HYBRID SPACE:
DESIGNING THE INTERFACE OF PHYSICAL AND DIGITAL PUBLICS

by

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CONTENTS

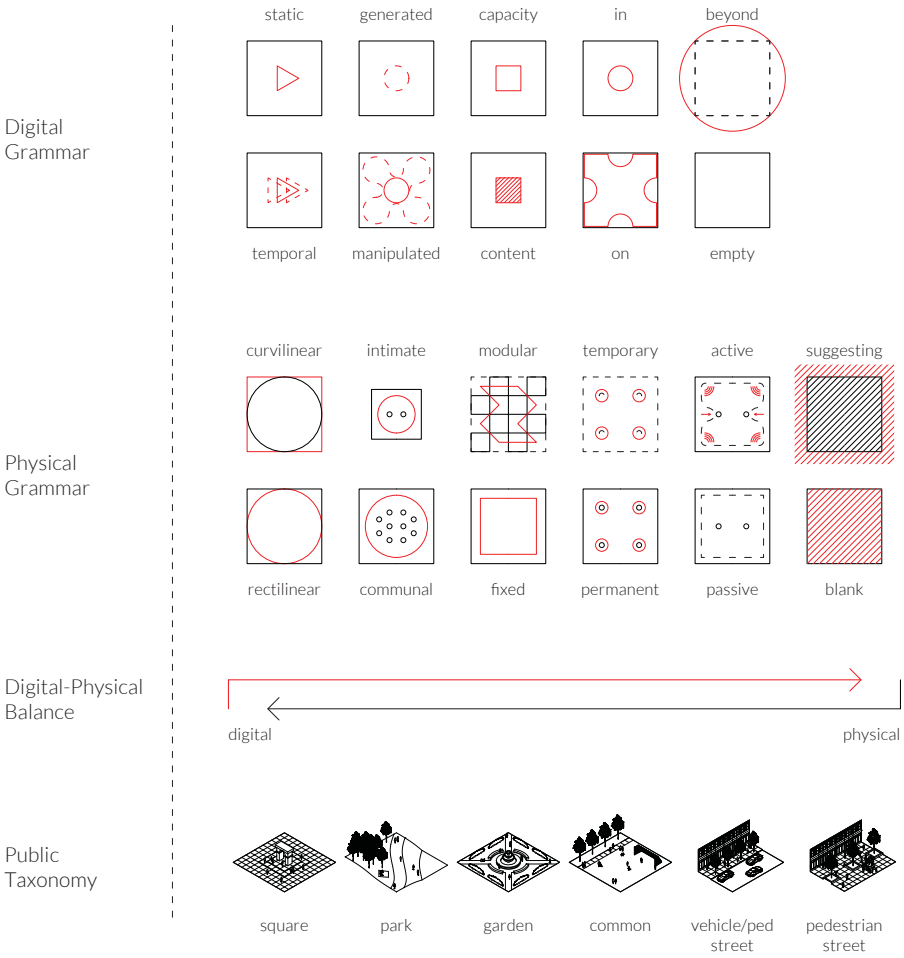
ABSTRACT

The term “mixed reality” (MR) describes an environment comprised of real-time, spatially-linked physical and digital content connected through the interface of digital technologies. While social and technological trends indicate a shift toward MR-enabled environments as our primary means of engaging with networked resources, there has been little attention paid to the holistic design of this nascent hybrid space.

This thesis attempts to develop a grammar for the design of both the physical and the digital halves of hybrid space. The grammar will then be tested against a series of design interventions proposed for the Halifax Commons. Each of these interventions will be driven by program centred around public interaction and sociability. The task of the architect is to ensure that the evolution of spatial typologies in this new space reflects our societal values and enhance our communal quality of life.

LIST OF ABBREVIATIONS AND SYMBOLS USED

AR	Augmented Reality
DoF	Degrees of Freedom
HCI	Human-Computer Interaction
HMD	Head-Mounted Display
HRTF	Head-Related Transfer Function
MR	Mixed Reality
VR	Virtual Reality



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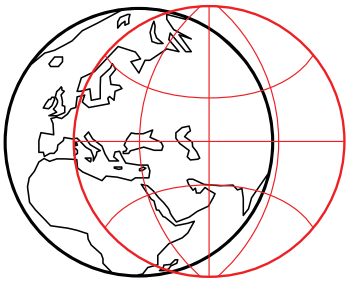
CHAPTER 1: INTRODUCTION



Concept diagram of hybrid space.

> We are in a unique position, I think, to synthesize different factors - social, technical, cultural, political, environmental - and to pose alternative scenarios based on them. The point of borrowing from the languages of futurology and speculative fiction is also to explore the role of architect itself - to reposition the architect as a cultural agitator, one who designs and imagines entire future scenarios, not just discrete buildings. Architects can then start to imagine the implications and the consequences of today's trends, emerging technologies, and emerging ecological conditions. That's the mandate. (Manaugh 2013, 108)

Technology is developing at a faster pace than ever before, and with it our societal norms. Projecting beyond the socio-technical makeup of today, this thesis predicts a new shift in the way that we interface with the digital world: mixed reality. Describing technologies that allow people to engage with digital content overlaid on the physical environment, mixed reality will change the way that we engage with and inhabit space. The consequence of this change will be a new spatial typology: hybrid space. However, while the technology behind this paradigm shift develops, little attention is being afforded to the design of this nascent hybrid space.

Though the emergence of these technologies will affect everything from homes to workplaces, cultural institutions, and more, the most compelling segment of the built environment will be the public realm. In public spaces, not only will mixed reality provide new connective experiences between participants, it will challenge established constructs of publicness. This thesis will explore the potentials of mixed reality, hybrid space, and the evolution of the public realm.

Chapter 2 defines mixed reality and the associated technologies, explores historical trends of technological innovation and adoption, and speculates on the system of infrastructure that would support a mixed reality-based hybrid space.

