the alert ear begins to separate, to identify sources, bringing together, perceiving interactions. If we don't listen to sounds and noises and instead listen to our body (whose importance cannot be overvalued) usually we do not understand (hear) the rhythms and associations which nonetheless comprise us. (Lefebvre, 2006, p. 219)

Lefebvre is suggesting that a relationship needs to exist between sensor and the information being sensed. The process of sensing within a context is what allows for the filtering of noise and the perception of patterns, the emergence of rhythms. Without a proper context, the sensed data becomes so noisy that in essence it becomes a rumour, unable to be verified or substantiated. There is a big difference between a rumour and the figurative (even if one may find much figurative language inside a rumour), for the former is an incomplete thought and the latter an imaginative proposition. In short, the data needs to be translated; it is a necessary part of the sensing process, one of reintegration after abstraction.

In information theory noise is to be reduced for effective communication, however noise generated during translation as opposed to the transmission can be viewed as valuable, and necessary, feedback:

> Translation is inherently dialogic: it does not merely transfer information, but is rather productive of information through transference. Translations always strive to be 'loyal' – to create bridges – but ultimately must take a 'leap' of faith into a new language. In this sense, and in accordance with Shannon-Weaver's information theory, translation, as mediation, always creates some 'noise'

> which accumulates as new information. Translations and especially retranslations, we might say, are feedback loops that operate cybernetically. (Darroch, 2008a, p. 9)

The above is from the article titled "Language, Translation, and the Telematic City" by Michael Darroch, in which he explores theories of translation and their relationship to notions of the city through the work of Vilém Flusser. The translation concepts addressed by Darroch (2008a) in the article, notably those of Benjamin, Wittgenstein, and Derrida, resonate with the language metaphors used by de Certeau (such as the rhetoric of walking) reinforcing the notion that the city possesses great narrative potential:

> Semiotic theory has sought to see the city as readable through its signifying forms: the grammar of space versus the actualising expression of place, city dwellers compelled to 'read' the city through their movements and to 'speak' the city through their actions. The perception that the city itself is discourse – written, translated, and deciphered by its inhabitants – is put forward by Barthes (1986) in his early outline of a 'semiology of the urban', cited at the outset. In each of these perspectives, language is viewed as more than a constituent element of the city: the city itself is a language spoken by its users in everyday practices. (p. 3)

Here is the Barthes quote as referenced in the article:

> The city is a discourse and this discourse is truly a language: the city speaks to its inhabitants, we speak our city, the city where we are, simply by living in it, by wandering through it, by looking at it. Still the problem is to bring an expression like "the language of the city" out of the purely metaphorical stage. It is very easy metaphorically to speak of the language of the city as we speak of the language of the cinema or the language of flowers. The real scientific leap will be realized when we speak of a language of the city without metaphor. (p. 1)

What is interesting here is Barthes desire for a literal, scientifically functional language of the city, suggesting the figurative metaphors are somehow lacking. This to me goes against the arguments put forth by de Certeau, where he sees the ingenuity of the city and its inhabitants in their tactical, almost poetic, manipulation of the more structured strategies of the city. This ingenuity is all about figurative translation, the rhetorical potential of juxtaposing defined forms for novel purposes. A view of the city as linguistically efficient, where the translation of meaning from city to citizen is perfect, where no noise is ever produced, would be a narratively impoverished one.

It is difficult to properly frame my notion of poetic translation since, for the most part, translation theory approaches the subject from the point of view of conveying the original meaning or the author's intent. In

the context of the city, who is the author and what is their intent? When it comes to putting data to use, what is its intrinsic meaning? This is why, increasingly thanks to the ubiquitous sensing networks of the contemporary metropolis, Barthes desire for a literal language is both coming to fruition and revealing itself to be problematic. Thankfully, Walter Benjamin (2000) opens up the possibility for a certain poetic license, so long as the translator is emphasizing essential information found in the source material:

> But do we not generally regard as the essential substance of a literary work what it contains in addition to information -- as even a poor translator will admit -- the unfathomable, the mysterious, the "poetic," something that a translator can reproduce only if he is also a poet? This, actually, is the cause of another characteristic of inferior translation, which consequently we may define as the inaccurate transmission of an inessential content. (p. 1)

If the city possesses a unique language, especially if that language is composed of data, it is the translator's responsibility to not only reveal, but emphasize its unique significance: "Rather, for the sake of pure language, a free translation bases the test on its own language. It is the task of the translator to release in his own language that pure language which is under the spell of another, to liberate the language imprisoned in a work in his recreation of that work" (Benjamin, 2000, p. 4). It is no exaggeration to say that the translation of data from discrete bits to sensed output carries a responsibility as great as that of moving from one spoken language to another. Marshall McLuhan saw computers as a potential equalizer, an electronic Tower of Babel, capable of reducing noise and creating a certain linguistic unity across languages. While advancements in linguistic processing have certainly improved computation-based translation, the *sensus communis* which the city formerly represented, and which McLuhan hoped would reemerge, has not been restored:

> Now that by electricity we have externalized all of our senses, we are in the desperate position of not having any *sensus communis*. Prior to electricity, the city was the sensus communis for such specialized and externalized senses as technology had developed. From Aristotle onward, the traditional function of the *sensus communis* is to translate each sense into the other senses, so that a unified, integral image is offered at all times to the mind. The city performs that function for the scattered and distracted senses, and spaces and times, of agrarian cultures. Today with electronics we have discovered that we live in a global village, and the job is to create a global city, as center for the village margins. The parameters of this task are by no means positional. With electronics any marginal area can become center, and marginal experiences can be had at any center. Perhaps the city needed to coordinate and concert the distracted sense programs of our global village will have to be built by computers in the way in which a big airport has to coordinate multiple flights. (McLuhan, 1987, pp. 277-278 as cited in Darroch, 2008b, p. 166)

There is clearly something beautiful in the hope that computational power will be able to reanimate a common sense back into the city, rendering it a place where a vast variety of stimuli are unified through translation. The reason a common sense has not returned to urban environments is because sensors are predominantly biased to the isolation of phenomena for reasons of linear causality. To suggest that these sensors be used to harmonize multidimensional relationships through a unifying common sense implies that a common sense exists a priori, rather than emerges as a byproduct of the interdependencies of a complex network, as the information generated through translation, or the noisy feedback. This is why computational translation can never be a true unifier; it would eliminate noise, and thus close the system:

> On the one hand, general machine translation is achievable only if some kind of universal characteristic transcending all linguistic variation does exist. If this universal character were discovered, then translation would become a superfluous activity, as it would be far more efficient to use such a universal character directly. On the other hand, if general machine translation is impossible precisely because there is no universal characteristic, then translation is ultimately necessary as the only means to negotiate linguistic diversity. “Ironically, universal MT is possible only if it is ultimately superfluous, and necessary only if it is fundamentally impossible” (Gunkel 1999: 75). (Darroch, 2008a, p. 8)

While perfect mechanical translation may be impossible, and thus paradoxically necessary, this impossibility justifies employing figurative computation methods in order to perform the function of McLuhan's common sense: the translation of one sense to another. In my opinion, there is a poetic, generative beauty in the noisy inefficiency of this process, giving the sensed data a complimentary figurative existence alongside the literal one it was engineered to represent.

CODE/SPACE AND ‘DIVIDUALS’

As I have already discussed, modernism has imposed a predominantly rational translation upon collected data, favouring linear causality over more social or subjective interpretations: "All emotional relationships between persons rest on their individuality, whereas intellectual relationships deal with persons as with numbers, that is, as with elements which, in themselves, are indifferent, but which are of interest only insofar as they offer something objectively perceivable" (Simmel, 1903, p. 12). Indifferent is another way of saying agnostic; numbers are purely objective, they do not care. Of greater importance for the moment is that that which is "objectively perceivable" has taken precedence over that which might be considered

emotional or affecting. In these instances the measured differences become quantifiable and thus interchangeable, which renders their particular variety of difference impoverished (in the sense that there is less variety in terms of types of difference within their measure) in comparison to sensed differences, which might be translated across a rich emotional spectrum. As a result, individual subjectivity has been compromised to the point where individuality is but another abstract metric: "We no longer find ourselves dealing with the mass/individual pair. Individuals have become "dividuals", and masses, samples, data, markets, or "banks"" (Deleuze, 1992, p. 5). This makes the challenge I have proposed all the more pressing and increasingly difficult: how can sensors and their data be put to figurative use when those responsible for their translation are themselves data removed from a particular context? Or as Lefebvre might describe it: translators listening to their bodies as opposed to their environments?

A potential solution becomes clear: imbue the ignored environments with poetic translations of their routine behaviour. Take the overly objective interactions with the city as input, and program, through code, non-linear translations in order to hopefully recover some sense of subjectivity in the metropolis. Like all languages, code can be put to both literal and figurative use. While, like any formal language, it has rules that govern its structure (syntax), it is always simultaneously capable of effectively communicating and creatively inspiring. In addition, just as much of everyday language is used pragmatically, much coding is done towards a specific functional end. When distributed across the city, it provides an extra layer of translation where "Software signals a fundamental reorganization of the environment, a vast system of distributed cognition through which the environment increasingly thinks for itself, an extra layer of thinking" (Thrift & French, 2002, p. 329). Yet, software's influence can have a more fundamentally transformative effect beyond simply providing an extra layer of abstract analysis. Software has the potential to respond.

In order to understand how code can be a translator, it is important understand how it acts upon contexts: "The effects of software (code) on the spatial formation of everyday life are best understood through a theoretical framework that utilizes the concepts of technicity (the productive power of technology to make

things happen) and transduction (the constant making anew of a domain in reiterative and transformative practices)" (Dodge & Kitchin, 2005, p. 162). This definition ascribes code the power to act upon specific situations (technicity) thus engendering a new iteration of that which it responded to (transduction). In essence, code is both responsive and generative. When technicity and transduction are combined with lived environments the result is an entirely new kind of space: "Code/space occurs when software and the spatiality of everyday life become mutually constituted, that is, produced through one another. Here, spatiality is the product of code, and the code exists primarily in order to produce a particular spatiality" (Dodge & Kitchin, 2011, p. 16). In the instance of a code/space, software is responsible for the space's existence. So, how exactly does code produce such spatiality?

> Code solves relational problems by acting as a catalyst for transductions to occur and sustaining individuations within a modulation. Code changes the conditions through which everyday life occurs because it modulates how other technologies function. Code enhances the technicity of coded objects and infrastructures, enabling them to perform as intended; using a computer to access an online shop transduces, that is, alternatively modulates, how a person buys goods. (Dodge & Kitchin, 2005, p. 171)

As Dodge and Kitchin state, code solves relational problems, such as how to respond to a low than desired temperature in the home (turn on the furnace), by acting as translator, or transducer. However, it is more sophisticated than simply flipping a switch. Code allows for the existence of online shopping by creating a space for online shopping. Another prime example given in *Code/Space* is the airport check-in desk. Today, if the software running any check-in desk ever crashed, that space, the space we know as an airport, would be an airport by reputation only. Without software, the functional intent of the space is nullified, rendering it, practically speaking, a hangar: a place to temporarily store something and protect it from the elements (in this case, passengers).

While this weaving of the spatial and computational allows for unprecedented types of spaces, I ask: where are the creative code/spaces of the city? Check-in desks existed before computers; they have merely been rendered dependent upon computational power. Where are the truly novel forms of code/space? My answer is they have yet to materialize because of a predominant functional application of code to space. Or as

Malcolm McCullough (2004) says: "Whatever our desire for a “sense of place”, we seem destined to get “places with sense" (p. 172).

THE POTENTIAL OF ACOUSTIC PLACES

Acoustic space, as I have framed it up until now, affords me an interesting angle with which to approach my work. While I have dedicated much to establishing my position on how visual and acoustic space affect notions of the public and difference, it is in fact place that I am far more interested in. In *Digital Ground*, Malcolm McCullough summarizes the state of discourse around place with the following point: "Whether by scientific, theological, or architectural construction, modern space has been abstract, absolute, extensible, metric, universalizing, objectifying. If it has not been lost outright amid these spatial tenets so central to modernity, place has at the very least been reduced to mere location" (p. 176).

The definition and utilization of place as location is the strategy employed by many location-based applications, with GPS navigation a prime example. My problem here is twofold. First, this prioritizes the destination over the journey, and second, it abstracts location to a mark on a map. Even from a more humanist approach, ignoring for a moment any technological mediation at play, Yu-Fu Tuan (2001) suggests a strikingly similar distinction: "if we think of space as that which allows movement, then place is pause; each pause in movement makes it possible for location to be transformed into place" (p.6). This is a common interpretation: place is where space goes to die.

Michel de Certeau's (1984) choice of the word trajectory is obviously no accident; not only does the word afford an excellent entry into criticizing mapping, as previously addressed, but it also serves as a key term in his definition of space: "A *space* exists when one takes into consideration vectors of direction, velocities, and time variables. This space is composed of intersections of mobile elements. It is in a sense actuated by the ensemble of movements deployed within it" (p. 117). This certainly echoes Tuan's choice of words. For de Certeau, trajectories define spaces because they carry the narrative, the journey, the movement, where "What the map cuts up, the story cuts across" (p. 129). While I certainly agree that infusing any spatial

discussion with temporal concepts is welcome, for reasons McCullough outlined above, I must ask what trajectories do places carry, if any? What stories do they tell? Here is de Certeau's explanation: "Places are fragmentary and inward-turning histories, pasts that others are not allowed to read, accumulated times that can be unfolded but like stories held in reverse, remaining in an enigmatic state, symbolizations encysted in the pain or pleasure of the body" (p. 108). In other words, they are composed in past tense. They are dead. This is not a hyperbolic interpretation:

> [..] the opposition between "place" and "space" will rather refer to two sorts of determinations in stories: the first, a determination through objects that are ultimately reducible to the *being-there* of something dead, the law of a "place" (from the pebble to the cadaver, an inert body always seems, in the West, to found a place and give it the appearance of a tomb); the second, a determination through *operations* which, when they are attributed to a stone, tree, or human being, specify "space" by the actions of historical *subjects* (a movement always seems to condition the production of a space and to associate it with a history). (de Certeau, 1984, p. 118)

Stories are the primary *tactic* employed to navigate everyday life. This is a consequence of the "proper", defined by de Certeau as "*a triumph of place over time*" (p. 36) (one of the power strategies frequently referred to in the book) where place is a substitute for the word stability (p. 117), or from the point of view of the tactician "*space is a practiced place*" (p. 117). Here, I have presented 3 different de Certeau statements that suggest that place is static, or to use Tuan's term, pause. Places have no agency in and of themselves. Hence the need for stories. For stories "carry out a labour that constantly transforms places into spaces and spaces into places" (p. 118).

By now it should be clear that I believe sound, and acoustic space, to be underrepresented concepts in the construction of urban public space. While I have no intention of negotiating, nor enlightening, political power structures through my work as de Certeau has, I believe the conceptual devaluation of place represents a similar creative opportunity as that of sound. Contemporary places treat their history as though it is dead, or something available when politically or sentimentally convenient. Marc Augé wrote of contemporary supermarkets and airports as non-places, specifically for the way they ignore historical narratives:

> The hypothesis advanced here is that supermodernity produces non-places, meaning places which are not themselves anthropological places and which, unlike Bauderlairian modernity, do not integrate the earlier places: instead these are listed, classified, promoted to the status of "place of memory" and assigned to a circumscribed and specific position. (Augé, 1995, p. 78)

In other words, places are still frequently being mapped and reduced to historical marks in time. This, we have heard before.

What was rather prescient of de Certeau was his recognition that there can be more than one narrative direction. Not simply in terms of the number of possible paths by which one can rhetorically walk the city, but in the sense that, today, everyone has access to a multitude of simultaneous histories because of the way network culture has been structured (databases, search engines, blogs and forums leave traces, each representing unique trajectories). In addition, to suggest that histories are inverse trajectories, dead narratives, plays in to the entrenched modern notion of progress, which has a tendency to overvalue the future. This was the point of much of his criticism of "the Proper", and through the tactical adoption of stories, speech, and sound he suggests a method for transforming, or translating, spaces into places for all to adopt. The key is to recognize the simultaneity of place and space. They are both live in the present, with the sound of stories offering the necessary kinetic energy to break the temporal inertia. Brandon LaBelle (2010) does a beautiful job describing just how sound can in fact produce place in this passage from *Acoustic Territories*:

> In the movement of sound, the making of an exchange is enacted; a place is generated by the temporality of the auditory. *This is our moment* is also immediately, *This is our place*. Auditory knowledge is a radical epistemological thrust that unfolds as a spatio-temporal event: sound opens up a field of interaction, to become a channel, a fluid, a flux of voice and urgency, of play and drama, of mutuality and sharing, to ultimately carve out a micro-geography of the moment, while always already disappearing, as a distributive and sensitive propagation. (p. xvii)

The movement of sound is an important consideration, for if place is being reduced to position by locative technology, then infusing place with sound may give it a certain narrative velocity. No more do we have to consider place as pause or silence. If there is one contemporary trend that supports this it is clearly the ubiquity of mobile media, of which the portable audio player and mobile phone are prime examples. Yet even prior to a technologically mediated mobile place, Edward Relph (1976) wrote of the sense of place

that ultimately develops amongst travellers, referencing Levi-Strauss' observation that being on a boat "[...] was the opposite of 'travel', in that the ship seemed to us not so much a means of transport as a place of residence" which leads Relph to conclude "[...] location or position is neither a necessary nor sufficient condition of place, even if it is a very common condition [...] This is of considerable importance for it demonstrates that mobility or nomadism do not preclude an attachment to place" (p. 30).

If sense of place can be fostered across trajectories, then it follows that acoustic places are possible, despite being composed of historically contradictory terms (the first is static, the second is transient). I make this point because the purpose of the arguments put forth until now, conceptual as they may be, is to demonstrate that place can behave acoustically.

Thus, if acoustic places are theoretically possible, how might I design one? Malcolm McCullough (2004) has one suggestion for any practitioner endeavoring to affect place: "Practical place-centered design must seek a middle way between a universal uniformity, which has been typical of high technology, and a local desire for completely belonging to one place, which has typically been antitechnological" (p. 173). If technology does not provide the solution (though it can certainly play a considerable role if implemented elegantly) then where should design considerations be focused in order to render place acoustically? Edward Relph (1976) offers one possibility:

> There is only routine, changes in appearance and activity lose any significance, tradition never was important, and place becomes a scarcely changing, overwhelming present. Time is usually a part of our experiences of places, for these experiences must be bound up with flux or continuity. And places themselves are the present expressions of past experiences and events and of hopes for the future. (p. 33)

Addressing routine, the glue that holds the everyday together, might offer the breakthrough that would ensure that acoustic places could resonate rather than fade away.

EVERYDAY ROUTINES

> Banality? Why should the study of the banal itself be banal? Are not the surreal, the extraordinary, the surprising, even the magical, also part of the real? Why wouldn't the concept of everydayness reveal the extraordinary in the ordinary? (Lefebvre, 1987, p. 9)

Routine and everyday are not synonyms, but there is an unfortunately common cultural preconception that everyday life is but a routine. Like children in the back seat asking 'are we there yet?', the chore of routine is nothing more than an underappreciation of the journey. I have already detailed the spatial consequences of abstraction and mapping, but here is an attitudinal by-product: the destination takes precedence when "We can happily become lost in the anonymous ritualized journeys to and from work, for we know that this surrenders nothing that is important to ourselves. We do not live or do identity work in these places. Real life is elsewhere" (Cohen and Taylor 1976, p. 50 as cited in Bull, 2000, p. 162). This attitude does not simply apply to matters of navigation, but also to interpersonal relationships; it is a symptom of the blasé: "The purely intellectualistic person is indifferent to all things personal because, out of them, relationships and reactions develop which are not to be completely understood by purely rational methods just as the unique element in events never enters into the principle of money" (Simmel, 1903, p. 12). What Simmel is describing is the dominant objectivity of urban relationships, where it is easier to treat people like exchangeable commodities because it ensures relationships can be based upon something measurable, and thus more easily evaluated. The reduction of everyday life to matters of definable end (goals, destinations, targets) leads to the association of routine with terms like chore and monotony because, for the most part, ends rarely change. Rather they get defined, often as a quantitative or delimiting abstraction (sale targets, profit margins, a bigger house) and are subsequently pursued daily. The value is placed on the end, and once obtained, the question becomes, what now? Depending on your attitude towards routine, you can answer "again" or "next" and live either cyclically or in linear fashion:

> The everyday is situated at the intersection of two modes of repetition: the cyclical, which dominates in nature, and the linear, which dominates in processes known as "rational." The everyday implies on the one hand cycles, nights and days, seasons and harvests, activity and rest, hunger and satisfaction, desire and its fulfillment, life and death, and it implies on the other hand the repetitive gestures of work and consumption. In modern life, the repetitive gestures tend to mask and to crush the cycles. The everyday imposes its monotony. It is the invariable constant of

> the variations it envelops. The days follow one after another and resemble one another, and yet-here lies the contradiction at the heart of everydayness-everything changes. (Lefebvre, 1987, p. 10)

While Henri Lefebvre is writing from a Marxist perspective in "The Everyday and Everydayness", relating much of his analysis to labour and consumerism, the above nonetheless does a wonderful job of both describing the everyday as a concept, as well as problematizing our relationship to it. And the problem, repetitive exchanges towards objective ends that obscure natural cycles, sounds awfully similar to the blasé. The everyday is a modern construction, a predictable rational model that imposes a rule of unnatural repetition upon the flux of the world. Repetition is the key word here. While Lefebvre uses the word to categorize two different temporal patterns, if we consider repetition as Deleuze (1994) has, the notion that repetition is a rational imposition upon the everyday carries greater resonance. Here is an explanation of repetition from *Difference and Repetition*: "Repetition as a conduct and as a point of view concerns non-exchangeable and non-substitutable singularities. Reflections, echoes, doubles and souls do not belong to the domain of resemblance or equivalence; and it is no more possible to exchange one's soul than it is to substitute real twins for one another" (p. 1). Deleuze is saying that repetition is a concept that has very strict preconditions: for something to be repeated it must be both unique and a multiple, or an x to the nth degree. Notice how there is no equal sign in that function. This is deliberate. Deleuze is being critical of the scientific method, which confuses equality and equivalence; in the same way no two days are truly alike, no two experiments are true repetitions. Thus any suggestion that the everyday is repetitive is nothing but lazy perception.