Chapter 3 explores the architectural significance of this nascent technology and of hybrid space. As a

means of promoting the thoughtful design of hybrid space, digital and a physical grammar are developed to help define key attributes of each. The grammar is then tested through a series of pavilions and abstracted hybrid space.

Chapter 4 establishes the public realm as the area of focus for the exploration of hybrid space and grammar. The history of public space is examined leading up to today's split between physical and digital publics, a split that may be remedied through the use of mixed reality technology.

Chapter 5 outlines an intervention strategy that will guide the design of a series of hybrid interventions throughout the public realm, with a focus on improving the quality of public life. A series of case studies with a similar structure to the intervention strategy are presented, concluding with a design/build completed in the program with a team of students for Nocturne 2018.

Chapter 6 establishes the Halifax Peninsula as the site for the hybrid interventions. A public taxonomy classifies the types of public spaces and their associated attributes. Within the city's public realm, the Halifax Commons is identified as the most promising space for intervention, both for its specific qualities and for the unique opportunities presented by the concept of a commons.

Chapter 7 situates six specific interventions across the commons, corresponding to the public taxonomy. Each intervention is used to explore the physical and digital grammars in use, as well as broader speculations surrounding the design of hybrid space.

CHAPTER 2: MIXED REALITY

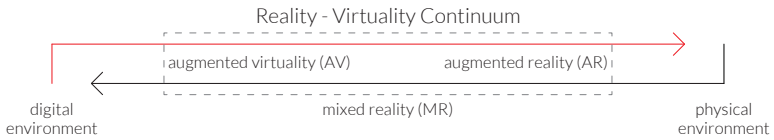
Mixed Reality (MR) is an umbrella term for a variety of technologies that allow users to spatially engage with digital content. In 1995, Paul Milgram coined the “Reality-Virtuality Continuum”: a spectrum used for classifying mixed reality technologies spanning between the real environment and the virtual environment (Milgram 1995, 283). While this spectrum was used specifically to classify display technologies, it can be adapted more broadly to cover the interface of any sense with digital content.

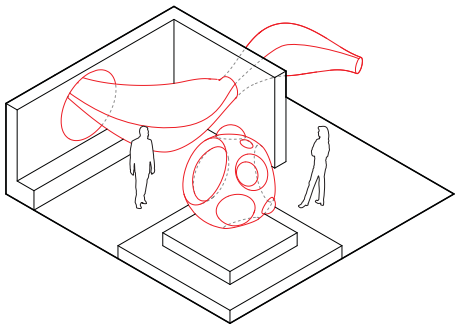
For the purposes of this thesis, the reality-virtuality continuum will be amended for a key distinction. Instead of a spectrum between reality and virtuality, mixed reality will be discussed on a spectrum between the physical and the digital. The difference is that the digital no longer exists as a virtual simulation of the ‘real’ world, but instead as an environment with its own validity, distinct from the physical.

To better explain the continuum, we will explore the two dominant categories of MR technology: virtual reality (VR), and augmented reality (AR).

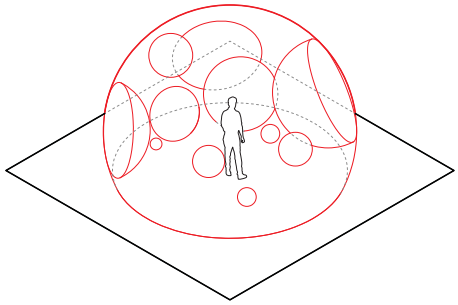
VR typically refers to an immersive digital experience produced by a Head-Mounted Display (HMD)(Ryan 2014, 511). The headset tracks a user’s head motion and replicates this motion in the digital environment. Depending on the sensors in the headset, this tracking may produce 3 or 6 degrees of freedom (DOF). 3DOF only tracks rotational tracking (roll, pitch, and yaw), while 6DOF also tracks translation (elevating, strafing, surging) (Studios 2018). This motion tracking is the only aspect of the user’s physical environment that integrates into the VR experience. The digital experience is isolated - transporting the user away from their physical environs. This technology can be classified near the virtual end of the spectrum.

Conversely, AR technology can be classified near the physical end of the spectrum. Using an HMD with a clear visor, or a screen and a camera, AR enables users to display and interact with digital information integrated into their immediate physical environment





Augmented Reality



Virtual Reality

Diagram of the reality-virtuality continuum, illustrations of AR and VR (Milgram 1995, 283).

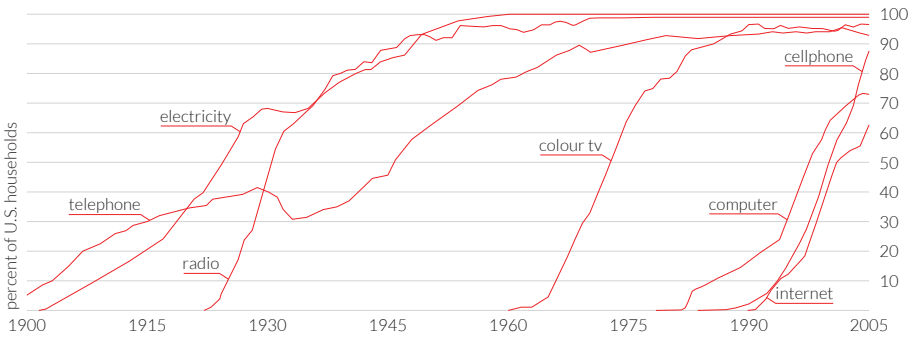
(Ryan 2014, 30). The fidelity between the two is achieved in both cases via cameras that detect and track the surrounding environment; making a 3D map of physical space to be populated by digital content. The benefits of this technology are its responsiveness to the physical realm and the user's ability to share the experience of both the physical and digital with other users in the same space.