When Lefebvre mentions change as the inherent contradiction in notions of the everyday, he is inserting *resemblance* and *equivalence* into the discussion, making it no longer appropriate to look at cyclical and linear as repetitions, but perhaps instead as types of practiced habits: "As a result, habit never gives rise to true repetition: sometimes the action changes and is perfected while the intention remains constant; sometimes the action remains the same in different contexts and with different intentions" (Deleuze, 1994, p. 5). The former variation of habit bears a likeness to linearity, whereas the latter strikes me as being more cyclical. I draw this conclusion based on the relative stability of the desired end. So, how do these everyday

habits manifest themselves on the street? And what of routine? Lefebvre (2006) has an answer in his article "Seen from the Window":

> These last rhythms, (those of schoolchildren, shoppers and tourists) would be more *cyclical*, with big and simple intervals - cars, regulars, employees, bistro clients. The interactions of various repetitive and different rhythms, as one says, animate the street and the neighborhood. The linear, that is, succession, consists in comings and goings and combines with the cyclical and spells of longer duration. The cyclical is social organization manifesting itself. The linear is routine, thus the perpetual, made up of chance and encounters. (p. 222)

The routine seems to be just as much a victim of progress as the everyday. The cyclical example given by Lefebvre echoes the strategies described by de Certeau for they are both macro-level structures, suggesting that Lefebvre's routines are de Certeau's tactics. However, de Certeau argues that tactics can in fact challenge the dominant strategies inherited from modernism and disrupt the linear drive of progress, in essence naturalizing (in the sense employed in Lefebvre's original definition cyclical) habits. It follows then that specifically addressing routines in order to render them more cyclical, more natural than linear, may represent the best tactical design approach for addressing the blasé. At heart, it is a matter of emotion over logic, of affect over intellect, where that which is physiologically experienced is more cyclical than linear, as Brian Massumi (1995) describes in "The Autonomy of Affect": “Stimulation turns inward, is folded into the body, except that there is no inside for it to be in, because the body is radically open, absorbing impulses quicker than they can be perceived, and because the entire vibratory event is unconscious, out of mind. Its anomaly is smoothed over retrospectively to fit conscious requirements of continuity and linear causality” (Massumi, 1995, p. 7). Affect is found in the inward turning impulses, not in rational linearity or causality. This may be why many of the cyclical examples listed by Lefebvre, "nights and days, seasons and harvests, activity and rest, hunger and satisfaction, desire and its fulfillment, life and death", are some of the grand subjects of art, often producing significant affective impact. The modulation of affect through varying of rhythmic routines could reveal, or infuse, the extraordinary in the everyday.

There is evidence in support of this hypothesis: personal stereo users have been using the rhythms of music to regain control over the imposed linearity of everyday life: “The structure of everyday life is constituted by rhythms imposed upon subjects. Personal-stereo users' lifeworlds are thus built upon routines and

repetition which are both historically and culturally conditioned as are the structurally conditioned nature of 'escape' routines found within culture" (Bull, 2000, p. 163). Unfortunately what this passage suggests is that music has been routinely used to escape the routines of the everyday.

Sadly, this has been one of the most employed tactics to date, even if it does come close to creating an affective experience, for the right elements are present: sound, mobility, routines, rhythms. However, they need to be reconfigured in order to engender the one element that is missing: *place*. Rather than focus on the loci of a sensually managed body, the body within the sonic environment should be prioritized. The point of this discussion is to highlight particular conceptual areas that can be targeted by design. Here I have explored routine, journey, destination, end, cyclical, linear, repetition, habit and affect, in an effort to simultaneously elicit and foreshadow the emerging essential characteristic: *the generative*.

THE CALMLY GENERATIVE

> Nature appears as the vast territory of births (Lefebvre, 1991, p. 70)

Charles Baudelaire was a French poet, best known to contemporary urbanists for introducing the archetypical character of the flâneur to the world in his essay "The Painter of Modern Life", first published in 1863. Baudelaire (1995) has a unique take on the term 'modernity', one that does not describe an era nor represent a set of values, but is instead a process of artistic revelation: "By 'modernity' I mean the ephemeral, the fugitive, the contingent, the half of art whose other half is the eternal and the immutable" (p. 13). The flâneur is one such agent of 'modernity', a poet of sorts whose wandering of the street, observing and absorbing the life transpiring around him, is his artistic, painterly, contribution: "For the perfect *flâneur*, for the passionate spectator, it is an immense joy to set up house in the heart of the multitude, amid the ebb and flow of movement, in the midst of the fugitive and the infinite" (p. 9).

The flâneur proved to be an inspirational figure and trope, one that was both a critical subject of Walter Benjamin's *Arcades Project* and a conceptual muse for Guy Debord and his Situationist International group

providing inspiration for their psychogeographic dérives. With the ubiquity of personal GPS, the flâneur has seen a renaissance of sorts, with many applications encouraging individuals to wander their cities as Baudelaire's painter wandered Paris. However, is the figure of a privileged man who has all the time in the world to devote to passively watching his fellow citizens labouring to make ends meet an appropriate contemporary urban role-model, or even worthy of aspiration? Simply put, no: "The figure of the flâneur as contemporary user blithely ignores the arrangement of social, cultural, and economic conditions enabling his existence. Designing by and for flânerie involves reifying these conditions through new technological forms. Thus, despite our best intentions, we replicate anachronistic patterns that are best undone" (Williams, Robles, & Dourish, 2008, p.8). This is not to say that the city should be devoid of beauty and delight, but rather that the objective distance of the flâneur has no consequential impact on the city. Ironically, today much of the revelation is happening through the guidance of devices, not painterly observation, creating a hybrid urban figure: the blasé flâneur. Yet, the artistic purpose of the flâneur should not be forgotten: "In short, for any 'modernity' to be worthy of one day taking place as 'antiquity', it is necessary for the mysterious beauty which human life accidentally puts into it to be distilled from it" (Baudelaire, 1995, pp. 13-14). Maybe 150 years ago painterly observation was enough, however, today poetic translation is needed. There's a certain charm to Baudelaire's call for artistic distillation of everyday urban life, so I ask, what are the contemporary distillation agents if the flâneur is an anachronism?

One potential answer is ubiquitous computing, a term coined by Xerox PARC researcher Mark Weiser, who envisioned a world in which computational power was environmentally responsive and distributed, such that the terminal or desktop would no longer be necessary. He also called for "calm technology", which was an extension of his ubiquitous computing vision where computation would happen on the periphery without drawing undue attention to itself; where screens historically commanded regular attention, Weiser envisioned more natural, screenless, interactions with computation and technology. This became the agenda for numerous research laboratories, however, as Paul Dourish and Genevieve Bell (2011) argue in *Divining a Digital Future*, the myopic pursuit of Weiser's ideal has blinded much of the ubicomp world to the fact that it has indeed already arrived, just in a different form:

> Nevertheless, while the majority of ubicomp's research attention has traditionally been devoted to the proximate future, just around the corner, we have suggested instead that some twenty years after Weiser originally formulated it, ubiquitous computing has indeed arrived. If the availability of devices with wireless data communications and powerful computational properties is anything to go by, then it is hard to deny that computation is already ubiquitous. (p. 91)

This observation is potentially transformative, in the sense that at the very least the definition of ubiquitous computing and its associated research agendas should be updated; rather than designing for the near future, this not so subtle critique should inspire designs for the present. Unfortunately, mobile devices do a poor job of operating on the periphery, and are certainly anything but calm. One only has to look at the number of people consumed by their phones to understand that ubiquitous computing is, behaviorally speaking, so compelling it is overpowering. Consequently, ubiquitous computing as currently deployed is not an ideal agent for the distillation of Baudelairean modernity. But it comes very close. The sensors embedded in mobile devices and the built environment have artistic potential for they are tuned to record the moment. But again, it fundamentally becomes a matter of distilling the beauty, poetically translating it. Or, as Nigel Thrift (2006b) calls the emerging approach to just such a calculation, qualculation:

> in recent years the activity of calculation has become so ubiquitous that it has entered a new phase, which I call 'qualculation', an activity arising out of the construction of new generative microworlds which allow many millions of calculations continually to be made in the background of any encounter. I argue that it is no longer possible to think of calculation as necessarily being precise. Rather, because of massive increases in computing power, it has become a means of making qualitative judgements and working with ambiguity. In other words, what we are seeing is a new form of seeing, one which tracks and can cope with uncertainty in ways previously unknown. (pp. 583-584)

This relates back to the notion that noise, feedback, is necessary for the creation of new knowledge. It is not a matter of repetition and precision, but rather of a Baudelairean distillation of modernity. And this qualculation transpires calmly on the periphery: "I want to emphasize that these developments are producing not only shifts in what is understood as 'human' but also shifts in what is understood as 'environment' since, increasingly, the 'artificial' environment is sentient and has the feel of a set of 'natural' forces blowing this way and that" (Thrift, 2006b, p. 591). When the periphery is appropriately considered from a design point of view, an atmosphere is created which envelops and influences, at best subtly, as a sort of delightful enchantment of place:

> Other emerging ubicomp technologies, however, are being established to try and to re-enchant human links to place by recording and sustaining the personal and transient meanings of places. These artistic practices suggest that the effect of memory is not the creation of perfectly known environments. Rather, it involves a destabilization of spaces, a haunting of place with absent others. The double, indeed triple and quadruple, coding of spaces and people through narratives and information carried in digital networks may thus actually serve to disperse our notion of both person and place. (Crang & Graham, 2007, p. 812)

In order to achieve many of these desired effects, a considered use of sound could make a marked difference. This is not about installing speakers and drowning spaces with pre-recorded sound. No, this strategy will not produce acoustic places. Instead, using the conceptual framework of calm computing and a more generative approach to the acoustic treatment should help avoid many of the characteristics contributing to a blasé attitude in the city, namely: the literal, the repetitive, the abstract, the linear and the objective. Brandon LaBelle (2010) already sees the city as an acoustically generative landscape, if one would only listen:

> In this way, the everyday is an open geography shaped and contoured by specific forces and relations. To engage these territories through the mode of listening, and according to auditory behaviour, I'm interested to define such geography as generative, full of dynamic resonance, as an orchestration of sharing and its arrest; that is, to recognize the already existing relational movements of the contemporary situation which mark the global. (p. xxiv)

Unfortunately, simply asking people to listen is not enough, nor is encouraging a certain acoustic flânerie for the same reasons given above, not to mention the potential to have such an encouragement manifest itself with a pair of headphones: “Personal-stereo users, in controlling their experience, appear to negate difference in colonizing space and place. They, unlike *flâneurs*, are not concerned with aesthetically drawing in the urban world but rather solipsistically transcending it” (Bull, 2000, p. 143). No, the generated sound must be sourced from its surroundings while also being a part of the very same environment that it responds to. It must be woven into the flows, into all the rhetorical narratives the city produces:

> Linking acts and footsteps, opening meanings and directions, these works operate in the name of an emptying-out and wearing-away of their primary role. They become liberated spaces that can be occupied. A rich indetermination gives them, by means of a semantic rarefaction, the function of articulating a second, poetic geography on top of the geography of the literal, forbidden or permitted meaning. They institute other routes into the functionalist and historical order of movement. (de Certeau, 1984, p. 105)

It is about providing an alternative trajectory, novel routes, to follow while travelling along the paths that are already defined and worn by familiarity, by routine. The routine does not have to disappear; the journey simply needs to be amplified to a perceptible level: “There is a certain externality which allows the analytical intellect to function. Yet to capture a rhythm one needs to be *captured* by it. One has to *let go*, give and abandon oneself to its duration. Just as in music or when learning a language, one only really understands meanings and sequences by *producing* them, that is, by producing spoken rhythms” (Lefebvre, 2006, p. 219).

The generative is not simply responsive. The generative is reciprocal. A generative instrument, such as a wind-chime, takes external impulses and translates them poetically into a form that naturally casts the attention back upon the initial gust. In the built environment such treatment of impulses could help engender acoustic places that, even if just for a passing moment, might resonate harmonically with the inspiration for its emission.

PROCESS

BETWEEN DESIGN AND ART: THE OSCILLATIONS OF A TIGHTROPE WALKER

> To explain this, Kant mentioned the general authority of discourse, an authority which is nevertheless never more than local and concrete: where I come from, he writes (*in meinem Gedenden*: in my region, in my "homeland"), "the ordinary man" (*der Gemeine Mann)* says (*sagt*) that charlatans and magicians (*Taschenspielers)* depend on knowledge (you can do it if you know the trick), whereas tightrope dancers (*Seiltänzers)* depend on an art. Dancing on a tightrope requires that one maintain *an equilibrium* from one moment to the next by recreating it at every step by means of new adjustments; it requires one to maintain a balance that is never permanently acquired; constant readjustment renews the balance while giving the impression of "keeping" it. The art of operating is thus admirably defined, all the more so because in fact the practitioner himself is part of the equilibrium that he modifies without compromising it. In this ability to create a new set on the basis of a prexisting harmony and to maintain a formal relationship in spite of the variation of the elements, it very closely resembles artistic production. It could be considered the ceaseless creativity of a kind of taste in practical experience. (de Certeau, 1984, p. 73)

I must admit, I have consistently struggled to accurately situate myself along the designer/artist spectrum. More specifically, I struggle with the more traditional notions of design as applied knowledge (the magician) and art as a more personal exploration (tightrope walker). This is complicated by a tendency to oscillate between the two roles depending on whether or not I am forming or responding to a question, for, in very problematic and reductionist terms, artists pose and designers solve. Never vise versa.

Consider this table from the Royal College of Art's Anthony Dunne (obstained from a talk given by Paola Antonelli at York University on April 26, 2013) listing the past (A) and present (B) characteristics of design (and notice the third pairing which I have emphasized):

A	B
Affirmative	Critical
Problem solving	Problem finding
Provides answers	**Asks questions**
Design for production	Design for debate
Design as solution	Design as medium
In the service of industry	In the service of society
Fictional functions	Functional fictions
For how the world is	For how the world could be
Change the world to suit	Change us to suit the world
Science fiction	Social fiction
Futures	Parallel worlds
The 'real' real	The 'unreal' real

Narratives of production	Narratives of consumption
Applications	Implications
Fun	Humour
Innovation	Provocation
Concept design	Conceptual design
Consumer	Citizen
Makes us buy	Makes us think
Ergonomics	Rhetoric
User-friendliness	Ethics
Process	Authorship

The struggle mentioned at the outset of this section is likely due to an overwhelming exposure to design practice from column A, while identifying myself much more with the concerns of column B. Having come from the Fine Arts, the questions and motivations that inform contemporary designers are certainly familiar. To align myself with Critical Design or Critical Making would be fitting, for much of the conceptual sensitivities and motivations honed through my art background are directly applicable to both practices. Yet I am reluctant outright to call myself a designer, or an artist, or a maker. Can I not be all three at once? Eschewing all labels, I see my practice, and contemporary transdisciplinary praxis more broadly, as the application of conceptual and inquisitive rigour to a particular concern. If I absolutely had to label my practice I would say that it bears most resemblance to constructivist praxis, but to say that I was a constructivist would look terrible on a business card.

In the end this is an irrelevant distinction, be it artist, designer, maker or 'constructivist', for it does nothing to further my work and informs it even less. The only service labeling myself could possibly perform is to generate a far greater number of nods of the head when responding to the question 'what exactly do you do?'. But those nods would be hallow, for, as Dunne's table clearly illustrates, the definition and practice of design is changing such that it might be more effective to simply point to some work and say 'that is what I do'. Hence the didactic (data visualization) and aesthetic (transparent acrylic) considerations present in The Chime; it absolutely needed to both inspire and communicate on its own, without labels. Some may call it art. And some may call it design. And they would both be at best half right. Yet, at the same time, they could not deny I made it. So maybe, by absolute default, I am a Critical Maker. Maybe that is my third half,

and I combine two of them at any given moment. The old ‘Cheap, Fast, Good: Pick Two’ triangle, but with new vertices: ‘Designer, Artist, Maker: Pick Two’. Maybe.

This is why I find the introductory quote from Michel de Certeau, referencing Immanuel Kant, particularly enlightening, as I absolutely identify with the tightrope walker. Whereas the magician executes a series of actions towards a particular end, the tight ropewalker has to constantly reevaluate the moment in order to determine the next step. There is an objective in mind for the tightrope walker, and even though the path to said objective is straight, it is a constant negotiation between internal and external forces. This negotiation is the struggle that consumes me throughout my work. It is not simply a matter of defining an objective and progressing slowly towards the goal but rather, for me, about defining my intent rather than my desired outcome. For clarity, let us take a look at the Merriam-Webster definition of intent: *the state of mind with which an act is done*. For me, this is the ‘why’ that preceeds any endeavor. It is the motivation, or volition, behind the undertaking. And for me, this realtes more to the process, or the journey as opposed to the destination. This is a subtle distinction, defining intent instead of objective or goal. In the case of the tightrope walker, an objective would be to get to the opposite platform, whereas an intention would be to maintain balance, and hone a better relationship with one’s body in the process, across the entire length of cable; a goal is the outcome, whereas the intent is the motivation that drives the journey. This subtle distinction is why I find myself oscillating between artist and designer, or better yet, negotiating the ‘Designer, Artist, Maker’ triangle. This oscillation creates a never-ending feedback loop (which one could cynically deem perfectionism) that consists of constantly posing and answering questions along a particular trajectory. Or in other words, it is the process of maintaining balance between my defined intention and the results ultimately produced.

There is a similarity here to the process Bruce Sterling introduced in his talk titled "Atemporality for the Creative Artist", in which he describes how problem solving has evolved with increased connectivity: it is thanks to contemporary networked technologies that atemporality as an approach to problem solving is even possible. Sterling (2010) begins by outlining the process for intellectual labour as defined by Richard

Feynman: "Richard Feynman once wrote about intellectual labor, and he said the following: ‘Step one – write down the problem. Step two – think really hard. Step three – write down the solution’". Sterling goes on to describe the process a contemporary creative, someone who approaches things from an atemporal perspective, might undertake in order to address the concerns hanging over said creative's head, and ends with this summary:

> So, old Feynman, who was not the atemporal Feynman, would naturally object: ‘You have not solved the problem! You have not advanced scientific knowledge. There is no progress in this. You didn’t get to Step three – solving the problem.’ Whereas, the atemporal Feynman would respond: ‘It’s worse than that. I haven’t even done step one of defining the problem and writing it down. But I have done a lot of work about its meaning, and its value and its social framing, combined with some database mining, and some collaborative filtering, which is far beyond you and your pencil.’ (Sterling, 2010)

This is exactly why I prefer defining an intent as opposed to an objective. Through the evaluation of an intent more questions arise, and consequently through their exploration constraints begin to present themselves, delimiting the potential solutions. Yet, there is never but one solution to a concern, hence the value in discovering relevant constraints (the blasé was just such a constraint, one which arrived nearly half way through my exploration). I refrain from using the word problem here, choosing instead to use concern for two reasons. The first is because I want to maintain Sterling's observation that the atemporal creative never even made it to step one of the Feynman process. And secondly because in all likelihood there are multiple problems complicating matters at any given moment, each of which need to be kept in balance so as to maintain an inquisitive trajectory. Or, to return to Kant via de Certeau, at first glance it may appear as though the tightrope walker is travelling in a linear fashion towards the platform at the end of a tightly stretched wire, however, considering each twitch, each undulation, each modulation of stability better articulates the true nature of the path undertaken.

Since my project is focused on the potential of sound as medium for engendering a sense of place (again, like the blasé, sound arrived late as a result of prior intent related oscillations), I believe it fitting that the behavioural quality of an audio waveform also most accurately visualizes my process. If we were to observe my process on an oscilloscope we would see me move from stability, or silence at the point of zero

crossing, to a positive point thanks to an impulse (the posing of a question), which is met with a near perfect reflection, yet imperfect enough because of the presence of noise to inspire another positive reflection across the axis of intent. My process involves impulses which positively generate questions, and responses which attempt to reflect the original transmission, ultimately failing, yet, after numerous oscillations, resolves itself so as to produce a waveform that mirrors, as closely as possible, the original; though I do not start with a pure sine wave, I strive to end up with a waveform that accurately reflects the original impulse. I suppose this could be considered reflective practice, literally, though I believe my take inherits some of the poetic license I have granted myself in the construction and translation of The Chime. An acknowledgement that ultimately leads to the question: what was my intent for this project? Simply, my intent was to explore ways to delightfully render transient spaces into meaningful places.

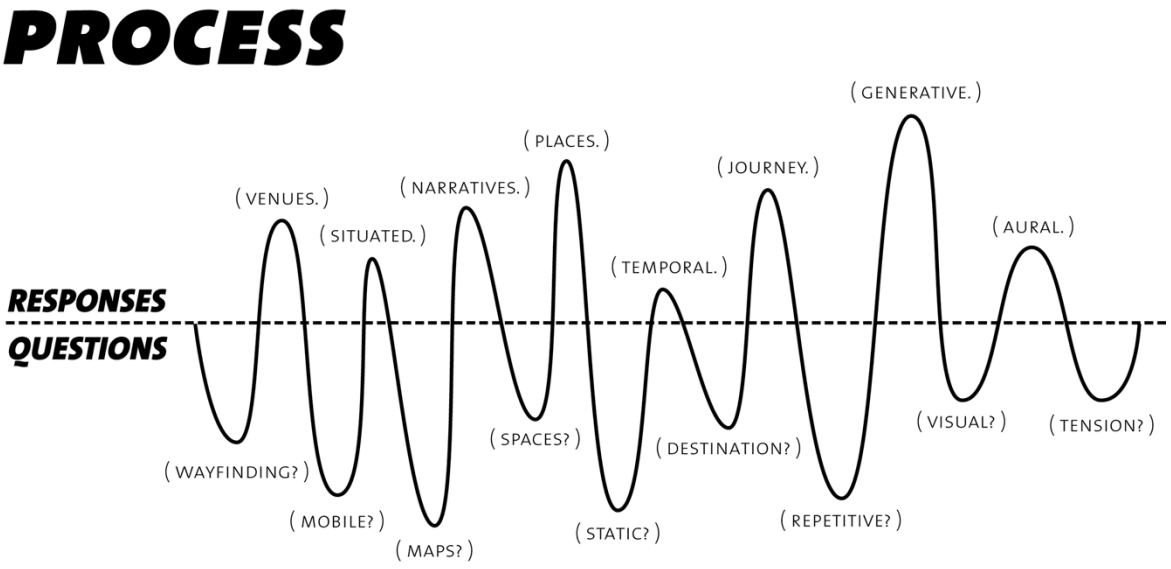

Figure 2: Process diagram

EXEMPLARS

In the following sections I detail the relative builds and effects of the three major production components of this project. The word ‘exemplar’ is used to illustrate the nature of my output. These are not the results of an experiment. Nor are they prototypes. I like the word exemplar because it implies a connection to the more conceptual ideas previously discussed, suggesting that my work is an attempt to illustrate and explore some of these critical conclusions. These productions are thus conversational in nature, in that they are the avenues by which I am most comfortable contributing to the topics previous discussed.

I am no philosopher. I enjoy challenging thought, but I have no intention, nor desire to respond to the discourses through the most traditionally accepted arena: writing. The reason is quite simple. When I read a particularly interesting passage, I never think of a direct response. I instead take the idea and begin to shape it, stretch it, and abuse it to fit my applied areas of interest. My response is in my work, not my writing.

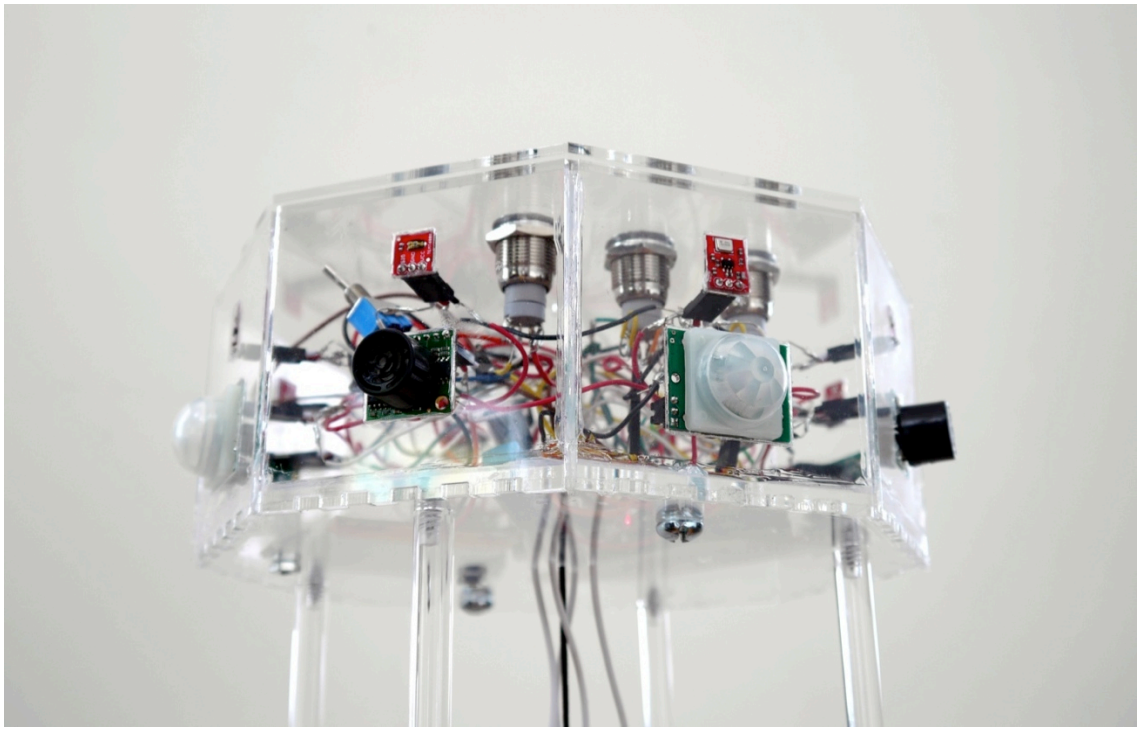

Figure 3: The Chime (Shell)

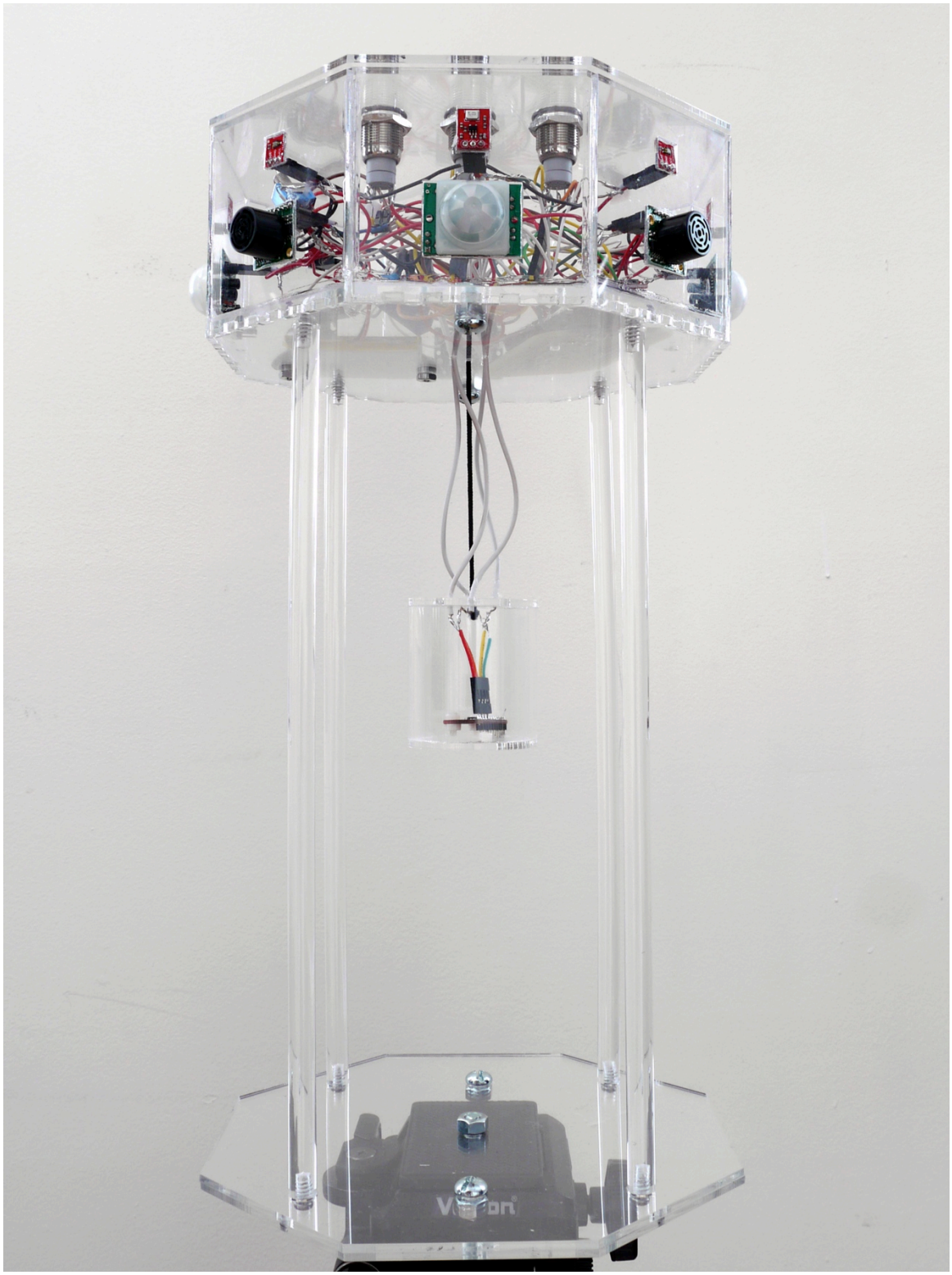

Figure 4: The Chime (Front)

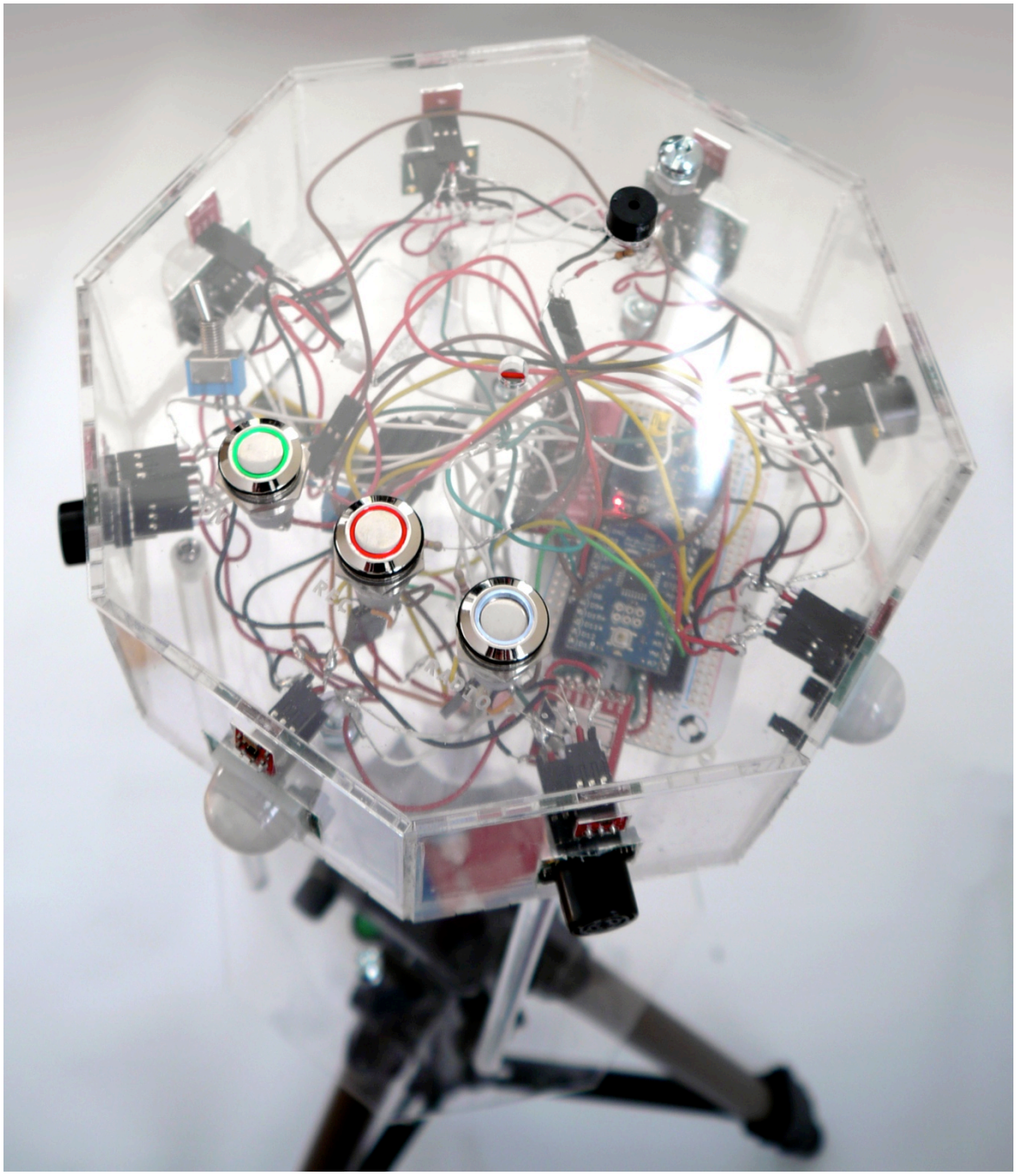

Figure 5: The Chime (Top)

THE CHIME

The Build

The final output, this instrument that I call The Chime, is composed of 18 environmentally biased, yet fundamentally agnostic, sensors recording readings either for wireless broadcast or for logging approximately every 50 milliseconds. More specifically, 17 of the 18 sensors are distributed as pairs in an alternating pattern across the octagonal transparent acrylic shell enclosing the microcontroller, with a digital temperature sensor protruding out of the lid. The 16 sensors are connected to the microcontroller via a 16 channel analog multiplexer responsible for reading analog voltage values from the following: 4 Sparkfun TEMT6000 ambient light cells, 4 MaxBotix EZ1 sensors for ultrasonic rangefinders, 4 Parallax PIR Rev B sensors for infrared motion detection, and 4 Sparkfun ADMP401 MEMS microphones. The temperature sensor is an insulated DS18B20 digital thermometer. Below the shell is a pendulum suspended by a shoelace, with four wires carrying power, ground and I2C communication to the enclosed MPU-9150 9-axis IMU (Intertial Mesurement Unit) and back to the microcontroller. The sensor records X, Y, and Z values from the integrated accelerometer, gyroscope, and magnetometer. All of the above is connected to an Arduino Fio microcontroller paired with a microSD socket for data logging. The Fio also contains a built in socket with an XBee footprint for wireless serial transmission. In order to control the Fio, the shell has three switches responsible for toggling power, record state, and radio transmission state respectively. To ensure easy access, the Fio has been fastened to the shell's lid, along with a 2000 mAh Lithium ion battery, with all connections being of the pin and plug variety, allowing the lid to be completely removed.

The code is very straight forward, as once in record and/or radio mode the Fio simply loops until the mode's state switch is turned off. The record and radio switches control the microcontroller's mode of operation, however the record button also creates a new file every time it is pushed on, and only closes that file when it returned to the off state. This is important to note for should the Fio lose power or reset itself, all recorded data will be lost; the file must be closed for the data to be securely recorded to the microSD card.

There are four main functions in the Arduino code: nineAxisCall(), which obtains readings from the motion tracking sensor, multiplexerCall(), which cycles through all 16 channels of the multiplexer, writeTemperature() which calls for a reading every 5 seconds, and logTimer(), which monitors and logs the performance of the microcontroller, logging every cycle's interval to ensure accurate durational playback. During setup, the Fio initializes the microSD socket, the temperature sensor and the MPU-9150, which communicates via I2C using the MPU-6050 (6-Axis version of the same IMU) library developed by Jeff Rowberg from I2Cdev and updated for use with MPU-9150 by Aaron Weiss of Sparkfun. This library gives access to all of the sensor's raw data, in addition to complex MotionFusion calculations (which I did not explore). Upon successful completion of the setup function, the LEDs embedded in the switches will blink according to a specified sequence and the buzzer will beep five times. This is also the same feedback that precedes the beginning of recording, allowing any audio recorder fastened to the shell through the standard tripod mount sized hole in the lid, to be synced with the recorded data at a later time. The base, which supports the shell thanks to four mechanically fastened acrylic rods, also has a hole for tripod mounting. Though not entirely waterproof, all joints that could not be secured mechanically are sealed using silicone, which comes with the added benefit of being non-permanent, meaning the sensors can be easily replaced.

The performance of The Chime can be monitored live via radio or later with comma separated TXT playback through a visualization built in Processing. Each of the eight sides of the shell is represented relative to the orientation of the lid's 3 buttons, which align with the bottom, or south panel, when in use and consequently also aligns with the bottom of the screen when visualized. For linear sensor readings such as ambient light or proximity, the values are visualized using a scaling rectangle and a colour gradient between blue/purple/red/pink. For non-linear sensors such as the motion tracker and microphone, a 50 bar array visualizes their oscillating waveforms. The MPU-9150's 9 axes occupy the center of the visualization within a 3x3 grid where the accelerometer, gyroscope and magnetometer each occupy a row. The motion detectors trigger a coloured triangle in the first version, which changed into animated directional growth and retraction in the final instance of the visualization.

That is the most basic description of its functional design. That was the objective. But the intent of The Chime goes well beyond sensing for transmission or archiving. The intent was to create a composition tool, an instrument of environmental difference.