While the kind of immersion provided by VR technology has a wealth of applications, its inherent separation from the physical environment does not lend itself to the reciprocal relationship of hybrid space. As such, this thesis will focus on the range of spectrum surrounding AR technologies for the exploration of hybrid space.

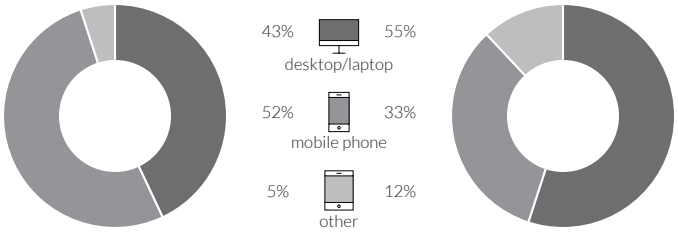
TECHNOLOGY TRENDS

The rate of adoption for new technologies over the last century is increasing. The cellphone reached 90% household adoption in the U.S. in approximately a quarter of the time that it took the telephone (Thompson 2012). As technology continues to adapt to societal changes, it is entirely likely that MR instruments will replace our current screen-based devices. Global trends of digital usage in recent years point to a transition away from desktop-style computing and toward mobile technologies. In Canada, from 2017 to 2018, there was a 7% decrease in the use of desktop/laptop devices and a 16% increase in the use of mobile devices to access the internet (Kemp 2018, 43). Since 2012, the global consumption of mobile data has increased nearly tenfold (Kemp 2018, 115).

These findings underline a growing desire to access the internet anywhere, anytime, and on to go. Extrapolated, this trajectory points to a concept called ubiquitous computing, describing the ability for computing to occur everywhere and at all times through a constellation of devices that are all linked together, sharing real-time data (Poslad 2009). Within this constellation, MR technology could facilitate the human-computer interaction (HCI) that interfaces users with their digital content.

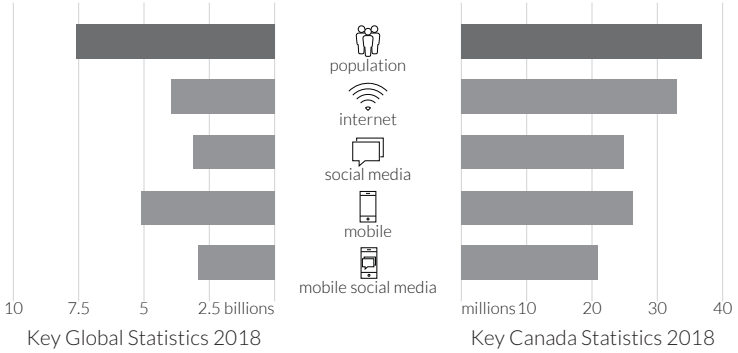


Technology Adoption Rate



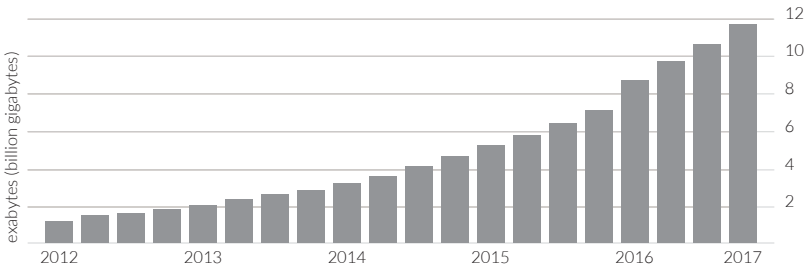
Global Share of Web Traffic

Canada Share of Web Traffic



Key Global Statistics 2018

Key Canada Statistics 2018



Global Mobile Data Growth

Global and Canadian statistics on the use of internet and internet capable devices (Kemp 2018).

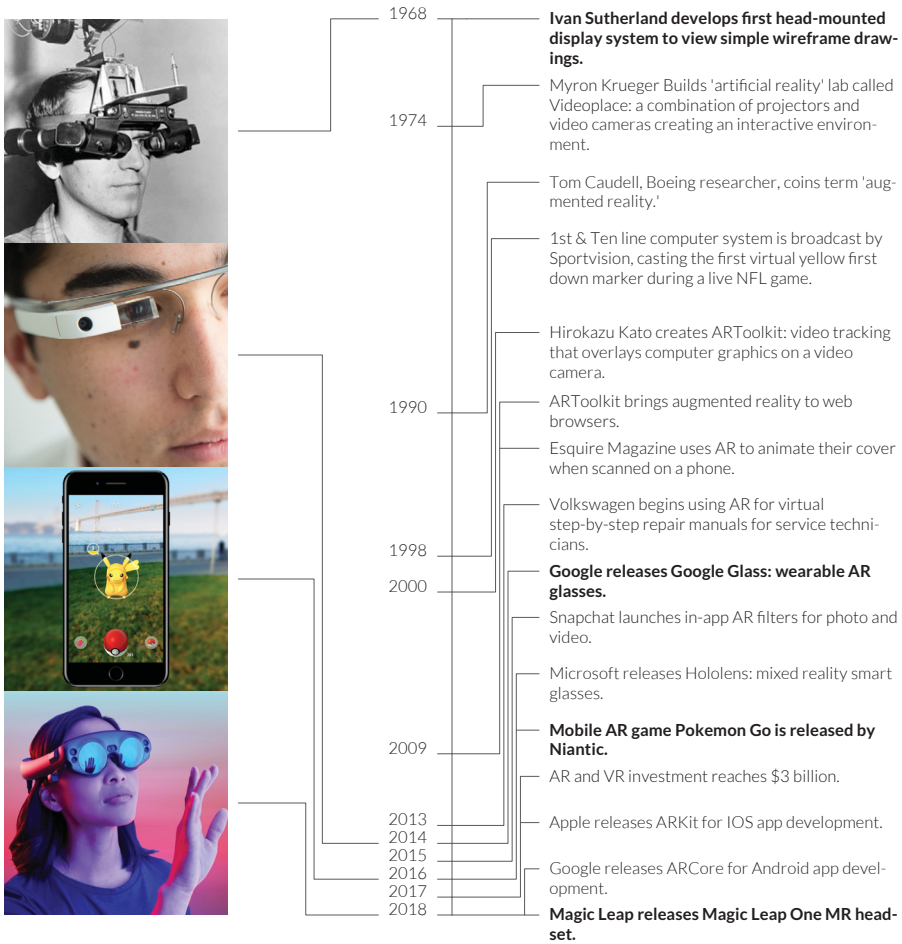
Canada's internet saturation makes the country a favourable candidate for the implementation of MR technology, with Vancouver quickly becoming a global hub for AR and VR (Deschamps 2018). Canada has a 90% penetration of internet usage, compared to a global penetration of 53% (Kemp 2018, 39). Building off of existing infrastructure, the country could make a fluid transition from the devices of today to an MR ecosystem.

SYSTEM INFRASTRUCTURE

> Augmented space is the physical space which is "data dense," as every point now potentially contains various information which is being delivered to it from elsewhere. At the same time, video surveillance, monitoring, and various sensors can also extract information from any point in space, recording the facial movements, gestures and other human activity, temperature, light levels, and so on. Thus we can say that various augmentation and monitoring technologies add new dimensions to a 3D physical space, making it multi-dimensional. As a result, the physical space now contains many more dimensions than before, and while from the phenomenological perspective of the human subject, the "old" geometric dimensions may still have the priority, from the perspective of technology and its social, political, and economic uses, they are no longer more important than any other dimension. (Manovich 2006, 8)

The infrastructure needed to support a shared MR environment consists of three elements: technologies that interface between the physical and digital; ubiquitous network coverage for consistent connection between devices; and robust data centres to run and store the digital half of hybrid space ("Preparing for a Cloud" 2017, 02).

The first element is that of the interface: a constellation of technologies that both track users and their physical environment and allow users to sense and interact with the digital content mapped to surrounding space. These technologies divide into two categories: outside-in tracking and inside-out tracking (wearables). Outside-in tracking consists of various types of sensors embedded into the environment to



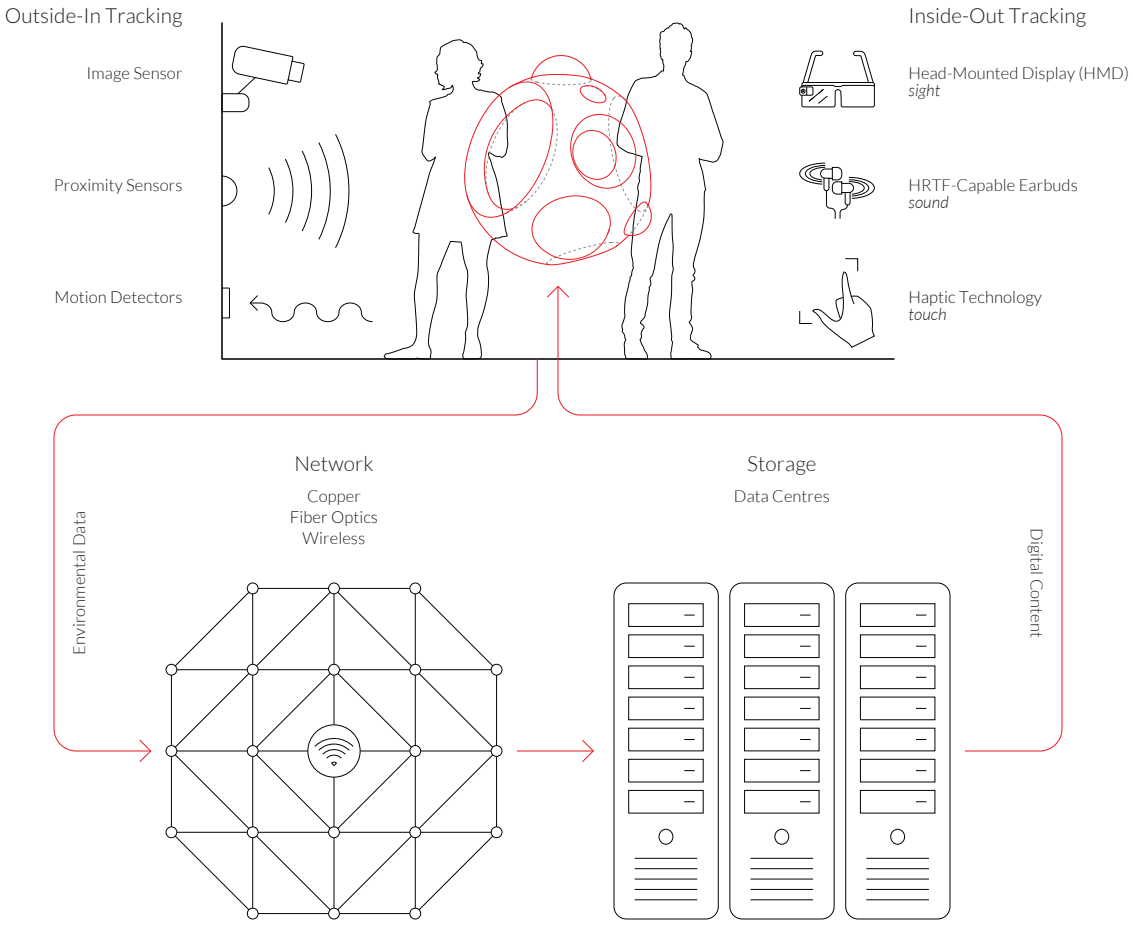
Timeline of the development of AR technology (Augment 2016). Images (Augment 2016).

collect information that will inform the digital content, like the movement of an individual in a room ("Types of sensors" 2013). Inside-out tracking encompasses a variety of wearable technologies that can both track the user's position in space and/or map digital content into their surrounding environment. This front-end loop of input and output will run in a cycle through the greater system to provide seamless continuity for digital experiences.