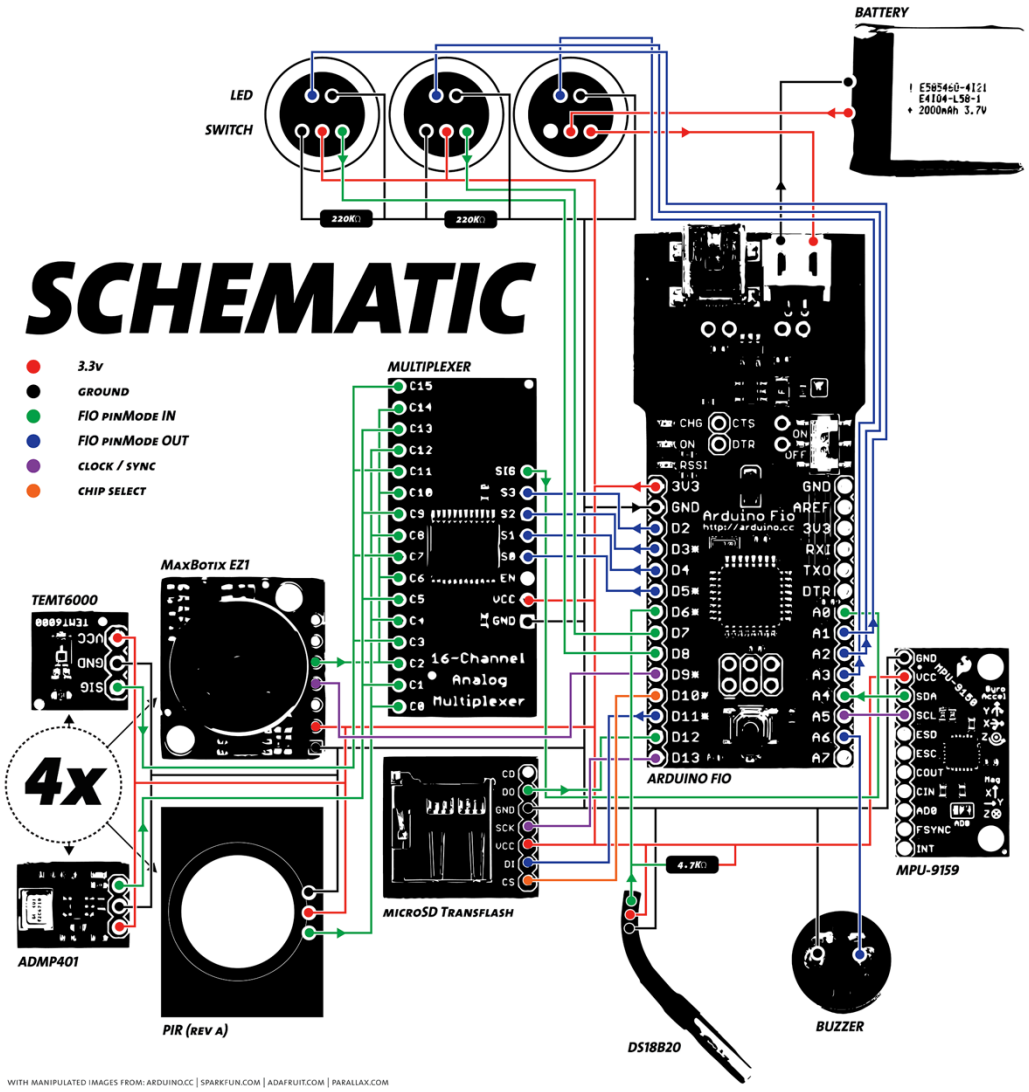

Figure 6: Schematic diagram

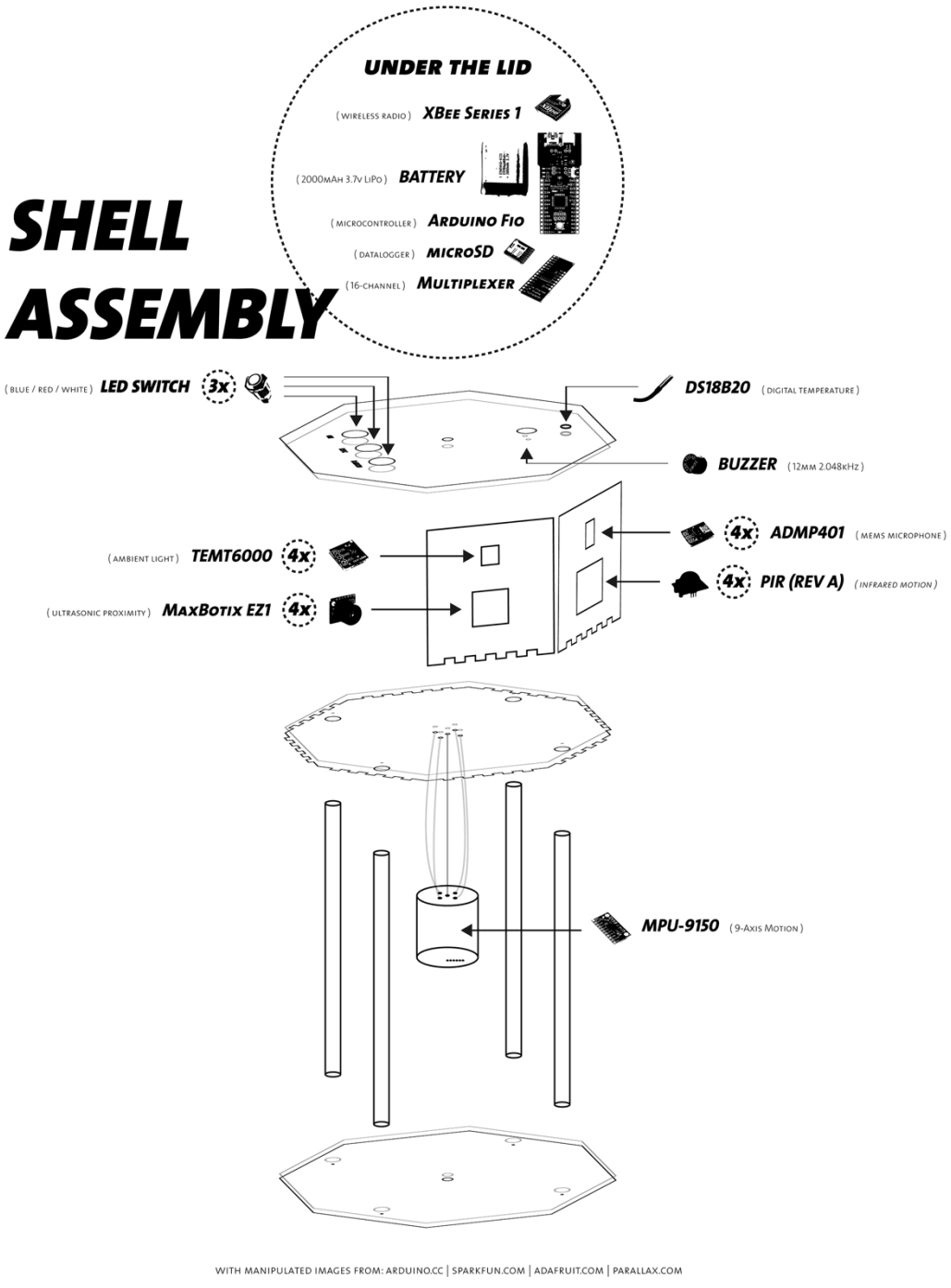

Figure 7: Shell assembly diagram

The Effect

Immediately following my first successful test, I began to go through the permutations and combinations of when and where I could deploy this creation. Because of the variety of sensing contained within a single shell, I imagined how different places would influence The Chime. Indoor places would obviously generate little kinetic feedback in the pendulum, but might have interesting patterns of traffic flow over the course of the day while providing a rather static environmental signature in terms of sound and light levels. Outdoors, The Chime would be subject to a greater variety of influences. Perhaps this was intentional, as I do think of the city as manifested more as an external, street level experience, simply because that is where behaviour is most explicitly public. At the same time, it is where citizens have the least control, and thus where the greatest number of simultaneous variables, controlled or otherwise, intersect. As a result it is here where the greatest difference should be sensed, translating into a more dynamic sonification. The comfort of the controlled, the optimization of invariability, and the reduction to norms all seem to summarize the intentions of most designed interior spaces. This is why the construction of The Chime has led me to consider ways in which sonification can be implemented into the acoustic character of dynamically flat interior environments. Unfortunately, I never got the opportunity to explore these spaces (permits being the greatest obstacle) but did get to run The Chime live indoors during exhibition, which I will detail later.

The more time I spend thinking about contextual deployments of The Chime, the more I am aware of the explorative and experimental nature of the instrument I have created. Because it is not engineered to directly correlate the data into representational knowledge, it opens up a wide variety of potential poetic applications, such as dynamic lighting, responsive urban screens and more interestingly, orchestrated collective behaviour with the intent of reproducing a particularly desirable effect. Be it sonification, illumination, or coordination, this type of sensor deployment could enchant, and delight, what are other static public spaces. My argument against visual space stemmed from a tendency is be represented by fixed or looping temporalities, focusing on audio was rhetorical (in the sense employed by column B of Dunne's disagram) simply because of its essential temporality. The necessary data visualization that helped me

understand the behaviour of The Chime is evidence that I was in no way arguing for the abolishment of the visual, but rather more consideration of temporality in relation to urban spaces.

I hesitate to call The Chime a prototype for two reasons. The first is because it meets all of the functionality I set out to instill it with. The second, and more important reason, is that it operates equally well as a vehicle for thought. Given that in its simplest form, when striped of all the imbued urban significance, it is but an agnostic recorder, The Chime becomes a device through which a conversation about sensing, engineered or natural, can take place. At least, that has been the debate I have been engaged in ever since first closing the lid, turning it on, and pressing record.

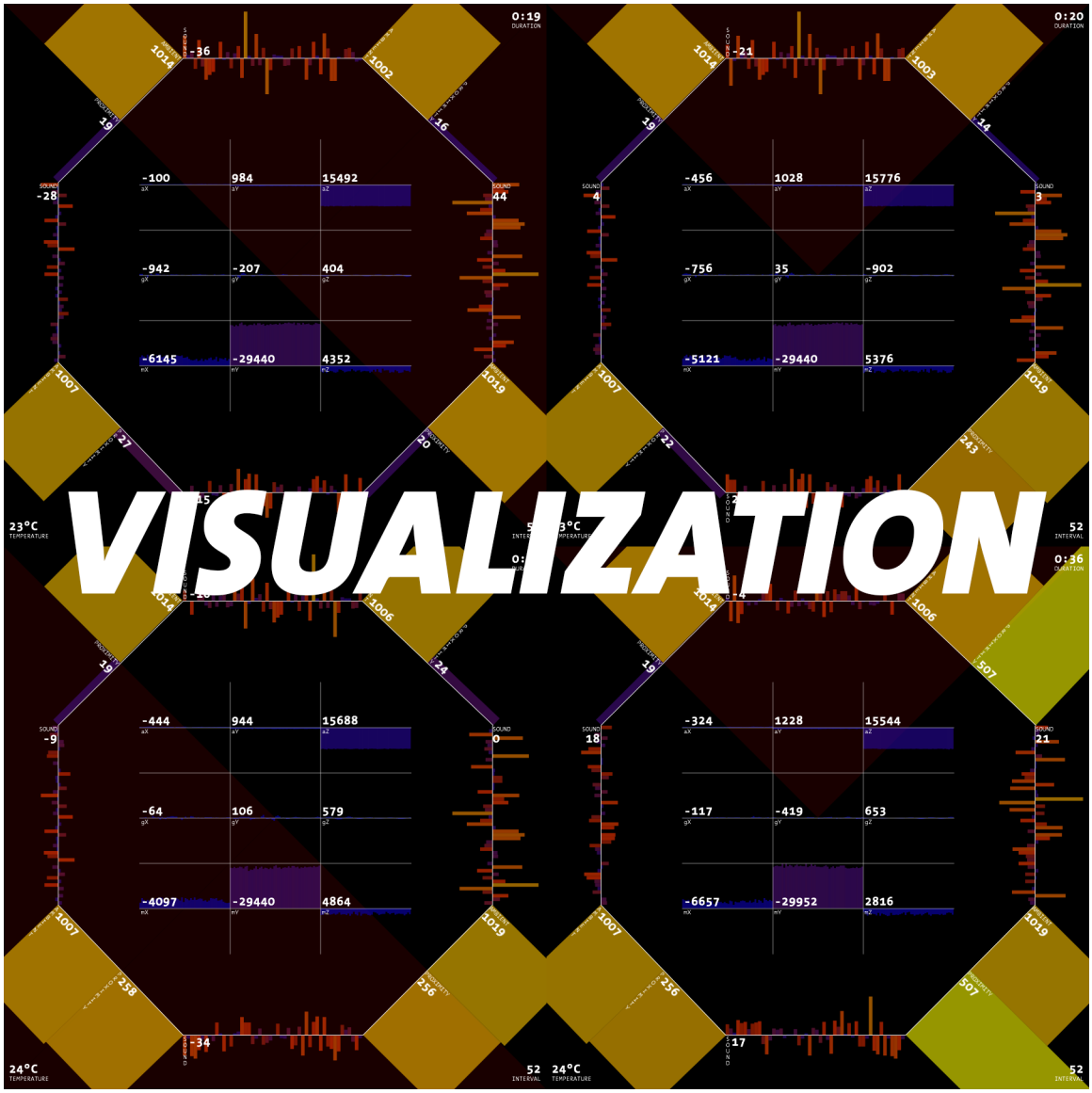

Figure 8: First Processing data visualization

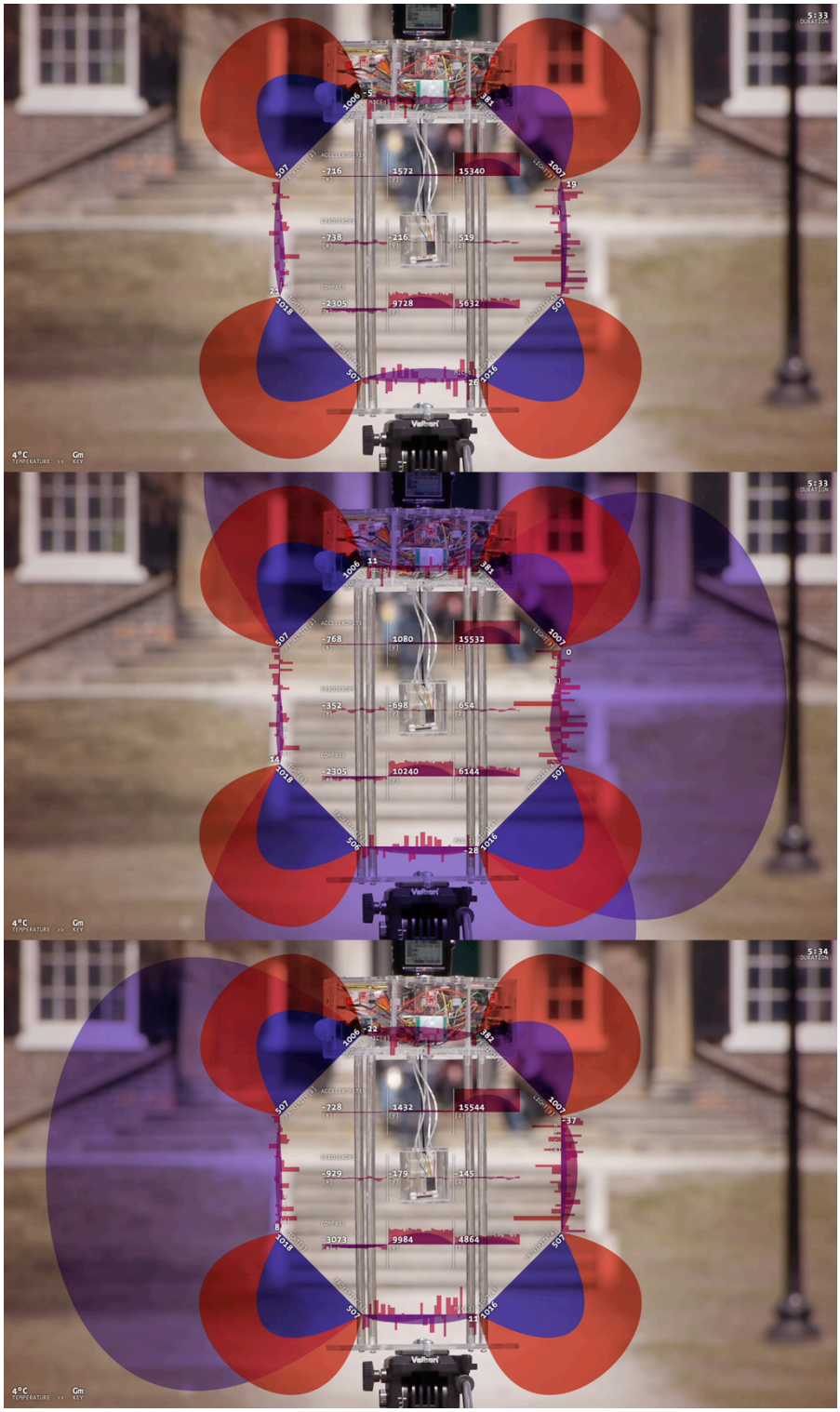

Figure 9: Final Visualization Frames

THE COMPOSITION

The Build

After acquiring a 12-minute set of data from The Chime, I began the translation process. Fortunately, Ableton Live 9 was released the week I was set to focus on composing. As part of the full Live 9 Suite is Max For Live, a special version of Max/MSP designed to live inside Ableton Live. It allows for the creation of "devices", Max patches that work within the Ableton session interface like more common audio plugins, only their underlying signal/MIDI (Musical Instrument Digital Interface) processing architecture is available for edit at anytime. The advantage here was that I no longer had to use a MIDI library to get the data from Processing to Ableton. Instead, I could now use OSC (Open Sound Control), giving me total control over data routing, where MIDI restricted data to either General MIDI for note control and SysEx (System Exclusive) commands for hardware, or software, specific parameter changes.

With data flowing from Processing to Ableton via Max For Live patches, I was now ready to start sonifying The Chime's sensors. While actual sonification happens in Ableton through the use of virtual instrument and signal processing plugins, the conditioning of data could take place either in Processing prior to arriving in Max For Live, or directly within the Max For Live devices. Personally, I found Processing's map() function to be invaluable in conforming the data to ranges that work for Ableton session parameters (though a similar object is present in Max For Live, I chose to stick with Processing), such as -70 to +6 for channel volume, or 0 to 127 for MIDI note mapping (while the MIDI protocol is not being used for data transmission, MIDI is still a function component of Max For Live, where using the "makenote" object, which combines pitch, velocity and duration values, in conjunction with the "noteout" object produces a MIDI note).

The bed of the composition is built upon the behaviour of the four motion detectors. Here, every time the motion detector pulls high (reads above 800), the Max For Live device will play the next note in a 16 note sequence, based upon four, four note chords: Fmaj7, Cadd9, Am/E, and Fmaj7 (different voicing). Thus

each motion detector contributes a note that if played together form a chord, one which does not necessarily match the above 4, but is composed of their notes. This offers the possibility of 3876 potential 4-note combinations, not to mention their asynchronous behaviour, which further varies their collective effect. The virtual instrument being triggered is a modeled string ensemble (native to the Live 9 Suite), and each channel has its own dedicated instance of this motion sensitive Max For Live device. The sonic quality turned out to be lush, dense, and fluid, providing an ideal ephemeral tonal foundation for all subsequent data translations to sit atop.

The motion sensor also provides input for two other Max For Live devices. The first device responds to all motion detectors, but plays a sequential melody. This melody device has a verse and chorus mode that switches everytime all four motion detectors are pulled high (this shift is signaled by the triggering of four guitars playing the same chord). When it is in chorus mode, it plays a predetermined melody. When it is in verse mode the melody is determined by mapping the fluctuations of the compass, the magnetic field, to two octaves of the key of C. By creating this verse/chorus device I was able to include a motif without excessive repetition. The second device is nearly identical to the first except it takes input from all motion detectors and plays the exact same sequence as individual motion detectors, only the sequence is advanced based on collective triggering. It has two instances in the composition, with the first contributing vibes and the second a choir to the mix. These two instances are paired, as are the melody and string devices, where each pair is inversely related; the volume of each device sits in inverse proportion to its pair. This is made possible by mapping channel volume to the averaged microphone volumes on The Chime. Thus, the volume of the two devices tied to each motion detector is paired with its nearest microphone, and mapped with an inverse relationship to one another. This produces a melody that reveals itself during moments of calm, and disappears as the volume of the microphone tied to the dedicated motion channels increases. By mapping the sound averages of the last second in Processing (based on the absolute difference relative to the point of zero crossing, which in this circuit, with this sensor, reads as 512) to a minimum of -70, and a maximum of +6, I am able to control the volume of each. However, because the mapped values tended to hover around an inaudible -70, I adjusted the minimum to be -30, giving the channel a range of 36db. These

values were then routed to a “live.gain” audio object in Max For Live, which is a simple slider with the aforementioned output range of -70 and +6. In addition, using the same microphone averaging values that mix the motion detector devices, I was also able to set thresholds for loud spikes (3 times the current average) which triggers drums.

While I tend to compose using more complex chords and multi-key progressions, avoiding simple majors and minors, the asynchronously generative nature of this setup introduces great dissonant potential. So much so, that I have chosen to compose exclusively in the key of C, minimizing non-intentional dissonance. However, this does not mean that the key remains static. Rather, the notes defined within the key of C are shifted according to the temperature reading, where each degree change up or down shifts the composition by a whole step accordingly. This shifting is achieved by routing the “/temp” OSC message, subtracting the temperature reading ascribded to middle C (I have assigned 6°C as middle C for the final compositions), and using the resultant to shift the numerical MIDI notes accordingly. This process is included in all Max For Live devices that output MIDI notes within my composition.

The proximity sensors were translated into an 8 note run, which was subsequently mapped across 8 octaves according to the measured distance of the sensor. The resultant audio effect is similar to an arpeggio. The proximity sensor outputs an analog distance reading in the Arduino between 0 and 512, which I mapped to 32 and 1 in Processing, where the longest distance corresponded to the lowest note, and vice versa, providing 32 trigger points across the proximity beam spectrum. In Max For Live, the incoming mapped values were routed to note triggering (if a change in value was detected), and adjusted for its relative range (the incoming value, with a maximum of 32, was first divided by 4, and then multiplied by 12 to produce the relative octave shift). The notes produced by this device were sent to a music box like virtual instrument (IK Multimedia’s SonicSynth), producing delicate tine tones.

Next was the translation of the motion-tracking unit. I began by watching the Processing visualization for patterns of behaviour in order to determine the most appropriate sonification for each of the three embedded

sensors: accelerometer, gyroscope, and compass. As I mentioned previously, the compass determines the notes played by the piano melody when in verse mode. The accelerometer was difficult to design for because of the minimal force exerted upon The Chime by the wind in this data set; it was visually indiscernible. I consequently built a function in Processing to monitor for changes relative to an average resting state. The recorded changes were miniscule in terms of intensity, so I had to magnify their levels using a multiplier. Originally, I had hoped to map intensity to velocity, using the standard 0 to 127 MIDI velocity range, however the relative change values rarely rose above 20 when mapped to this range, producing essentially inaudible output when mixed with all the other sonification. So a multiplier of 10, in combination with a maximum (10) and minimum (3) limiter, conditioned the incoming accelerometer values to a range of 30 to 100. Thus any change value of 3 or above would trigger a note with a correspondingly scaled velocity. This trigger then went to a virtual instrument emulating an organ producing chord impulses with a duration based on the multiplication of the incoming temperature and the scaled velocity: an accelerometer reading of 5, would be multiplied by 10 to determine its velocity, and then multiplied by the incoming temperature, say 20 degrees Celsius, to produce a duration of 1000ms. This was repeated for each of the 3-axies of the accelerometer, with each axis assigned a different chord. I chose the organ because of the on/off nature of its attack, which to me was like the brief but significant bursts of acceleration that would hit The Chime's pendulum.