The second element is the network that supports the internet. Having established the exponential growth curve of increasing data volumes, today's networks will require development to maintain ultra-reliable connectivity. While fibre optic-based networks will continue to provide the backbone of the internet, increasingly sophisticated wireless technology can be used for the connectivity between devices and network nodes (Ekudden 2018). Devices themselves may be used in cooperation as part of the network, establishing a more diffuse borderline between devices and nodes (Ekudden 2018).

The third element, physically containing the relay of digital content and information, is the data centres. In response to wearable MR tech becoming less obtrusive and tethered, more reliance will be placed on data centres to not only store content but also take on the processing that wearables will be ill-equipped to handle (ABIresearch 2017, 8). Also known as cloud computing, this kind of relationship between device and server makes computing a shared resource into which users tap through their wearables (ABIresearch 2017, 9). The processing demands of both tracking the environment and real-time rendering would benefit greatly from such a system.

Just as computers were once prohibitively expensive outside of industrial or institutional work, the early devices and infrastructure surrounding MR today are too costly for mass-adoption. However, if the history of technological innovation and proliferation is indicative of what is to come, MR is no longer a question of if, but when. To this end, it is imperative that we begin to understand and prepare for the ramifications that this technology will bring.



Systems diagram of the infrastructure that would support an MR ecosystem.

CHAPTER 3: GRAMMAR

The reason that MR will become an architectural issue is that it is inherently spatial. Unlike the TVs, desktop computers, laptops, tablets, and smartphones of today, MR takes the leap from confined, two-dimensional screens to a three-dimensional user interface woven into the physical environment. Suddenly the way that we engage with digital content will affect our quality of space just as much as the walls of a room. Without deliberate design intent, this emerging hybrid space is prone to become cluttered, distracting, even hindering.

The short film “Hyper Reality”, by Keiichi Matsuda, provides a cautionary tale of a future where physical and virtual realities have merged, and the city is saturated in media (Matsuda 2016). The film is an example of what hybrid space might become without carefully considered design intent - mixed reality as pop-up ads. In this speculative future, there is no consideration for the built environment or basic qualities of space for that matter. Everything is blanketed arbitrarily. In Adaptive Sensory Environments, Lehman states:

> Architectural environments are technologically messy with overflowing information that competes with pre-existing sensorial congestion. In fact, as various distractions surface, frustration often follows. Thus, as architecture evolves, it will need to collect and filter information for relevant intervention for its occupant. (Lehman 2016, 12)

To regulate this possibility, we will propose a language for the thoughtful design of hybrid space. This language will be broken down into two grammars defining hybrid space: the digital and the physical, each with regard for the other. Not only will digital content become more attuned to its role in shaping the spatial experiences of the user, but architecture will begin to adapt to the needs of that digital content. Rather than an inadequate veneer of digital applied to the existing physical environment, the proposed tabula rasa of this thesis enables an exploration of the full potential of hybrid space.

Video stills from the short film “Hyper-Reality” (Keiichi 2016).

GRAMMAR: DIGITAL

The first of the two grammars distills digital content down to its primary elements, based on Janet Murray's four affordances: procedural, participatory, encyclopedic, and spatial (Murray 2012, 51). Murray posits these affordances as foundational to the designer's palette for representation in any digital format or genre.

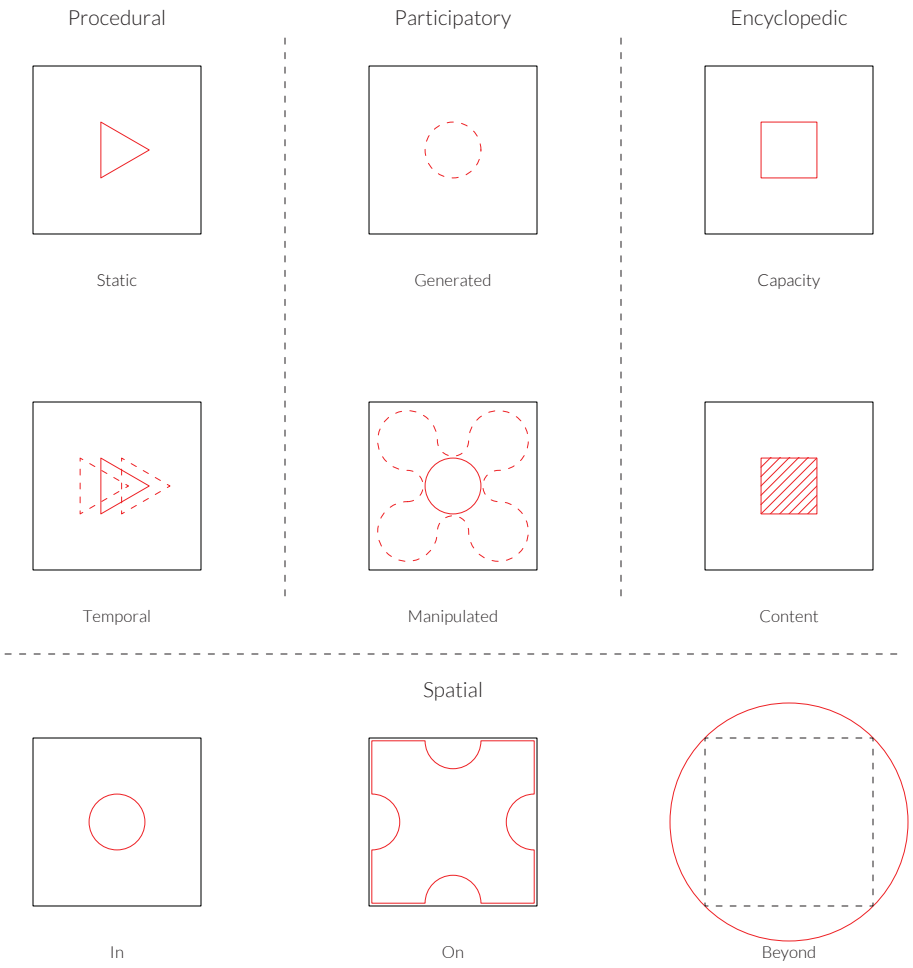
Procedural: composed of executable rules. This affordance can be described in a binary of static and temporal. Static digital content exists as an unchanging entity, while temporal content may continue to evolve based on established executable rules.