The gyroscope uses a similar Processing function to determine wind impulses as the accelerometer's limiter, one that looking for peaks and valleys relative to zero; when a peak is reached which also exceeds the assigned threshold, an OSC message is sent to the Max For Live patch which plays the next note in sequence. This sequence is the same melodic sequence as the one triggered by the motion detector. However, because of the different temporal behaviours of the motion detector relative to the gyroscope, the resulting sonic effect is more akin to a traditional chime, with a flurry of notes in rapid succession. Hence, the virtual instrument assigned to this translation is that of a tine based electric piano, known as a pianet (IK Multimedia's SonicSynth).

The final translation is the glue that holds the whole composition together: reverberation. This device is very simple. It consists of mapping of the ambient light levels of each sensor to directly correspond to the volume of the associated reverb bus. Because of the linear nature of the ambient light sensors, I simply had to map their range (0 to 1023) to a "live.gain" object's range (-70 to +6). Done. Each of the above translations has their audio signal sent to a corresponding reverb bus, or a combination of buses, and depending on the brightness of the light enveloping The Chime, will envelop the performance of the composition with a similar intensity of reflection.

The Effect

The composition as an aural experience satisfied a specific musical ambition I had always wanted to explore. As I have no formal music training, I have always believed I would never have access to these specific tones and timbres, let alone the ability to assemble them within such a compositional aesthetic. I am a guitarist, a guitarist who cannot tune his guitar without the help of a tuner. Yet, over the years I have developed a very refined and deeply personal harmonic and melodic style. I know how to assemble notes into groups or patterns that move me. I emotionally respond to lingering tension with moments of resolve, a relationship that is somewhat the inverse of contemporary composition, where tension is used sparingly, if at all, for dramatic effect: the augmented, diminished, sevens, and major sevens of the twelve-tone system, whose beauty lies in their suspension of resolve. However, this form of musical tension is really only effective when progressions are synchronized. Hence the composition approaches tension from a different perspective: the asynchronous.

When I played in a band, I had a metronome for a drummer. His precision was incredibly forming and influential; it was his meter that guided the delivery of my compositions. There was an inescapable, predictable logic to the songs from a temporal point of view. My harmonic aesthetic meshed well with his style, which provided the strict predictable foundation that permitted my variety of harmonic complexity since every element moved in lock step. What The Chime affords me is an instrument through which I can compose for tension through temporal shifts as opposed to tonal shifts. I still use complex chords and

melodies inspired by my affinity for 20th century romantic era solo piano composes, such as Ravel, Debussy and Satie, however I have layered them over an aesthetic influenced by contemporary production: the ambient work of Brian Eno and Stars of the Lid, the experimental collaborations of pianist Ryuichi Sakamoto and Christian Fennesz and contemporary classical composer Max Richter. I can safely say that without The Chime, I would not have an instrument through which I could produce infinitely variable, yet finitely constrained generative music that comes close to the above composers that so move me.

I decided to name the composition "I Can't Tell If You're Coming or Going" to comment on and emphasize the agnostic character of the sensors employed in this instrument, while also injecting a certain amount of ambiguity into the generative nature of the piece. I have called the output 'performances' since The Chime is simply programmed to respond to conditions, without interpretation, yet the manner in which the resulting performances surprise, in the sense they generate unexpected combinations, produces an affective reaction akin to the most considered compositions, suggesting a refined palette exists. But does it exist in the composition or the environment? In The Chime or the city? Is The Chime an extension of my creativity, or a virtuso of urban difference? The simple answer is to say it always resides somewhere in between. However, without knowledge of how The Chime operates, the listener could very well ascribe creative credit exclusively to The Chime. Having set out to create an instrument for sensing difference that might bring attention to the overly proscribed and direct way in which data is presented to users, one which ultimately produces a certain blasé acceptance of the data as fact, this possibly is problematic. Yet it is exactly this causal ambiguity that the title attempts to foreground. An ambiguity that gets even further complicated by the didactic data visualization presented synchronously with The Chime in the installation, making the title of all the more fitting.

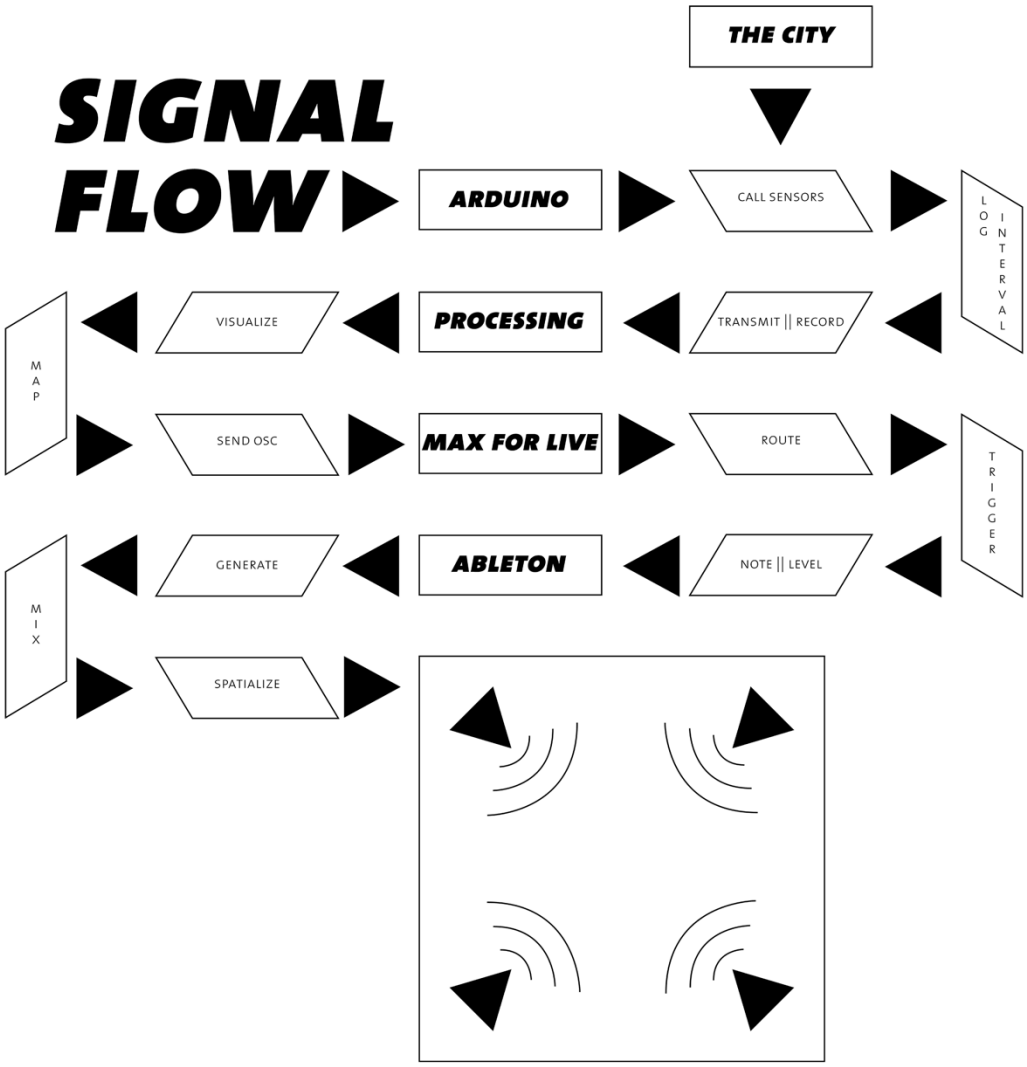

Figure 10: Signal flow diagram

THE INSTALLATION

The Build

With The Chime perfectly functional and the composition almost fully refined, I set out to begin recording the final performances that would best demonstrate the instrument I had created, all the while thinking how exactly I was going to exibit and share the results. During this time, I began mocking up the interface. I thought that the octagonal shape of The Chime should be reflected in the design, which led me to think about how many compositions such an arrangement would afford. The obvious answer was eight, however I knew that I wanted The Chime to be able to be run live, which meant that at least one side of the octagonal interface should be dedicated to the live performance. This left me with seven sides, and thus seven unique locations. Yet, I remembdered that part of my original concept involved time specific site studies, a component the fell in significance as the feasibility of the project became of greater concern: the simpler the better. However, the dependable functionality of The Chime gave me confidence I could double the number of performances, meaning each location would be recorded twice at difference times of the day, or different days all together.

With the number of locations and performances now set, I began to identify sites and times of day that I wished to record. The selection criteria was in many ways as subjectively poetic as the composition process, however I wanted to ensure I captured as broad a spectrum of environments and times as possible. The seven final locations were: King St and Spadina Ave (a busy intersection with much foot traffic due to the nearby subway exit, recorded in the afternoon and early evening), Nathan Phillips Square (a large concrete modernist downtown plaza, recorded in the early afternoon and late afternoon), Queen St and University Ave (a busy intersection with both car and foot traffic, recorded in the early evening and at night), Grange Park (a popular downtown park, recorded in the early afternoon and evening), Grenadier Pond (a pond inside the largest park in Toronto, recorded in the early morning and at sunset), Lakeshore Boulevard (a high volume traffic artery next to the lake where its beach and path are primarily used for recreation,

recorded in the morning and the evening), and Roncesvalles Ave (a neighborhood residential/commercial strip, recorded in the early evening and the morning).

After recording these sites, I began the rendering process (both audio and visual). This proved to be the most challenging part of the whole project as syncing all the different media (The Chime's data playback, the four surround channels of environmental audio, and the documentary video) with their respective time codes was essential to the effectiveness of the experience as a whole. I foresaw this being an issue when I chose to embed a buzzer into the The Chime's shell design, yet the various computational latencies took a while to understand despite including this clear sync point.

The first problem had to do with playing back the TXT files while mitigating drift. During my early playback tests it became apparent that using a delay function in Processing, set by the recorded interval, was causing the performance to last longer than the total duration as logged by the Arduino (I logged both the interval and cummulative time after each log, in addition to logging the total duration, which gets set after record is turned off). This led me to build a simple function that compared the live millisecond value of the Processing playback sketch to the logged time of each index of the TXT file, and if they were out of sync, the index incremented from within a while command until the runtime of the index was greater than Processing's millisecond reading:

```
void dataCallSync() {
  if (!go) {
    startTime = millis();
    runTimeRead(i);
    go = true;
  } if (millis()-startTime <= trackLength) {
    while ((runTime) <= millis() - startTime) {
      if (i < sensorData.length-3) {
        i++;
        runTimeRead(i);
      }
    }
    if (i < sensorData.length-3) {
      txtRead(i);
      chimeOSC.oscMessages();
    }
  }
  else {
    playTrack = false;
  }
}
```

This solution also helped me figure out how I might render each frame of the visualization into an image sequence for compositing overtop of the documented video, guaranteeing that video and visualization would never lose sync, nor drop any frames. To do this I could not rely upon Processing's millis() function as it took time to write each frame to a png file, consequently throwing off sync with the recorded runtime of the TXT file. I thus had to create my own clock by which to sync the data with each frame. At first I thought about substracting the time it took to write each png, but then quickly reazlied that the video I wanted to sync the visualization to had a strict interval I could follow: 24 frames per second. I thus inserted a simple clock command into the Processing sketch, one which incremented upon each loop and thus each frame:

```
if (time <= trackLength && i < sensorData.length-2) {
    txtRead(i);
    while (runTime <= time) {
      i++;
      txtRead(i);
    }
  }
  else {
    load = true;
    trackNumber++;
  }
  chimeLive.sketch();
  saveFrame("LOCATION1A/VISFRAMES/TheChimeVis-1A-#######.png");
  chimeLive.visText();
  saveFrame("LOCATION1A/VISTEXT/TheChimeText-1A-#######.png");
  time = time + (1000/24);
}
```

With these two syncs figured out, I began the long process of rendering all 14 performances. Once all the visualization frames and text were rendered (text was rendered separately to allow me to be able to add a subtle drop shadow in After Effects to improve its legibility) I composited them with the documentary edits I had made (I setup each edit with a wide establishing shot that cut to a close up of The Chime the moment the buzzer had finished its 5 buzz countdown in order to draw attention away from the visual environment and towards The Chime, the data it was recording and the sound being produced). After syncing all these visuals in After Effects, I then took the renders to Final Cut where I synced the environmental sound with the performances rendered by Ableton Live. The Ableton rendering consisted of recording two stereo AIFFs: the first corresponding to the front pair of speakers (relative to the orientation of The Chime) and the second to the back pair.

I should mention that my Processing sketches were able to playback the visualization, the video and the audio in sync without any prerendering, however the computation power needed to do so without noticeable performance issues was simply not available, and thus I pursued this particular post-production route.

With the media now synced and rendered, I put the finishing touches on the interface by mapping each performance to the octagonal UI, and finessed the responsiveness of the rotary encoder dial responsible for both selecting (turn) and playing/stoping (push) the performances. I intentionally chose the dial because of its simple functional constraints, and once I had it working with my Processing sketch I was finally able to cue the video (in Processing) and the audio (in Ableton) with a single push of the button. In fact, the completion of this interface proved to be the final step towards finally being able to run The Chime live; prior to this point I had had so much difficulty with wireless serial communication (trying both XBee and Bluetooth antenas) that I was unable to directly test the responsiveness of my composition. Using one of the holes I drilled into the base of the chime, I threaded some braided wire from the Arduino directly to my computer, setup a serial connection between Arduino and Processing, assigned a section of the octagonal interface as the on/off switch for serial communication, and thus created live audio and visualization playback control. The result was surprisingly responsive, with minimal perceivable latency. The Chime was now ready for exhibition.

The Effect

For the Digital Futures Graduate Exhibition, titled Xtension, I was fortunate enough to have a room to myself. Though there were other potential options within the gallery at 49 McCaul, including a black box theatre, the room proved to be ideal for The Chime. The reason for this was the transparency of the space; if I were not going to be able to fully situate The Chime within public space, a room with two walls composed of windows would provide sufficient environmental input to affect The Chime while it ran live. In addition, the space was large enough to adequately distribute the four speakers, thus rendering my composed spatializations with acceptable fidelity.

After much consideration, layed out the room in the manner I thought best didactically communicated the way The Chime worked. This meant placing The Chime in the center of the room with the table housing the video and visualiazation playback manitor directly adjacent; if I had wanted to emphasize the audio, I would have had to move the screen out of the square space carved by the placement of the speakers. However, as I anticipated, gallery visitors primarily congregated around the screen, and to a lesser extent around The Chime, most notably when it was running live. What was unexpected was the way the visualization captivated visitors. While many tried to use it to figure out how The Chime worked (as I had intended), many also found it to be a unifying part of the experience, as aesthetic, even as poetic, as the composition. It produced a feedback loop where The Chime's causality became multi-directional; it was possible to see the visualization as sequentially succeeding the sound, as opposed to preceeding and informing it. To me, it meant that the experience, both sonically and visually, was successfully unified.

While I was pleased with the exhibition, it only reinforced my original intention of situating poetic translations within the city. Recording site and time specific data and transporting it to another location for playback seemed at odds with my original intention. Yet, if seen as a study, it produced enough data, and concequently enough performances, for me to begin to get a poetic sense of the character of these selected locations. For example, the corner of King St and Yonge St proved to be the most chaotic and jazz-like, whereas Nathan Philips Square was calm, but because of the din of the city that surrounded the square, the mix was the most balanced of all locations, with strings and piano equally present. I found the comparison between Nathan Philips Square and the nearby Grange Park to be most interesting as they are both outdoor places of pedestrian circulation and repose, however one is concrete and the other more natural. The significance of this distinction, which is most obvious to the eye, had been ignored as a result of what could only be desfibed as my blasé attitude towards the places. However, thanks to this project I now not only notice relative levels of urban din but also the impact of materials upon use. Surprisingly, this applies equally to urban citizens as to urban wildlife: flocks of pigeons prefer Grange Park over Nathan Philips Square. I certainly never observed this before, despite my many prior visits. Was this revelation thanks to The Chime or simply a result of paying attention? My answer would be that the latter *follows* the former.

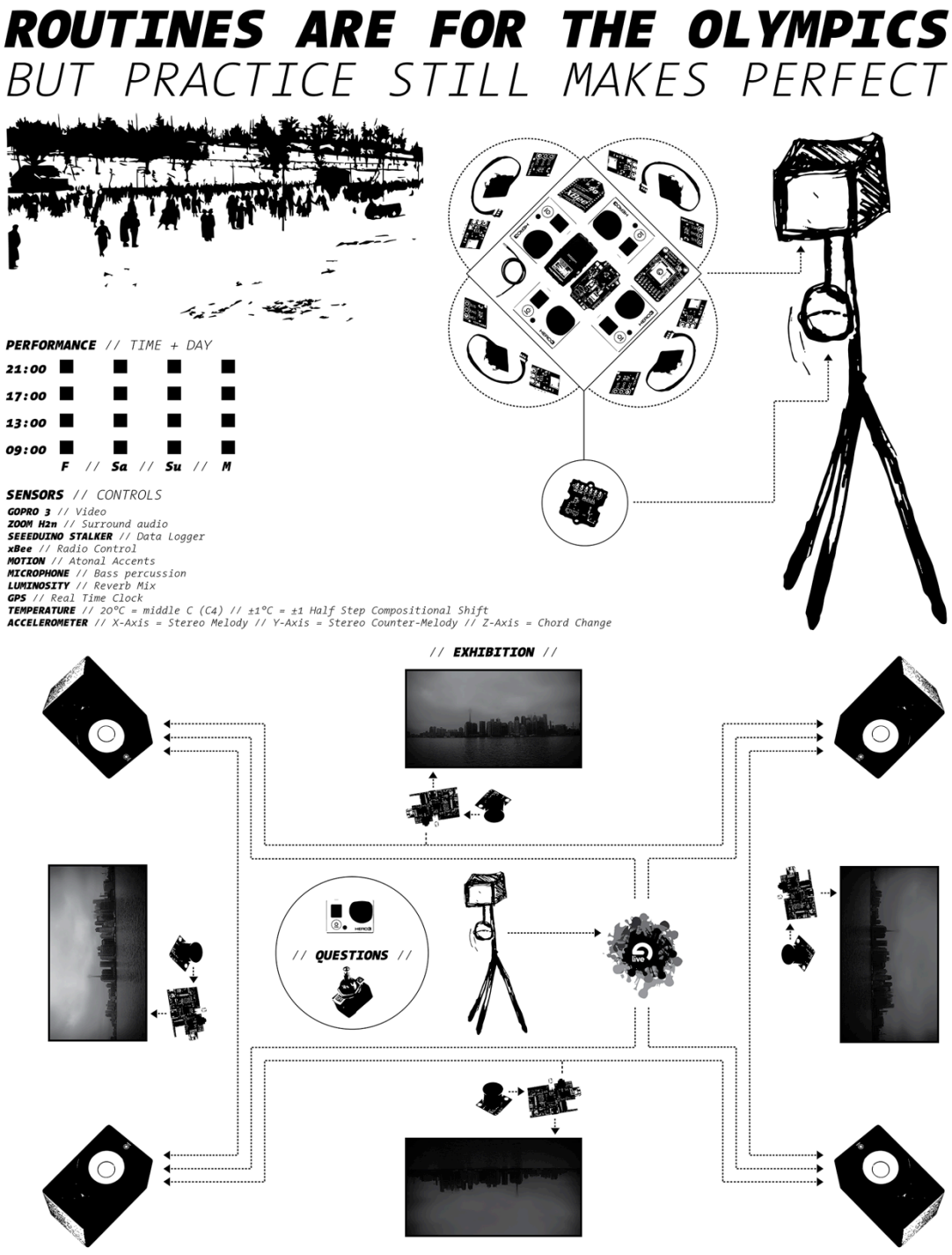

Figure 11: Project and installation proposal poster

Figure 12: Installation Setup (A)

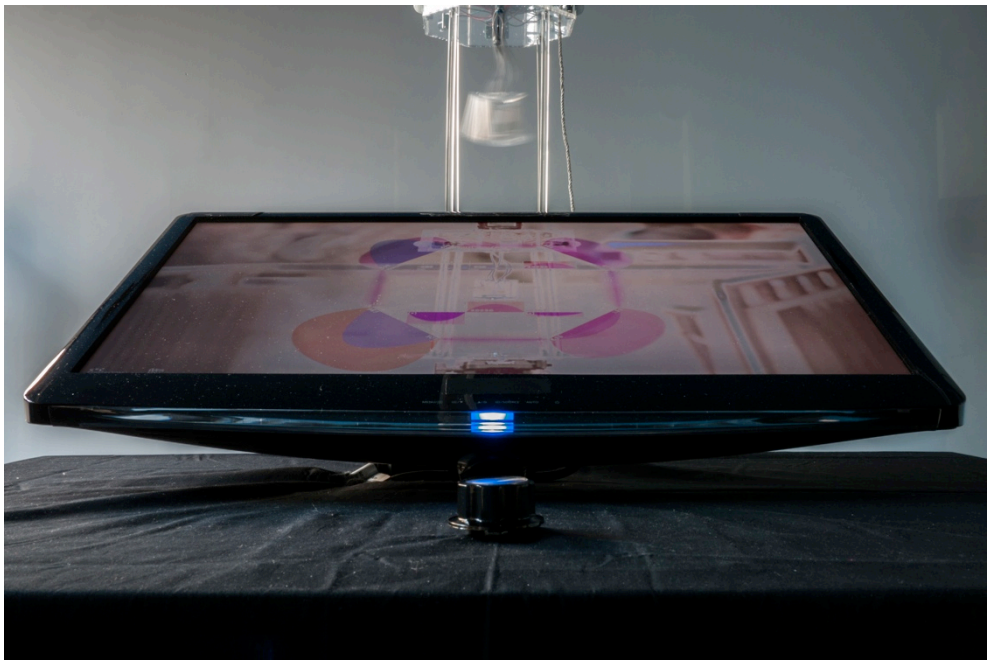

Figure 13: Installation Setup (B)

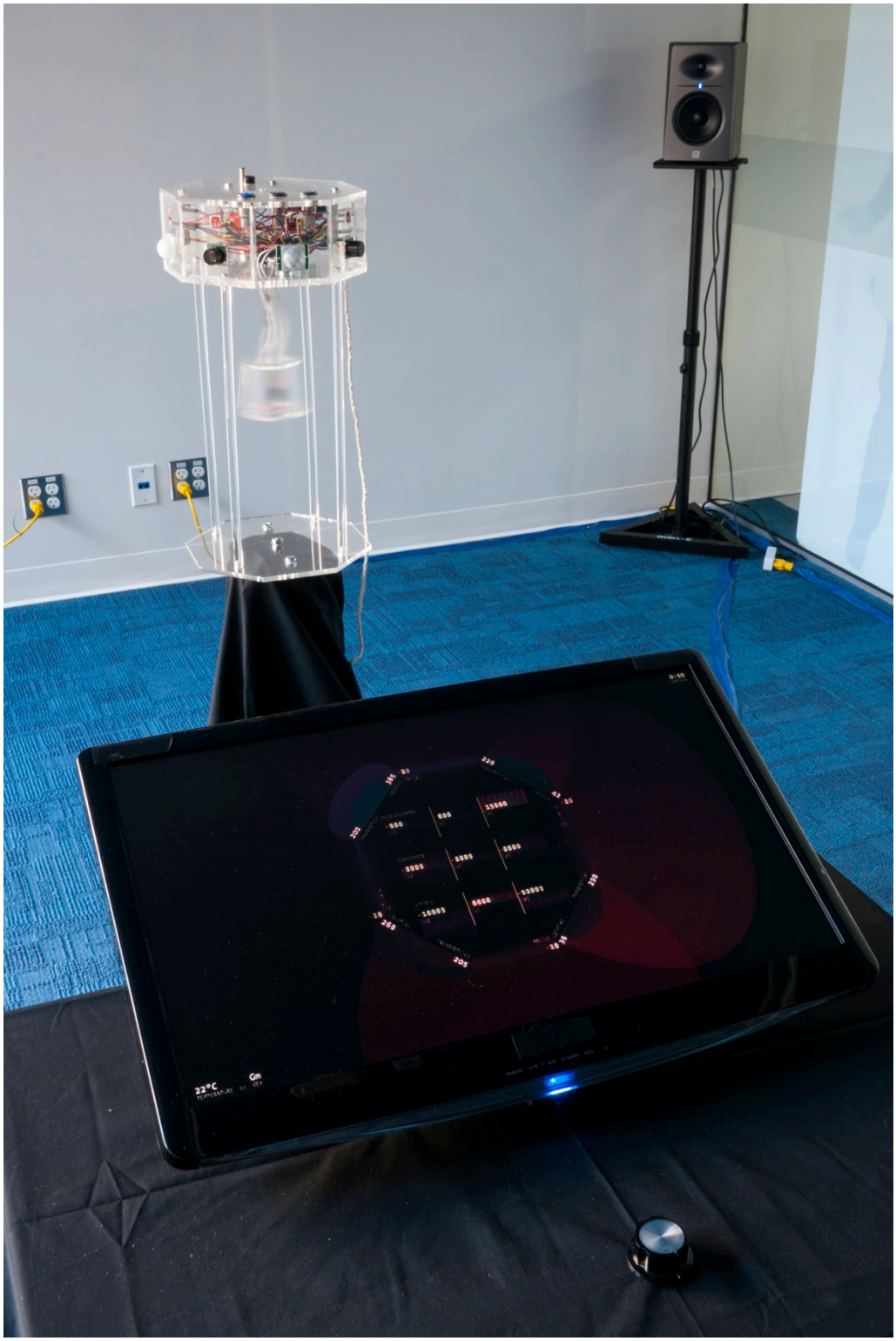

Figure 14: Installation Setup (C)

Figure 15: Menu Interface

SIGNIFICANCE: THE INTERNAL FEEDBACK LOOP

ROUTINES ARE FOR THE OLYMPICS BUT PRACTICE STILL MAKES PERFECT

One of the final creative works of my undergraduate studies, six years ago, was a video titled "Routines are for the Olympics but Practice Still Makes Perfect" which explored ideas of repetition, composition and performance. The video featured myself playing the song "Figure 8" from the School House Rock animation series, with an After Effects camera moving across three identical hallways, where the left one contained a record player, the center one framed myself and my instruments, and the right one left empty yet punctuated by superimposed imagery in sync to the meter of the music. The video progressed with me adding a new musical layer to the composition with each spin of the record, until I opened the door at the end of the hallway to reveal an empty auditorium. The work is dated, at least for me, however I feel that in many ways I failed to carry these ideas with me post-graduation, and left them dormant, simmering in some cellar of my mind. Consequently I find it fitting that after a very long and circuitous route, covering many different conceptual iterations, I find myself concluding my graduate studies by expanding upon the ideas I too quickly abandoned those many years ago, and making up for my negligence with greater depth, detail, and rigour.

The major difference between my first efforts and now is the context in which I am exploring these ideas. Where the video reflected a more personal focus, this project takes the conceptual themes of routine, repetition, performance, and composition, keeps their musical associations, but layers them on top of everyday life in the city. Here, video has been replaced with ubiquitous computing as primary media, while a spatial installation supplants the screen as delivery vehicle. In short, where my first work took an established media form, this project integrates a wider variety of material and media towards a more experimental end.

JOURNEY > DESTINATION

After spending an extended period of time negotiating exactly what kind of everyday intervention I intended to make, the final product represents the natural convergence of many conceptual and personal interests. In retrospect, it becomes clear that The Chime has been built primarily as a vehicle for a deeper exploration these ideas. It exists as both a tool and instrument, rather than as a solution. In fact, as much as I enjoy listening to the performances The Chime recorded, the sonification component of this project demands greater inquiry, both historically and practically. This is the most important realization that emerged from the exhibition. At its most basic, sonification is the translation of information into sound (a definition I can attribute to Kia Ng of the University of Leeds during his talk at OCADU on April 29th, 2013), and a full study on how this information is communicated, in terms of affect and effect would be a rich and worthy study. While I took more inspiration from music composers in designing my sonification, it is by no means the only potential communicative output.

What is interesting is that just days after the exhibition of The Chime, generative soundscapes designed for the Montefiore Hospital by Brian Eno were unveiled, presenting another potential spatial and social application of the ideas I have explored. In fact, related directly to the city, in 2011, interaction design agency Tellart, in partnership with advertising agency mono for client Parsons' The New School of Design in NY, produced a wall that generated music based on sensed street level activity. The installation, called *SoundAffects*, encouraged passers-by to put on headphones and listen to the streetscape. Another example, and one of my favourites, is the *21 Swings* project by Daily Tous Les Jours in Montreal, where they modified existing transit shelters by turning them into musical swings. The installation, which has returned every spring since its inaugural season in 2011, uses the pendulum like motion of the swings to trigger notes in a musical composition. What is particularly delightful is the way in which performers become collaborators simply by participating. Then there is the 2012 Royal College of Art thesis project from Mark McKeague, titled *City Symphonies*, which uses traffic models to generate music, anticipating a future where the electric car will be able to directly contribute to such performances, as opposed to simulating them with

present day models. And finally, there is *Tales from the Bridge*, a soundscape featuring choirs and poetry composed by David Bickerstaff, Martyn Ware and Mario Petrucci for the Millennium Bridge in London during the 2012 Olympics Games. What these examples demonstrate is the growing interest in sound's affective and effective potential when situated in and responding to urban environments. Thus, I am keenly interested in continuing along this trajectory of exploring situated, responsive and embedded sound in the city. I suppose one could call it my next journey, one which will certainly be generative (both computationally and personally). And much the like The Chime, the rules will be composted such that pleasant surprises ensue.

While I initially set out to explore wayfinding, I quickly realized that I was not interested in finding a better or more effective wayfinding solution and more inclined to explore the narrative potential of space. This eventually led me to acoustic places. However, what is most important is that The Chime is an integral and essential part of the journey, rather than the destination. In reality, I am just beginning my exploration of acoustic places. This process has been more about defining an arena to explore, rather than achieving an objective specification or productive output. And I truly the believe the infinite number of performances contained in the combination of my one composition and The Chime fully supports the notion that there is no destination, but instead a looping routine capable of producing meaningful difference, both in its sonification and within my everyday trajectories.

CONCLUSION

> In contrast to the temporality and spatiality of the narrative, playing out once and for all, we find a progression based on a shuffling between loops which are all active simultaneously, which are constantly changing their character in response to new events and which can communicate with each other in a kind of continuously diffracting spatial montage. There are no longer calculations with definite beginnings and ends. Rather there is a plane of endless calculation and recalculation, across which intensities continually build and fade. (Thrift, 2006b, p. 590)

Early on, within the first few weeks of my studies, it became apparent that space was to be of great importance to my Master's, exactly how was less known, but I at the very least had a thread to pull on. This document is the evidence of said spatial exploration, in both thought and practice. Through a critical evaluation of electronically sensed difference and its relationship to the everyday, I came to the realization that the city is well known as an empirical system thanks to these sensors, but as an experience, sensors make little difference. Consequently, the sensed data of the city is in need of reciprocally generative poetic translation, a process that absolutely echoes the above quote from Nigel Thrift. In other words, the city needs to be qualculated.

On the way to this conclusion, I discussed the nature of public space, introducing Simmel's notion of the blasé, which is an inability to recognize difference. I argued public space is synonymous with difference, however there is evidence that networked technologies have overwhelming taken an approach to curing perceived anomie by connecting the similar. This tendency impoverishes the collective nature of public space by fractioning citizens in to ever-smaller niches, as opposed to promoting a collective interest.

I then argued that sound, because of its transient and temporal nature, was the most public of the senses. One has very little control over what is heard, and unlike objects, sound cannot be possessed. Even though sound has been used to strategically withdraw from potential interaction in the city thanks to the advent of personal audio players, this could just as easily be used as evidence of sound's power to form space. It is no wonder that freedom of speech is so protected in most democracies, for speech, and sound in general, is to be shared. Public space is quintessentially acoustic.

Acoustic space has a unique character, one which has conceptually and philosophically been overlooked in favour of more visual approaches to spatial analysis. The reason for this is that acoustic space is very difficult to abstract. This is why McLuhan deemed acoustic space to be natural space, and visual space to be the product of the alphabet, which is in itself an acoustic abstraction. I argued that the dominance of the visual presented design opportunities for cities, for it has become clear that the notion of the map as totalizing representation of the metroplois is immediately an anachronism in the moment of its completion. Thinking about the city acoustically would immediately add the necessary temporality to fasciliate in better understanding the ebbs and flows of the everyday.

However, to understand these flows, the vast amounts of data collected by embedded and mobile devices need to be explored. The process for this exploration can inherit the modernist and visual tendency to abstract into repeatable forms, or, the data can be used to bring awareness to its reciprocal nature through the process of translation. I argue that the translation process needs to be noisy and inefficient in order to generate feedback, or difference in the signal. This is why I argue for the poetic translation of data. If sensors, these inherently agnostic instruments of engineering, were perfect translators across the senses there would be no need for them to be biased. Because they can only observe a narrow spectrum of phenomena, they need to be augmented with context. And so far, no one has developed a 'context' sensor. Thus, all sensors are contextually noisy, which is what makes them so poetically interesting.

On a social level, there is great potential danger in allowing sensors to be normalized, for this process of reducing noise and abstracting patterns when applied to individuals, renders them 'dividuals'. One has to look no further than Klout, a service that attempts to rank individuals based on their social media influence, to understand the perversely reductionist consequences of this practice. Hence I argue for a better understanding of how code operates: through technicity and transduction. What is essential to this framing is the agency code is given to create and dissolve space. Thus code does not simply analyze for abstraction, but in reality behaves reciprocally with that which it engenders. In the context of the built environment this leads to the creation of code/space, but I ask, where are the code places?

Place is one of the earliest, and most significant conceptual areas explored in my work. In a similar manner to sound, place is underappreciated both critically and philosophically, in thought and in practice. It might be because, like sound, it is difficult to abstract, and thus render an object. However this is what makes it poetic, and why it interests me so. More than mere location, place has a cumulative temporality, a history *and* a present. Hence, I put forth the notion that acoustic places are theoretically possible, and potentially desirable. I am reminded of William H. Whyte's description of Paley Park in New York (from his 1980 film *The Social Life of Small Urban Spaces*) whenever I try to think of an example of an acoustic place. Though they are rare, and would likely be predominantly associated with silence by the average citizen because of the dominant din of the city, Paley Park, with its waterfall and intimate surroundings, demonstrates rather beautifully how sound can be used to carve out space and create an acoustic place. For it is the atmospheric nature of acoustics, its ability to be temporal and thus narrative, that renders *spaces into places*.

Because I have argued that place is essentially temporal, the question becomes what is the nature of this temporality in the course of the everyday? I argue that routine need not be seen as a chore. Routine, be it in code as loop or on the street as a route, has the potential to produce great difference; it is a matter of prioritizing the journey over the destination, for destination are by their very nature static objectives, whereas the path, or tour, to said mark in time is ultimately that which is recounted in the narrative. This is why I believe that today, routine need not be though of as repetitive. Rather, like the city, routines are the foundation of generative systems, and as natural as the cycle from day and night, or from winter to spring.

This emphasis on the generative is what ultimately coheres my production and thinking. The idea of calm technology, ubiquitous computing that operates on the periphery, is the perfect design concept for notions of the generative. This is because of the abundance of sensed difference waiting to be translated, and retranslated, without end, or as Nigel Thrift has already stated at the outset of this conclusion: *Rather there is a plane of endless calculation and recalculation, across which intensities continually build and fade*. This is The Chime's *raison d'être*. And though the song remains the same, I am looking forward to its endless performance.

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APPENDICES

APPENDIX A: ITERATIVE IDEATIONS

Iteration No. 1: Wayfinding Narrative Places

Based upon the research proposal put forth for SSHRC's Joseph-Armand Bombardier Canada Graduate Scholarships Program Master's Scholarships, I envisioned a final thesis project concerned with location specific wayfinding, specifically digitally augmented wayfinding where GPS breaks down due to a lack of granularity. My experience working on major exhibitions at the Royal Ontario Museum influenced this trajectory greatly.

In order to construct an engaging gallery experience, the narrative arc must be designed spatially. Wayfinding in a museum context is more nuanced than pointing visitors towards their desired gallery. In the same way GPS is a very effective tool for finding a specific location, signage in the context of a museum does the trick. However, once a visitor arrives at their desired street corner or gallery, the environment as a whole takes over in terms of providing guidance. Ultimately, what I wanted to explore was how an environment's intrinsic qualities could be enhanced from a narrative perspective in order to engender a feeling of being welcome in the visitor. The reason for approaching the thesis from this perspective was that I believed a welcoming environment essential to encouraging participation.

Narratives, particularly mediated narratives, have traditionally been passive experiences. To me, the exciting opportunity provided to spatialized narratives by locative technology is a richer spectrum of interaction potential. By first targeting a welcoming environment, then novel and tailored interactive interventions, visitors would be exposed to a different kind of wayfinding experience, possibly more akin to the subjective and very personal narrative of "finding your way", hopefully leading to a sense of place, which is in essence a feeling of belonging.

While inspired by the constructed narratives of the ROM's exhibition spaces, the goal was to take this process, augment it, and apply it to public places. Rather than impose a specific narrative upon a place - history can easily be mined for just such a purpose, hence the proliferation of augmented reality applications superimposing relevant archived media onto present day locations - the interventions would be designed to encourage more personal narratives. This turn away from a more externally programmed wayfinding, to a more personal "finding your way" led to the second iteration of the final thesis output.

Over the course of reading I gravitated heavily towards Mark Weiser's (1996) notion of calm technology. His envisioned future consisted of computation power being embedded into the environment and performing a more peripheral type of augmentation. This vision was put forth in the early 90s, and set the stage for all Ubiquitous Computing research to come. What Genevieve Bell and Paul Dourish argue in *Divining a Digital Future* is that the relentless pursuit of Mark Weiser's original vision has severely limited Ubiquitous Computing's potential because it is unattainable as originally defined. It is a technological utopia, one which is incredibly powerful in terms of its ability to inspire, yet unintentionally devalues the present by continually pushing its arrival into the what Bell and Dourish call the "proximate future". The authors argue that Ubiquitous Computing has in fact already arrived; it is merely in a different form than Weiser imagined.

While visionary, Weiser never predicted that much of the augmentation he proposed would be realized through mobile devices. The consequence of such a realization is a tendency to access the world through a screen, which conflicts greatly with Weiser's desire to have computation enhance from the periphery. This conflict stood out as a design opportunity, and consequently became one of my driving principles. Approaching my narrative wayfinding from a desire to augment without the use of screens was an important constraint to impose on myself.

This decision was not made to adhere to Weiser's original vision for Calm Technology - though it certainly helps the project's historical contextualization within greater Ubiquitous Computing research - but rather

because the goal for narrative wayfinding, as I have set forth, is to experience narrative cues directly from a place. Mediating such a place through conventional mobile strategies goes against this objective; a greater sense of place cannot be achieved while experiencing it one step removed on a screen. The challenge is thus to enhance environments in such a way that no screen be necessarily inserted between location and visitor in order to enter into a meaningful interaction.

That is not to say that screens do not have their place. I would instead include screens within the wide variety of communicative surfaces that convey a location's significance and investigate its potential personal narrative. A screen is, in the context of this project, but signage. No better or worse than any other type of wayfinding strategy, and perfectly appropriate under the right circumstances.

I also interpret Calm Technology to mean a mode of interaction that does not necessarily require timely action in order for the design to be successful. By this I mean that reflection can be an equally compelling input mode as reaction. Most augmented applications prompt users for action, taking them out of the moment, and asking them to engage immediately. If not handled appropriately, this creates the same kind of distancing, where action is once removed from the scene, that mobile screen engagement produces. Consequently, I have added *reflective* as a desirable quality of any intervention. Now this may be seen as contradictory to the nature of wayfinding, in the sense that finding is very much an active process, however, I am less interested in designing ways to achieve a particular destination efficiently, and more interested in enhancing the journey.

The output of this particular thesis iteration was to be an open source toolkit offering instructions on how best to build and implement the various wayfinding interventions created and evaluated over the course of the research. Strong wayfinding is always a system of interrelated media. Traditional graphic signage is not interactive enough for the purposes of this exploration, however, even in a less experimental context, signage would have to be combined with maps, lighting, strategic barriers (ropes for example) in addition to more reactive technologies, to effectively guide and direct a flow of people.

Iteration No. 2: Wayfinding in Union Station

With the introduction of a potential partnership with Union Station, the focus of the thesis output shifted towards a more conventional notion of wayfinding: directing people through a major transportation hub. At first this seemed like a perfect convergence of my interests in wayfinding and public places. The conceptual challenge for me centered around how to use the traditional program of Union Station to explore contemporary notions of routines, journey and destination, built on efficient flows of people in and out of the building, and consequently the city. Understanding full well that the vast majority of travellers would have no interest in being awoken from their habitual routines, I began to think about how best to intervene without obstructing. This kind of sensitivity to context perfectly aligns with Mark Weiser's vision for Calm Computing, where technology augments the periphery rather than commands the center.