Participatory: inviting human action and manipulation. Generated digital content is produced entirely by the user. Manipulated content has a predetermined state, with the further ability to be transformed by the user.

Encyclopedic: containing a high capacity of information. In one instance, a digital system may have a capacity for information, like a sketchbook. In another instance, a system may be filled with content, like a textbook.

Spatial: navigable as an information repository and/or virtual space. In relation to physical space, this affordance may be subdivided into in, on, and beyond. For 'in', digital content occupies empty space within the confines of the physical. For 'on', digital content is mapped directly onto the physical surfaces of a space. For 'beyond', digital content can produce the illusion of fabricated space beyond physical surfaces.

When describing the digital grammar alone, as we have now done, the role of the physical appears diminished. However, in the following description of physical grammar and the consequent combination of both to define new spaces, the digital will be responded to in kind, providing a deeper understanding of how the two work together.



Diagrams of grammar for the design of digital space.

GRAMMAR: PHYSICAL

The physical diagrams offer up a series of binary design directions in relation to digital content or program. Notably, they assert that the design of physical space can and should aspire to be more than simply a blank canvas for the digital. Below, the physical grammar is explored as a series of questions that a designer might engage with through the process of design development for a particular program:

Geometry: what are the implications of a rectilinear space vs a curvilinear space in regards to the digital? How are different surfaces mapped, how do they frame experiences, and what are the opportunities of a fold?

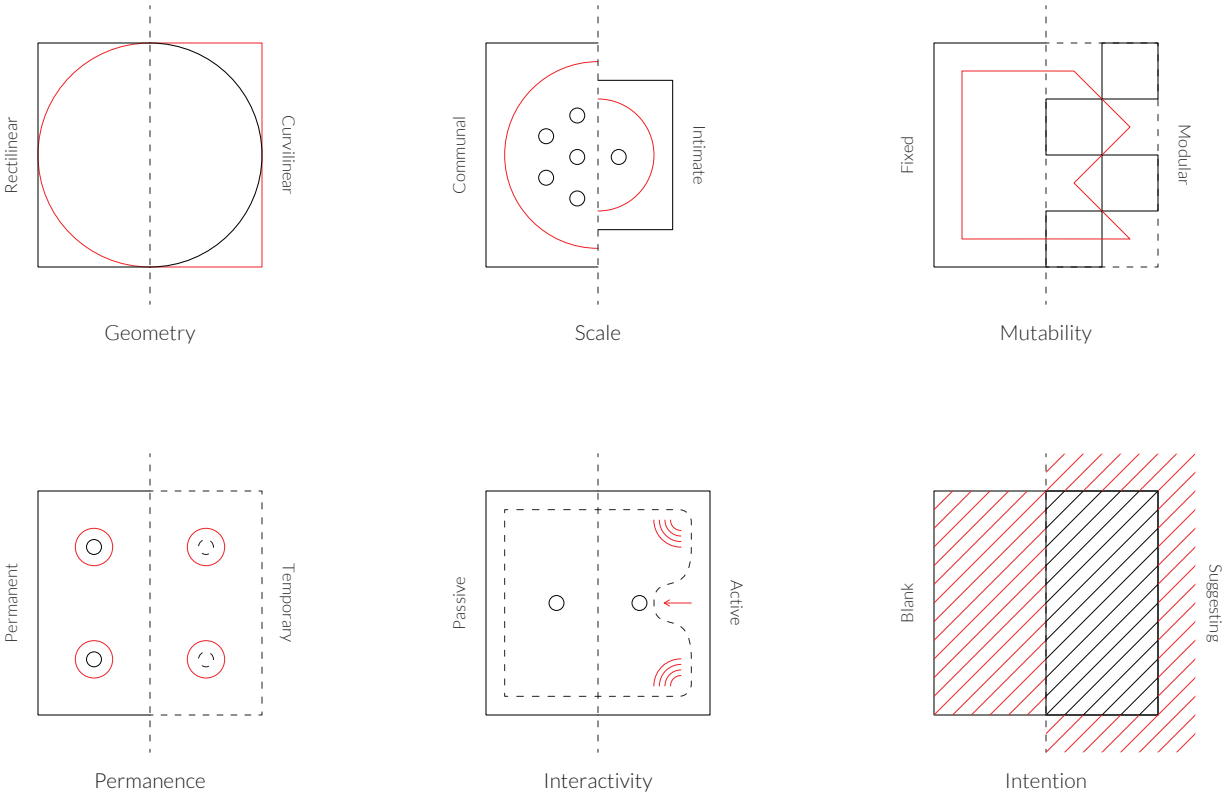
Scale: will the digital be experienced communally or intimately? Might a large space be made smaller with digital content, or a small space be given the illusion of expanse?

Mutability: are the qualities of a given space fixed, allowing the digital to evolve and iterate against its static nature, or does the space consist of mutable and modular elements that change alongside the digital.

Permanence: is the structure permanent or temporary? Does it exist only for an event or a season, tied to a specific program?

Interactivity: is there an active relationship between the space and the digital, the user, or the environment? Does the space behave passively in relation to these variables?

Intention: does the architecture behave as a neutral backdrop to be adorned by the digital? Do the physical form and materiality guide the digital toward a specific kind of augmentation or embellishment?