While this initially seemed like a perfect opportunity to explore the application of ideas and principles developed and researched to this point, I was hesitant to fully commit my thesis to a prospective partnership. I thus began to explore a second, parallel, thesis direction, while waiting to see what became of the Union Station opportunity.

Iteration No. 3: Subtractive Mapping of Everyday Routines

While the SSHRC proposal provided the early framework for my research, much of the exploration happened within my course work. In Media Theory I outlined my take on the conceptual distinction between place and space, arguing that Places were cummulative and Spaces were repetitively transactional. Related to repetition, I explored ideas surrounding spatial routines in the Digital Games class. My final project, The Everyday Tourist, was an HTML5 GPS logging application developed under a specific critical lens (though it did not actually log to retrievable memory). I was interested in ideas of productive efficiency and the slow creep of said efficiency into leisure time. Had the project been fully realized, the GPS logger would present a version of the city that was subtractively mapped based on the holder's routines. The hope was that by mapping daily routines, a greater sense of local awareness would be engendered. For example, large parts of the city would likely be blacked out, indicating areas where slight deviations, slight

inefficiencies, may yield interesting new experiences. Over the summer I kept returning to the idea of using subtractive mapping, only this time in support of the narrative structure, or the personal arc, of my wayfinding ideas.

I thus began toying with the idea of performing an intense life-logging, self-ethnography with a small portable GPS logger and no screen, for adding a screen would offer the opportunity to check-in on my progress, and consequently check-out of the journey. As with all ideas to date, the conceptual significance of Calm Computing is obvious. Related to the peripheral, is an emphasis on reflection rather than action. Screens call attention to the themselves and have tremendous ability to prompt individuals to act or respond. Both reflection and periphery, used here as design constraints, allow me to critically engage with the visually dominant direction computation has taken. There are consequences to assigning so much agency to our devices, and one of the major ones I am targeting here has to do with the diminishing necessity to form a cognitive map of our everyday world.

In addition, in the same way biases colour the production of news, design considerations colour the presentation of collected data, determining what information is important and consequently what stories will go untold. Most of the geo-locative applications are voluntary, self-imposed filters, restricting access to raw data. This is a further consequence of a trend towards designs that intervene and call for immediate attention and action. When they do so, they do so by executing scripts that respond to filtered data. While much of this filtering could be done through machine learning or the application of personal settings, the information presented should be critiqued just as rigorously as the news. There are biases to every design. A moment of reflection is all that is required. By restricting the evaluation of the raw GPS data to moments of reflection, at least one device is providing the opportunity to subjectively interpret, as opposed to objectively prompt a path.

I started to think about how I could use raw GPS data in order to construct reflective narratives, through the journaling of everyday routines, engendering them with greater significance and clarity. While working on

this direction, I came to realize that the best way to explore and evaluate these ideas was to instill myself as subject. I had many clear critical objectives at this point, but one of the main ones was to promote the subjective evaluation of routine experience. While there are many life-logging tools (Datum, Path and Foursquare for example), they tend require too much inputting, without an equivalent amount of interpretable output. This is the product of trying to design a tool that can be used universally, which has a normalizing effect on the user. How can a universal tool, with inherent designer biases, highlight the unique patterns of behaviour that compose a personal relationship with everyday places? Like a universal remote control, it is ultimately too ambitious, and thus too difficult to program. Consequently, I have chosen to design something very personal and very intimate as an example of how data could be used reflectively. Rather than design individuals into a proscribed behaviour, I could demonstrate the latent agency possessed by everyone who generates personal data over said data. My narrative represents but one way of relating to the city. Like a grammar, I am merely providing a set of rules that can be broken and recombined to unlimited, potentially poetic, effect.

One of the major shifts at the heart of this idea is a move away from a user-centered design approach to a more reflective and heuristic practice. It is here where I decided to eschew any methodological hybridization and trust my previous practical experience.

Iteration No. 4: Acoustic Wayfinding

Extending compositional arrangement from songwriting into wayfinding was the inspiration behind this fourth iteration. Using the 13 songs from a record I have been producing over the last 6 years as narrative material, I would develop a script, a score if you will, consisting of 13 unique prompts to be followed, each of which would direct listeners to a location of their choice. Upon arriving at the selected location the listener would be prompted to play the associated song. This would repeat over the course of a day, with 13 time specific prompts encouraging the listener to pair the song with a personally meaningful location.

There is a strong parallel to Michael Bull's ethnographic study of personal audio players in this idea, where he argued that these devices allowed individuals to regain some control over their own personal narrative by inserting a linear sequence of music into the repetitive routines of the everyday. In the case of this iteration, location is added to the personal scoring of the narrative.

Iteration No. 5: Generatively Scoring the City

The fifth iteration builds upon the musical layer introduced in the last idea, but instead of working with pre-composed songs, I will compose generative arrangements. Much like a wind chime, previously explored in a project titled Generative Harp, locations will perform tonal compositions. However, rather than building an object or instrument that responds to environmental stimuli, I will construct a data logger which will record multidimensional sensor input that will be fed into a composition (built in Ableton Live), triggering melodies and chords, and performing the song.

This iteration regains the self-ethnographic and performative components lost in version 4. As part of this production, I will score the everyday with 7 prompts, or tactics to borrow from de Certeau, directing the selection of the location where the data will be collected and documented with video and environmental audio. Each tactic will be paired with a composition. Part of the composition is the assignment of variables and constants to the location based tactics. There are 7 possible combinations of the 3 variables (Time, Location, Day) and thus 7 compositions. These compositions will be performed 7 times according to the scored tactics, for a total of 49 unique performances of the 7 compositions.

The blasé is the central theoretical concept tying everything together, and is responsible for the critical and creative refinements present in the final iteration presented, which included a de-emphasis of GPS as primary data and the inclusion of more sensors to better record difference in the environment. It should be noted that GPS is not being excluded entirely, for the locations still play a significant role in the project. This shift caused some confusion as my initial ideas surrounded active and reflective wayfinding, and the connection between the locative inspiration and the more expressive and performative final output was not

made explicitly clear. This is important to note as the musical compositions and performances are much less interesting without the locative motivations. I need to ensure the connection between the sound and recorded environmental changes is expressive and clear, in addition to choosing locations that complement these performances by adding the necessary context.

One comment that proved to be interesting on a macro level asked about what kind of critique, or feedback, could be given when the work being discussed is in its projected form, without any supporting in progress materials. The comment came from the maker/artist point of view, where the process of production plays such a big part in both the final result and the narrative. Because I was approaching the realization of the project from a more design perspective, more planning goes into each step, resulting in iterations do not necessarily take on a physically realized form (as evidenced by the iterations described herein). Obviously the compositional and sonic components require a much more traditional art approach to the production, where many of the decisions are subjectively motivated and intuitively triggered. However, the proposed presentation of the work, a 7 channel video and 4 channel audio installation, can be designed towards an intended effect. Both processes involve iteration, but the motivations for these iterations are quite different: one, involving the more aesthetic considerations, is predominantly subjective or artistic, while the second, with specific goals in mind, is more objective, or designed.

This too relates to the blasé, in the sense that Simmel observed an overwhelming majority of urban interactions were of the objective variety, and consequently reconciling, or rather balancing the subjective and objective becomes an important part of the project.

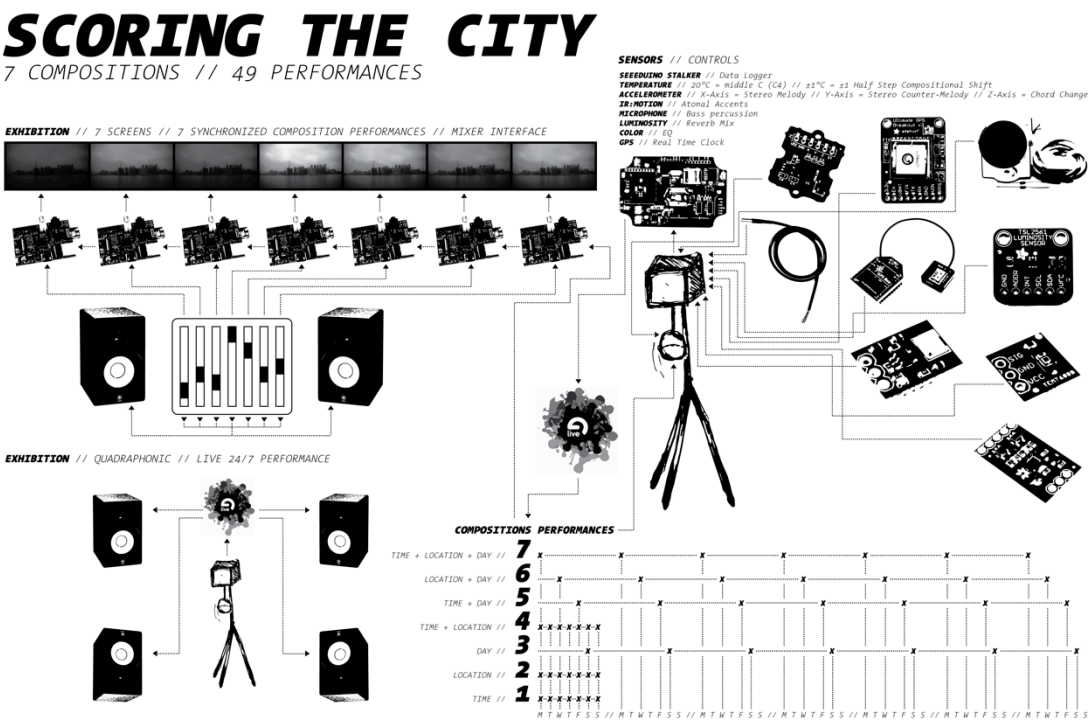

Figure 16: Initial project proposal poster (First encounter)

APPENDIX B: PRODUCTION DIARY

Phase 1: Sensor Testing and Evaluation

With the critical intent properly framed and the desired output gaining clarity, I set out to determine where my material, where my data, would come from. To begin, I tested a variety of sensors in order to understand how they behave and evaluate their relative strengths and weaknesses. What follows is a list of the sensors I tested and my assessment of their suitability to my project:

MICROPHONE EVALUATION: I connected each microphone breakout board to an analog pin on an Arduino Uno. I then linked each microphone to the brightness of an LED by using the absolute difference between the sensed impulse and the standing value, translating the wave properties of the microphone into a more linear representation. It should be noted that these microphones do not record sound in my project, but instead record sound levels.

MAX4466 MIC AMP (ADAFRUIT): Simple electret mic breakout board with adjustable gain. The microphone worked quite well when close to sound source, but was not as environmentally sensitive, in that sounds that could be useful triggers were lost in the din.

ADMP401 MEMS MICROPHONE (SPARKFUN): Breakout board for a small and quite sensitive MEMS (Microelectromechanical Systems) microphone. I chose to use this microphone because of the increased sensitivity relative to the electret version.

LIGHT EVALUATION: The evaluation of light sensors took place in the serial monitor of the Arduino IDE. Each sensor was connected according to specifications (Analog, Digital, I2C). I had previously done light sensor evaluation for my Generative Harp project, and found a wide variety of responses to input. Some were linear, others logarithmic, some had greater resolution in low light, others more definition in brighter situations.

TSL2561 LUMINOSITY SENSOR (ADAFRUIT): This sensor was fantastic. It measures both IR and visible light in one tidy sensor. The issue for my project was that it interfaces using I2C (Inter Integrated Circuit), a specific type of serial communication involving separate data (SDA: Serial Data Line) and clock (SCL: Serial Clock Line) connections, pins A4 and A5 on the Arduinos I was using (Uno, Mini Pro 3.3v, Fio). Though I2C has multiple channels, allowing for more than one sensor on the same pins, it unfortunately did not allow more than 3, and I needed 4.

TSL235R LIGHT TO FREQUENCY CONVERTER (SPARKFUN): This is the sensor I chose to use in the Generative Harp project because of its greater low light sensitivity and resolution. However, for a project that will ultimately be used outside, this strength would be negated. In addition, because the sensor used digital pins, I would not have been able to use it with the 16 channel analog multiplexer I deemed necessary in order to overcome the insufficient number inputs on standard Arduinos.

TEMT6000 AMBIENT LIGHT SENSOR (SPARKFUN): A very simple analog sensor breakout board, one which I finally chose as my light sensor. In testing I noticed that this particular sensor responded well to a wide range of light, outputting a signal that produces values between 0 and 1023 when read from an analog pin**.** While described as an ambient light sensor, I would define it more as a sun light sensor since it seems to respond to natural light better than artificial sources, unless those sources are pointed directly at the sensor. This natural light sensitivity is particular appealing for outdoor use, hence my selection.

ADJD-S311 COLOUR LIGHT SENSOR (SPARKFUN): This I2C sensor is very interesting. It is a light sensor that breaks down the recorded light into separate RGB values. This could be a very useful sensor for areas with controlled artificial light, however, as soon as the sensor detects any direct natural light source all three colour readings max out to 1023 making it rather useless outdoors, which is both understandable and unfortunate as I can foresee a myriad of potential acoustic translations for sensed colour. Consequently,

I left this sensor off the final design, though would love to explore its potential in a controlled indoor context.

MOTION DETECTION EVALUATION: Most motion detectors use changes in infrared light to turn a readable voltage on or off; these sensors are known as PIRs (Passive Infrared Sensor). This made them rather simple to evaluate, in that they really just needed to respond consistently. In addition, since all PIRs provide a simple high/low voltage output, it could work with either a digital or analog pin, thus compatible with my analog multiplexer.

PIR MOTION SENSOR (SPARKFUN): The first sensor I tested was one I purchased from Sparkfun. While it worked fine, I ran in to a problem running it at 3.3v, the preferred voltage for most of my sensors and consequently the voltage by which I chose my microcontroller (Arduino Fio). Because of this I began looking for a PIR sensor that could run at a voltage below 5v.

PIR MOTION SENSOR REV A (PARALLAX): I decided to go with the Parallax Rev B PIR sensor because of the lower operating voltage. However, this version also had the added feature of single or continuous triggering, which really simply determined how long the sensor would output a high voltage. I chose the lowest setting, allowing for more frequent triggering.

SPATIAL SENSING EVALUATION: Because I was aiming to build a multi-dimensional wind chime, it was important to find a sensor that could respond to small and large gusts with a wide array of output. At first I began with a simple accelerometer, but quickly realized that continuous pendulum like motion would not be detected by an accelerometer alone. I then began to look at IMUs (Inertial Measurement Units), capable of multidimensional motion sensing.

MMA8452 ACCELEROMETER (SPARKFUN): This 3-axis accelerometer interfaces with an Arduino using I2C and is a fine sensor (in fact, because of I2C it contains a variety options for sensitivity, filtering,

and interruption), however, in addition to the need for more dimensions of sensing, I also wanted to avoid multiple I2C sensors and decided against using this one.

ADXL335 ACCELEROMETER (SEEEDSTUDIO): In contrast to the above accelerometer, this one outputs three analog values for each X, Y, and Z, making it more compatible with the array of analog sensors I was intending to use. However, again, I needed more than just acceleration data.

MPU6050 6 DEGREES OF FREEDOM (SPARKFUN): This was the first IMU I tested, comprising a 3-axis accelerometer and 3-axis gyroscope, and while it took a while to get it up and running (you have to take power from the VDD pin to the VIO pin in order to pull it high and initialize the chip, which can either be done directly by soldering a jumper wire or by connecting the VIO pin to an Arduino pin outputting 3.3v - I chose the former). In addition, this IMU posed a serious compatibility problem with my Seeeduino Stalker (a microcontroller based on the Arduino Pro Mini 3.3v except with a built in XBee socket and microSD card slot). Despite my best efforts, going so far as emailing Jeff Rowberg (he who coded the library for interfacing the MPU6050 with an Arduino through I2C) and concluding that unfortunately the Stalker had a design flaw I could not address because of both a lack of time and expertise. I instead pursued a wireless solution (which I will detail later) because after realizing I needed a variety of Arduinos in order to debug hardware issues such as this Stalker specific one, I discovered that it was only the Stalker that was not able to interface with the MPU605 via I2C. This sensor seemed to be perfect for the project, that is, until I decided to make the final output a multichannel (surround) audio composition as opposed to a stereo piece, a decision which ultimately led to the need to determine the source of the impulse in 360 degrees. I needed a magnetometer, or digital compass.

MPU9150 9 DEGREES OF FREEDOM (SPARKFUN): This motion tracking sensor is a MPU6050 (accelerometer and gyroscope) combined with an AK8975 3-axis compass. Using a modified version of the MPU6050 library, one that takes into account the compass, I was able to pull all the motion data I needed for the pendulum of my wind chime. While this sensor is the one I ultimately chose, it too is unable to interface with the Stalker (though the compass works) and consequently led to the final selection of the

Arduino Fio as microcontroller. This selection was one of the consequences of deciding to forgo a wireless pendulum (wireless serial communication, not wireless kinetics) in favour of the faster and more reliable wired connection.

TEMPERATURE EVALUATION: From the very start, I knew environmental temperature was going to play an important role in the final musical composition. In fact, it was one of the first translations I had composed (temperature would determine the key of the composition). Here, I simply needed a sensor that would be both accurate and respond quickly to changes.

DS18B20 DIGITAL TEMPERATURE SENSOR: I originally thought I would use this temperature sensor as the pendulum wire, as it comes with a couple feet of insulated wire. Though this sensor is well suited to outdoor use, after moving to the MPU6050 and then the MPU9150, both of which have integrated temperature sensors I decided against it. However, after performing my first outdoor test of the MPU9150 inside its acrylic tube, I realized that my design insulated the MPU9150 from the environment and consequently rendered the onboard temperature sensor inaccurate, or rather extremely slow to reflect the true state of the temperature of the air enveloping the tube. Consequently, I decided to return to this sensor for the final design.

ARDUINO EVALUATION: Selecting the appropriate Arduino proved to be filled with trials and errors. What I believed to be the necessary core functionality from which all other decisions radiate proved to be in constant flux depending on the sensor configuration. My final configuration became an Arduino Fio with an external microSD slot.

ARDUINO UNO: While most of my sensor evaluations were performed with an Arduino Uno, I knew that I needed something that could run on rechargeable lithium polymer batteries, thus it needed a JST connection, in addition to an XBee socket and microSD card slot. While the latter two could be added to

any Arduino either through a shield or as an external component, I researched available integrated options and settled on the Seeeduino Stalker.

SEEEDUINO STALKER: The advantages here were numerous. This board, based on the Pro Mini 3.3v, had all the addition components I needed on one board, with the added bonus of a built in temperature sensor, a JST connector designed for solar charging the LiPo battery connected to a separate JST, and a pin layout that allowed for the use of standard Arduino shields. In the end my troubles using I2C communication with the MPU6050 forced me to look for another board, which is unfortunate since the Stalker had every feature I was looking for in one hardwired package.

ARDUINO FIO: This board is basically an Arduino Pro Mini 3.3v with an XBee socket, though it does also have a couple more analog pins. The reason I bought the Fio was to evaluate whether or not I had a faulty MPU6050 or a problem with the Stalker's I2C communication. As soon as I connected the MPU6050 to the Fio and got responsive readings from all 6 axis through the serial monitor I knew I had an alternative board which only needed an external microSD card slot in order to meet all my needs.

ARDUINO PRO MINI 3.3V: I turned to this board after uncovering the I2C problem with the Stalker. Rather than attach a microSD component to the Fio, I decided to pursue a wireless solution using the Pro Mini in conjunction with an XBee to wirelessly transmit the data from the MPU6050 to the Stalker. Because I wanted the MPU6050 to respond to wind it had to be hanging with as little structural resistance as possible. Consequently, I thought it would be best to design a pendulum that only had one strong but flexible thread (like a shoelace or twine) as opposed to the four wires needed to properly connect the sensor to the Arduino; the more wires, especially wires with solid metal cores, the more rigid the pendulum's response. I tried to find flexible wires, but that proved to be futile (until much later when I cut the ends off some alligator clips) so I move ahead with the development of a wireless pendulum using a Pro Mini 3.3v, an XBee and the MPU6050, with relative success.

Phase 2: Sensor Visualization

After choosing the sensors that were best suited to the ultimate goal of building a multi-dimensional environmental recorder, it became important to familiarize myself with how these sensors behaved; it was one thing to stare at the serial monitor attempting in vain to glean patterns from the flow of readings, and a completely different thing to watch the data in a visualization. At first I bundled the 4 sensors that could comprise each side of the wind chime (sound, light, proximity and motion) and connected them to a simple Arduino sketch that used LEDs to visualize the activity of each sensor. This worked well for the linear and momentary sensors (light, proximity and motion) because intensity or state could be easily mapped to the brightness of each LED, however for the microphone, a flickering effect, where values above the calculated noise floor turned a series of LEDs on according to intensity and values below turned the same series of lights off, was about the only readable representation possible given the setup. I consequently decided to build a visualization in Processing in order to retain the granularity present in the raw data. For linear sensors I used coloured rectangles that grew and changed from blue/purple to orange/yellow as the value of the reading increased. For non-linear sensors, such as the microphone and the 9-axis IMU, I built an array that displayed the last 50 readings as either positive or negative bars relative to a neutral axis, producing a visualization appropriate for sensors that output oscillating waveforms.

I want to take a moment to say that while I was critical of abstract visualizations in previous sections, particularly as it relates to mapping, it was with the intent of articulating what I perceive to be a reductionist and directly correlative tendency, one which ultimately produces rhetorically persuasive models as opposed to representations that can be left to open interpretation. I acknowledge this is a broad generalization, as there are many compelling examples of visualizations that distill complex data into effective communication, however for my purposes I wanted to create a visualization that presented the sensed data

in such a way as to help me begin to imagine potential sonic translations. I did not want it to solve relational problems by modeling and analyzing the behaviour of the system as a whole. Rather, I prefer to think of my visualization more as metering, like a thermometer, where an element of the system is presented as is. I say this because my visualization, while biased (aesthetically and in terms of the specific data being represented), is agnostic. What this data ultimately means is for me to determine in the sonification phase of this project.

Phase 3: Wireless Communication and Efficient Data Logging

Prior to beginning this project, I had no experience with wireless serial communication. Initially I imagined that the wind chime would at the very least be able to communicate the sensed data remotely to a computer. This is known as serial replacement. On the surface it is rather simple: swap out the wires connecting the external device, in this case an Arduino via USB cable, with two wireless XBee radios. Though the configuration of the radios can be challenging at first (I had to frequently reference *Making Things Talk* as *Wireless Sensor Networks* deals exclusively with XBee Series 2 and I had Series 1 radios at my disposal), their implementation is relatively simple if using a shield or an Arduino with an XBee socket built in: if your two radios are programmed correctly, and by this I mean on the same PAN (Personal Area Network) ID and addressed to listen to the each other through reciprocal MYIDs and DLIDs (where one radio's MYID address is 1 and listens for a DLID of 0, the other has the reverse, a MYID of 0 and a DLID 1, for example) and are both configured to communicate at the same baud rate, you really just have to plug them into their socket.

There are a variety of ways to configure an XBees radio. The most direct option is to manually communicate with the XBee via a terminal program, however there are also a couple of simple GUIs available (one from Sparkfun built in Processing and another which can be found at arduino.cc in the Fio wireless bootloading tutorial called XBeeConfigTool). While these GUIs proved helpful early on, I quickly began to favour coding an XBee configuration protocol directly into my Arduino sketches (a method I learned from Project 10, Duplex Radio Transmission, in *Making Things Talk*). These commands mirror the

commands used when communicating using a terminal, except it runs every time the Arduino boots ensuring that the XBee is always configured properly for the running program.

While serial cable replacement between an Arduino and a computer is relatively simple (and well documented), reliably fast communication between two Arduinos is tricky because there is no easy way to use the Arduino IDE's serial monitor to debug. As a result I relied upon LEDs to provide the necessary feedback, building upon the Duplex Radio Transmission project by swapping the potentiometer for a TEMT6000 ambient light sensor.

Once I had two Arduinos communicating wirelessly I swapped the Arduino Uno for a Pro Mini 3.3v with removable XBee socket and MPU9150 and began to write the code for logging the incoming motion data. However, I quickly ran into a sync problem. Because I was sending 9 discrete values in series, as opposed to constantly transmitting a single potentiometer value as in the Duplex Radio Transmission example, I was having difficulty deciphering just what variable was coming in, in addition to the numerous dropped bytes.

The first step was to index the transmitted data by putting a numerical header before the reading to be sent and have the listening Arduino look for the header before registering the data. Unfortunately, this severely compromised the efficiency of the communication, for one Arduino was simply cycling through indexed variables while the other was listening for headers and if the listener happened to miss a header it would have to wait a full cycle before a second chance to read that specific header would present itself. Though I would eventually get a string corresponding to the 9 values, it took multiple seconds as opposed to milliseconds to complete. I had a hunch this had to do with two independently running Arduinos, cycling through their respective programs without regard as to where the other was in their respective cycle. In other words, they were out of sync. The solution proved to be rather simple. Instead of one Arduino broadcasting and one Arduino listening, they both needed to broadcast and listen. In order to ensure this I simply added a transmit command on the listening Arduino, one which broadcast an '!' when it was ready to receive data. The other Arduino does nothing until it receives '!', at which point it runs through the

broadcast of one index and one sensor reading. The first Arduino listens and logs the incoming data to a string, and then broadcasts another '!' signaling it is again ready to receive data. This simple handshake took the time to complete a full 9 index and 9 value string down from seconds to about 30 milliseconds.

There were a couple other seemingly small but quite significant data formatting issues to deal with in order to ensure the recorded data matched the data sent where the specific transmitted format, be it char or byte, proved to be the difference. After some trial and error, I settled on formatting the handshake with a char ('!') because I knew the transmitted data was numerical, thus best suited for transmission as bytes, and wanted to avoid any potential confusion. The second crucial formatting issue had to do with accurately transmitting a 16-bit integer reading across a communication channel that only communicated in 8-bit bytes. I found a solution in the *Arduino Cookbook*, and simply broke the 16-bit integer into two 8-bit bytes, a highByte and a lowByte, which were transmitted and subsequently reassembled on the receiver end using the word() function. To further reinforce the distinction between the handshake and the communicated data, I transmitted the '!' character using the print() function, which allows for the transmission of a variety of data types, and sent the sensor values using the write() function, which only transmits bytes. While not necessary, I found it helped distinguish commands from data, reducing potential communication errors.

After establishing reliable communication, I turned my attention to improving the efficiency. To do this properly I needed to establish a way to monitor the serial communication between the motion tracker (Arduino, XBee and MPU9150) and the data logger (Seeeduino Stalker) in real time. To accomplish this I added a third XBee to the network, one which listened exclusively to the Stalker, relaying that data to my Processing visualization via USB. I found the documentation for multi-point Series 1 XBee networks to be severely lacking, and struggled to establish this network. I first explored adding a 3rd Arduino, one which was engaged in a handshake with the Stalker using a different character ('*'), however this severely reduced the efficiency of the entire network, and regularly threw the Stalker out of sync with the motion tracker. The other issue with this setup was that the XBee on the third Arduino, the one interfacing with the computer, had to speak to the computer using SoftwareSerial, a library that creates a serial port on any two digital pins.

I struggled to get SoftwareSerial working with an XBee, where the incoming data from the XBee gets routed to the SoftwareSerial port, which then gets directed to the hardware serial USB connection. As frustration mounted, I remembered that the 3rd XBee needed only a direct connection to my computer, rendering the 3rd Arduino inessential. Once I configured the 3rd XBee to listen exclusively to the Stalker by assigning it the same PAN ID and setting the DLID to the Stalker address I began to be able to monitor live serial communication and more importantly the efficiency of the data logging and transmission.

Inside my code is a timer function responsible for recording how long each cycle takes. I used this function to monitor the performance of the whole system. Focusing exclusively on speed, I was able to get full strings of 27 data points written in about 50 milliseconds. As soon as the microSD writing was added to the cycle, the duration more than doubled to somewhere between 120 and 150 milliseconds. While likely within an acceptable range for acoustic triggering applications, I was determined to have the system cycling every 50 milliseconds, including writing to the microSD card.

While speed was my focus, I also knew I had to ensure I was writing complete strings, with as few dropped bytes as possible. Striving for this level of efficiency proved to be a challenge, as adding more verification code inevitably slowed the system down. Yet, I needed some verification to ensure reliable data. This pursuit hit a significant wall when I noticed that every fourth string recording from a program that performed a cycle every 60 to 70 milliseconds (which was one of the best intervals I managed to achieve in this particular setup) dropped sixth index and its associated sensor reading; I consistently had three strings of perfect data followed by a fourth string with a missing sixth entry, then 3 more perfect strings and again a fourth with missing data at index six. As a consolation, at least the error was stable and repeatable, meaning if I could find the cause, the rest of the program would run perfectly.

I began to monitor the handshake, and saw a pattern emerge: several '!' characters were being transmitted, more than necessary for the transmission of the unique readings needed for one full string, meaning '!'s were accumulating the motion tracker's serial buffer, gradually throwing the two Arduinos out of sync. I

added a serial buffer purge to the motion tracker's program, where after the transmission of all 10 sensor readings, the buffer would empty itself through a function containing no commands. While this solved the issue for the most part (every so often an index would go missing) it unfortunately also slowed the whole system down to around 120 milliseconds when writing to the microSD card. I was about to resign myself to the fact I would not likely be able to improve the efficiency and thus the resolution of the system with this current setup, until I decided to try for a wired solution one last time.

Overall, I am pleased with the progress I made with wireless serial communication in such a short amount of time, and satisfied with the results, however, after returning to a wired setup I was able to reduce the interval to the desired 50 milliseconds. At first, I was recording average cycles of a disappointing 90 milliseconds, in addition to increased microSD card write errors. I knew writing to the microSD card took a significant amount of time thanks to all my previous testing, and without any wireless issues to address, also knew that if I was going to make this setup more efficient I would have to focus my attention there. What I discovered was that the process of opening and closing the file within each cycle dramatically increased the duration of the recorded interval. I changed the code so that the file opened when the record function was initialized and closed when the function was no longer in use, achieved through a simple button switch. The wind chime now wrote to microSD at the frequency I desired from the outset, though I am hesitant to attribute any increased efficiency to the direct wiring of the sensor since improving write time through a reduction in the number of open and close commands could just as easily improve the efficiency of the wireless setup. In the end, I stuck with the wired motion sensor because I was ensured perfect strings of data without any missing sixth indices.

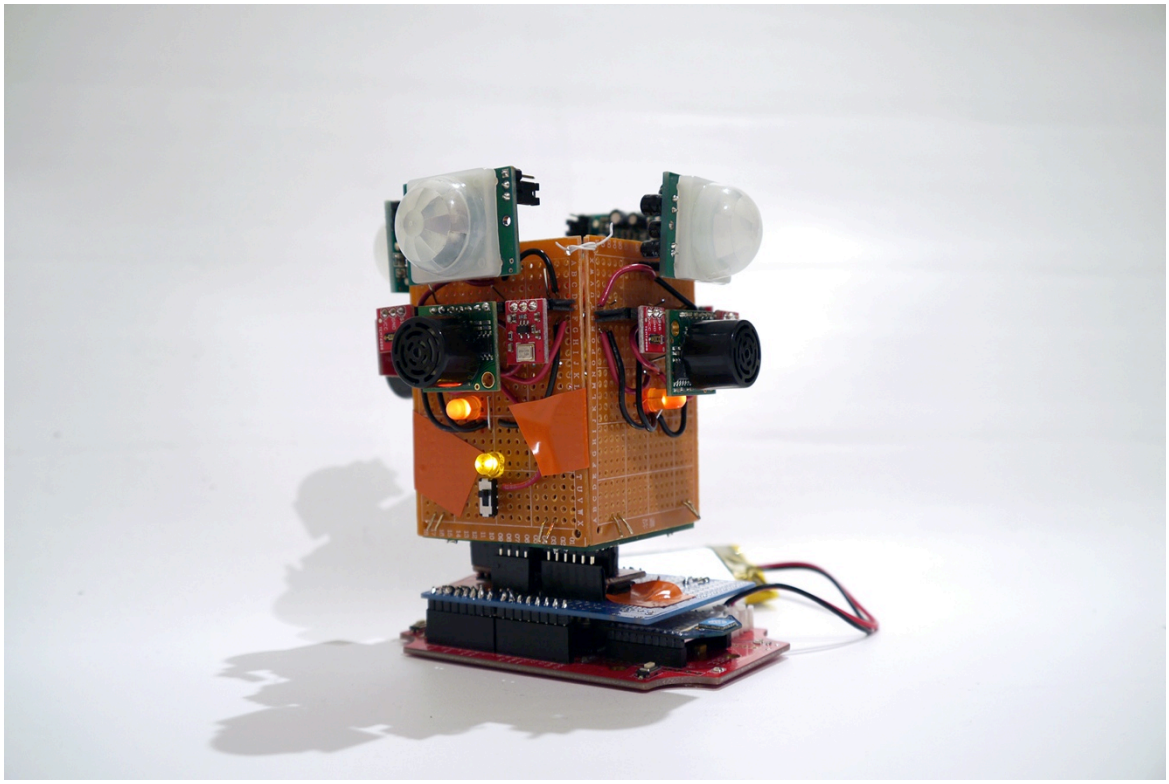

Figure 17: Initial prototype

Phase 4: Development of First Prototype

After selecting the most appropriate sensors, building a simple visualization in order to understand how they behave, and establishing reliable wireless serial communication between the data logging Arduino and the motion tracking Arduino, it was time to combine all three for the first prototype. The purpose of this prototype was to spatialize the sensing in 360 degrees and work out the functionality of the device. The final prototype features the Seeeduino Stalker as a base, a shield featuring the multiplexer and all necessary hard wired Arduino connections, with the sensor connection wired into a second shield designed to slot into the multiplexer shield. Though the majority is hard wired for stability, the shields, with their modular design and removable sensors, facilitate debugging the overall circuit.

I must admit, thinking through the best way to layout a circuit when space is at a premium is difficult; I made numerous false starts and was forced to remove or alter several soldered connections. This went beyond transferring a breadboard setup to a protoboard as the final assembled shell distributed the wiring in three dimensions and across multiple shields. Part of the complexity is self-inflicted as I chose to work with materials at my disposal, a constraint that dictated the amount of space I had to work with.

I began constructing the sensor shell by creating four identical protoboard panels, each with slots for the set of four sensors to be featured on each of side of the prototype. All the necessary connections were soldered on the backside of each panel with wire running to pins at the base, which plugged into slots on the multiplexer shield. In addition, I wired a switch that controlled whether or not the prototype transmitted wireless data to my computer, or wrote data to the Stalker's microSD slot. To ensure I had some feedback from which to evaluate the performance of the prototype, I also wired a series of LEDs that blinked as data was either recorded or transmitted. The LEDs also gave notification of successful booting and whether an error condition had been reached. While the underlying circuit proved to be quite simple (the sensors only required a power, ground, and signal wire), compressing all the wires into a tight package without inducing a short proved to be a sensitive and delicate endeavor. Wires were folded against their respective panels whenever possible, however the multiplexer connections were loosely springing from the center of the base. After assembling the panels multiple times only to get flashing error LEDs upon booting, I tore the assembly apart and slowly pushed each panel in place, this time with the Arduino IDE’s serial monitor giving me live sensor data. If a sensor read 1023, there was short. After delicately and patiently moving each panel in place, I had a shell giving me stable readings from 360 degrees.

This prototype represents the first time all 16 sensors, in addition to the wireless motion data, would be collected together on the same microcontroller. At this point, I began modifying my initial sensor visualization to reflect the spatialization of all the incoming data. The resulting Processing visualization presented the first opportunity to begin to get a sense of how the incoming data corresponds to the environment the prototype was monitoring. This was more than the behaviour of specific sensors; this was

the activity of the space as a whole. I hesitate to call it a visualization of a system because the sensors, and consequently their data, are independent. If in the composition phase I decide to tie two unique sensor behaviours together, then the data begins to behave more like a system, or is orchestrated to behave like a system if you will. But at this point, I simply watched as the space, my bedroom in this instance, influenced my prototype and began to imagine how it might execute my forthcoming composition.

Phase 5: Shell Design and Construction

With a first prototype providing access to spatialized environmental sensing in place, the pressing concern became how to take it outside. The current make-up would not have withstood the elements thanks to a fully exposed inner core. I thus began the process of designing a suitable shell for outdoor use. It should be noted I am by no means an industrial designer, nor do I aspire to add such a skill to my repertoire, however, I was raised on Lego and as a result can think in block-like three dimensions. In addition, thanks to my time attending the Copenhagen Institute of Interaction Design's summer school, I was familiar with rapid-prototyping with a laser cutter. So I stuck with what I knew and began sketching a shell.

After testing the first prototype, I felt that lining up a set of each sensors on panels positioned at right angles from each other would give me an overly simplified representation of the sensed space, one which would be difficult to dynamically spatialize across a quadraphonic sound installation. In essence, I was creating a one to one relationship between a speaker and a side, leaving me with little information as to what might be happening in between. As a result, the shape of the shell went from square to octagon, where I offset the two motion detecting sensors by 45 degrees, creating an alternating pattern of motion detection. This distribution also helps in the interpretation of the trajectory of the impulse by allowing for the evaluation of the sequence of triggering, something that would be impossible if the proximity and IR motion sensors were arranged on top of each other.

With the new shape decided upon, I began to design the sheet for laser cutting. Because I was not very experienced in designing physical enclosures, I made sure that I designed different sizes and configurations

of parts, a strategy that provided me with a set of pieces that I could mix and match as needed. For instance, I was not sure if four 3/8" acrylic rods would be sturdy enough, so I designed two versions of the base that the rods could be fastened to, one with 3/8" holes and another with 1/4" cutouts. The one feature I knew the shell had to have was a way to lock it to a tripod. Thankfully those screws are standardized.

I carried this strategy throughout the design, ultimately paying particular dividends in the pendulum casing. Again, I was not sure how the final version would work. Was it going to be wireless? Wired? If it was wireless, the housing would have to be large enough to envelop the motion tracking setup consisting of an Arduino, XBee, and MPU9150. Though quite small, it was much larger than the wired MPU9150 on its own. If I decided to go wired, I could have a smaller, and more importantly lighter, enclosure where less inertia means more a more dynamic response to wind. Since I was not yet sure I cut multiple sizes of tube, in addition to multiple versions of the enclosing lids. To ensure I could accommodate both wired and wireless options I put five cutouts in each lid (1 hole for the suspension thread in the wireless solution, and 4 holes for the connections in the wired version). In the end, this flexibility proved essential as I decided to go wired, and use a central suspension thread (a shoelace). This permitted me to loosen the electronic connection wires to permit maximum dexterity with minimum resistance in a manner similar to the arms of a robot, where the control cables are loose while the mechanical actuators are unobstructed.

I knew I wanted to use clear acrylic from the start because I felt it was important to make the final product as transparent as possible, both literally and metaphorically. What I mean by this is that it is important on a conceptual level for every step of the translation process to be accessible. I am not creating a platform with the intent of proscribing how a city should sound, quite the opposite. So much of our technology is closed and inaccessible, a design characteristic that produces numerous assumptions about how best to use a device, regardless of intentions. I want to make my intentions clear. I want The Chime to draw attention to itself. I want passersby to wonder what it is and what it is doing. If it were made of black acrylic it would inspire much less questioning about how it relates to the shared public place it occupies. I want there to be a

chance, no matter how faint, that someone might ask themselves what is so special about this place. I am positive this helps.

Having never worked with acrylic before I was completely unsure of how I would assemble the parts. Thought they fit together with laser precision, they still needed to held together either through mechanical fasteners or some kind of plastic adhesive. Thankfully I had a good friend, Adam David Brown, help me put it all together. Using a combination of both mechanical and adhesive assembly, the shell proved to be relatively simple to assemble. However, should I make a second version I will make an effort to design for as many mechanical fastening opportunities as possible. Not only were the bolts and screws cleaner than the silicon we used (we chose silicon because I wanted to be able to remove the sensors and undo the assembly should a future iteration require a part replacement), but they also allowed for disassembly (in this version only the legs supporting the main enclosure can be removed). Regardless of how it came together, I was pleased with both the aesthetics and build quality of the design, not to mention its functionality. All done with a single pass of the laser cutter thanks to my mix and match part design approach.

Phase 6: Electronic Assembly

With the shell constructed, all that needed to be done was to install the electronics. I first glued each of the sensors in place to reduce the number of moving parts. I then made some star shaped plugs, where one wire carried power or ground to multiple branches. I then made connected each of the sensors to the multiplexer with 16 female-to-female cables. This version of the circuit design also featured functional buttons for power (on/off), record (to microSD), and radio (transmit via XBee) providing valuable feedback through their embedded LEDs. Another important addition was the buzzer. For the final versions of the composition, I wanted to include the recorded sound of the environment that generated the sensor data. In order to accomplish this I cut out a hole on the lid where I can fasten a recorder using a standard sized tripod screw, and programmed the buzzer to buzz 5 times just before the microcontroller begins recording data to the microSD card. This allowed me to sync the data playback with the recorded audio after the fact.

While the finished product looks like a tangled mess, I have added mechanical fasteners to the lid that allow me to firmly attach the microcontroller and battery, as well as plugs for all the connecting wires, permitting easy access to the essential functional components inside, while being able to trouble shoot the microcontroller separately.

Phase 7: Data Playback

After all the bedroom testing, the wind chime was finally ready for its first outdoor test. I turned it on. Hit record. And watched as the pendulum swung gently in the breeze as an unusually large and steady flow of people walked by thanks to a stranded street just up the street. I took the recorded data and played it back in my revised octagonal Processing visualization. Adapting my live Processing visualization for playback required simply using the logged interval as a delay and parsing a comma separated TXT file as opposed to a comma separated serial stream. I watched as both subtle and dramatic environmental flows danced before my eyes. The question became: how should they sound?