Diagrams of grammar for the design of physical space.

HYBRID SPACE: ABSTRACTED

As an abstraction, the grammar sets allow for an infinite array of pure, spatial experiences. Without the parameters of site or program, the design is unbounded and expansive. However, certain qualities can still be explored in this space.

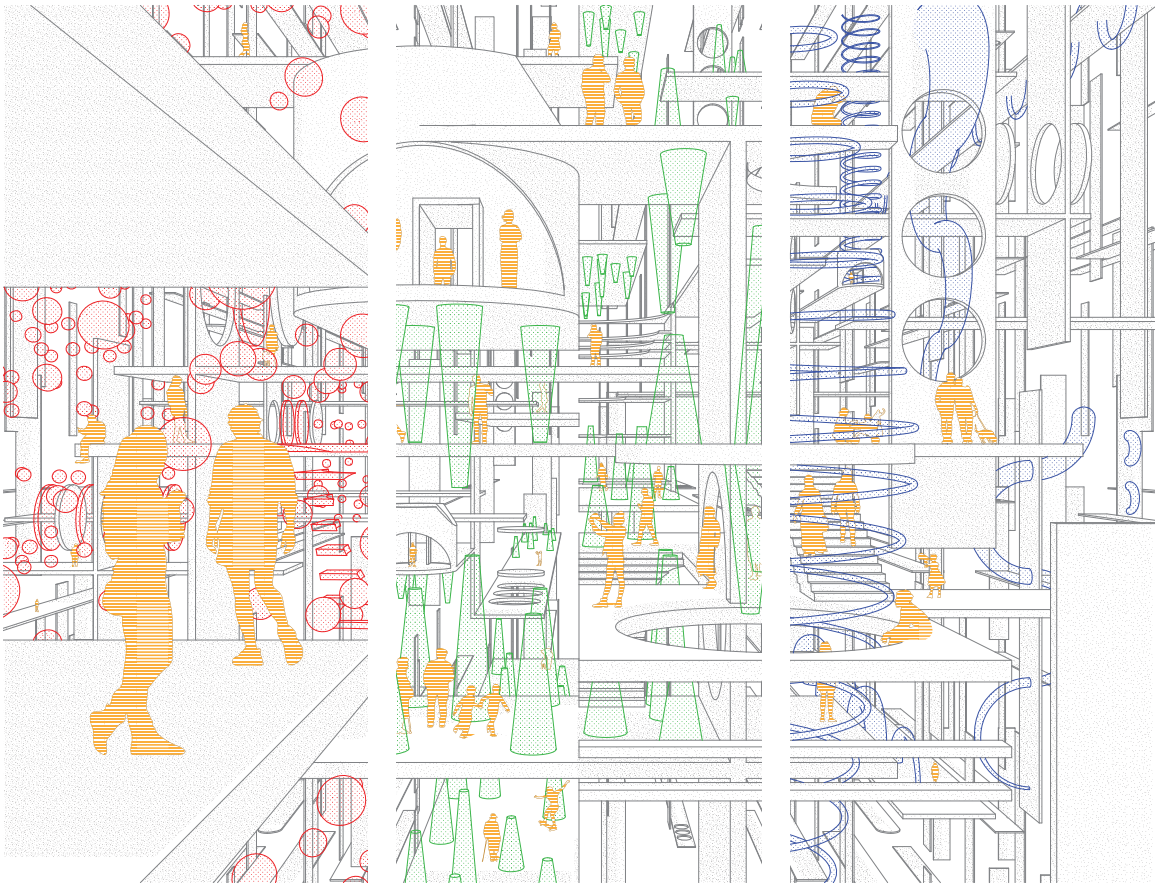
In the following illustration, we see one such abstracted representation of hybrid space, using principles established by the two grammars. The triptych highlights the way that the digital, in particular, can exist concurrently on multiple planes, adding a dynamic and malleable dimension to our understanding of space. In The Poetics of Augmented Space, Manovich states:

> The space that symbolizes the Information Age is not the symmetrical and ornamental space of traditional architecture, the rectangular volumes of modernism, nor the broken and blown up volumes of deconstruction. Rather, it is space whose shapes are inherently mutable and whose soft contours act as a metaphor for the key quality of computer-driven representations and systems: variability. (Manovich 2006, 24)

In contrast, the physical half of this space introduces the friction of adjacencies. The importance of this physical attribute cannot be understated. As Hayden argues:

> The elaboration of place-bound identities has become more rather than less important in a world of diminishing spatial barriers to exchange, movement and communication. (Hayden 1997, 53)

When merged, the unique qualities of physical and digital environments produce unprecedented scenarios that have yet to be explored.



Abstracted representation of hybrid space with multiple planes of concurrent digital content.

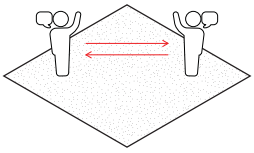
CHAPTER 4: HYBRID PUBLIC

> For while public spaces are physical environments, the "public space" is a more ephemeral term, capturing the conceptual nexus of the public and the resources that are readily accessible for its benefit. (Hemment 2013, 24)

Without the parameters of a site, the applications of the design grammar are much like the illustration of abstracted hybrid space: limitless. To move beyond abstraction, this thesis will focus specifically on public space as a typology in which to test the grammar.

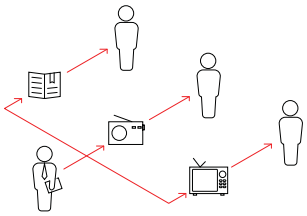
In "The Public Space of Social Media", Thérèse Tierney describes the public sphere as "a set of physical or mediated spaces where people can gather and share information, debate opinions, and tease out their political interests and social needs with other participants" (Tierney 2013, 22). This definition allows for a broader and more complex understanding of the criteria that can define a public. More importantly, it places impetus on the interaction between participants over that of the venue.

Looking at the concept of public through a historical lens, Tierney identifies three chronological categories: the spatial public, the media public, and the networked public (Tierney 2013, 25). The spatial public comprises of face-to-face communication within a performative space - historically spaces like the agora, commons, and square. With the advent of the printing press in the fifteenth century and ensuing media like the radio and television, the media public redefines an individualized space of reception. Its one-to-many mode of communication creates a collective means of discourse and knowledge sharing. Most recently, the proliferation of network technologies like the internet have established a many-to-many means of communication. As Mo McRoberts states: "it wasn't until the explosion in popularity of the public Internet in the 1990s that there was a broadly-accessible medium which allowed for both mass and peer-to-peer communication in one swoop" (Hemment 2013, 24). Suddenly communities can be anchored by special interest (professional, intellectual, political, religious, hobbyist, or social) rather than by physical proximity.



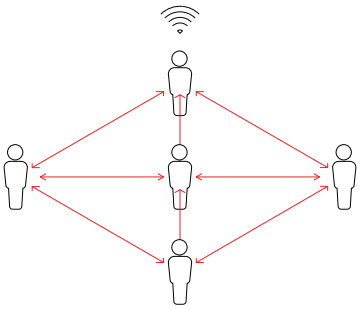
1 | Spatial Public

one-to-one physical interaction
within a performative commons



2 | Media Public

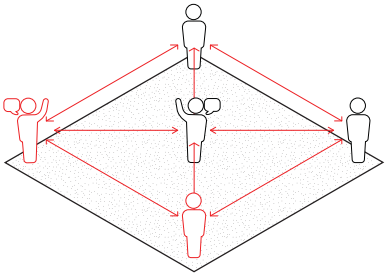
one-to-many means of social exchange
defining an individualized distributed
space of reception



3 | Networked Public

many-to-many means of social exchange
allowing for communities of associates
no longer connected by physical space
but a new kind of place

Proposed



4 | Hybrid Public

many-to-many hybrid social network
comprising of digital content
from the networked public
interfaced with the spatial public

Timeline of Tierney's classification of types of public, with a proposed hybrid public.

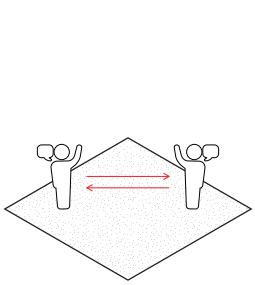
While each of these branches in our understanding of public has brought about significant societal changes, the overlap between them as they continue to exist concurrently is not without friction. To text someone on a phone while mid-conversation with someone else is jarring and uncomfortable. Similarly, speaking during a film at the theatre is considered a social *faux-pas*. To this end, Tierney states:

> Divisions between digital and nondigital public spaces are becoming less distinct, resulting in an entanglement of media platforms and practices, formations and allegiances across space and time. As a result, a critical tension between historicized views of spatial publics and more recent observations of networked publics is emerging. (Tierney 2013, 22)

This tension contributes to what might be understood as a split today between a neglected and limited spatial public, and a siteless and impersonal networked public. However, there is a strong potential for the interrelation of these public types. As Tierney proposes:

> Just as theories of publicness are provisional, space itself is neither permanent nor fixed. If space is reflexive and relational, then human operations are not limited but always have the potential to recreate and redefine a pre-existing spatial order. (Tierney 2013, 37)

Much like the origins of the media public in the invention of the printing press, emerging technologies today may enable the manifestation of a new, redefined spatial order. Specifically, through the implementation of MR technology, the spatial public and networked public could be hybridized into an altogether new public: a hybrid public.



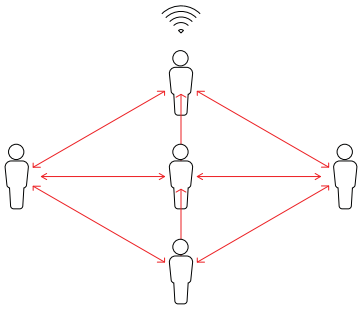
Physical Public

Strengths

Spatial/site specific
Shared in common
Real-time/in-person

Weaknesses

Limited
Neglected
Static



Digital Public

Weaknesses

Siteless
Privatized
Impersonal

Strengths

Networked
Engaged
Adaptable

Attributes of the physical and digital public to be combined in the proposed hybrid public.

CHAPTER 5: INTERVENTION STRATEGY

> The statement that "man is man's greatest joy" comes from Hávamál, a more than 1,000-year-old Icelandic Eddic poem, which succinctly describes human delight and interest in other people. Nothing is more important or more compelling. (Gehl 2010, 30)

If Tierney argues that the notion of publicness is defined by the act of social interaction, and Gehl describes this same interaction as the most important and compelling to people as a society, then the fostering of sociability and social interaction is crucial to the programming of public space. Moving into design, a series of interventions will be proposed using the physical and digital grammar to define space situated in the public realm and, perhaps most importantly, activated by social program.

The following pages contain a series of case studies highlighting contemporary artists that have created works with a similar focus on physical, digital, and social. The first, Rafael Lozano-Hemmer, is a Mexican electronic artist who develops interactive installations as platforms for public participation (Lozano-Hemmer 2015). The second, Julius von Bismarck, is a German multi-media artist using a spectrum of mediums from photography and video to installation and performance, in works that confront human perception and experience (von Bismarck 2011). The third, realities:united, is a transdisciplinary art group that merges art, architecture, and technology into hybrid installations, most notably media facades, digital surfaces, and lighting design (Vitra 2013). Each of the works by these three artists explore the hybridity of physical and digital media and their engagement with the public.

Lastly, an art installation developed by myself and a team of students for Nocturne 2018 is discussed as a built test case of the intervention strategy. We explore the components of the installation, its overarching intention, and its parallel to social media.

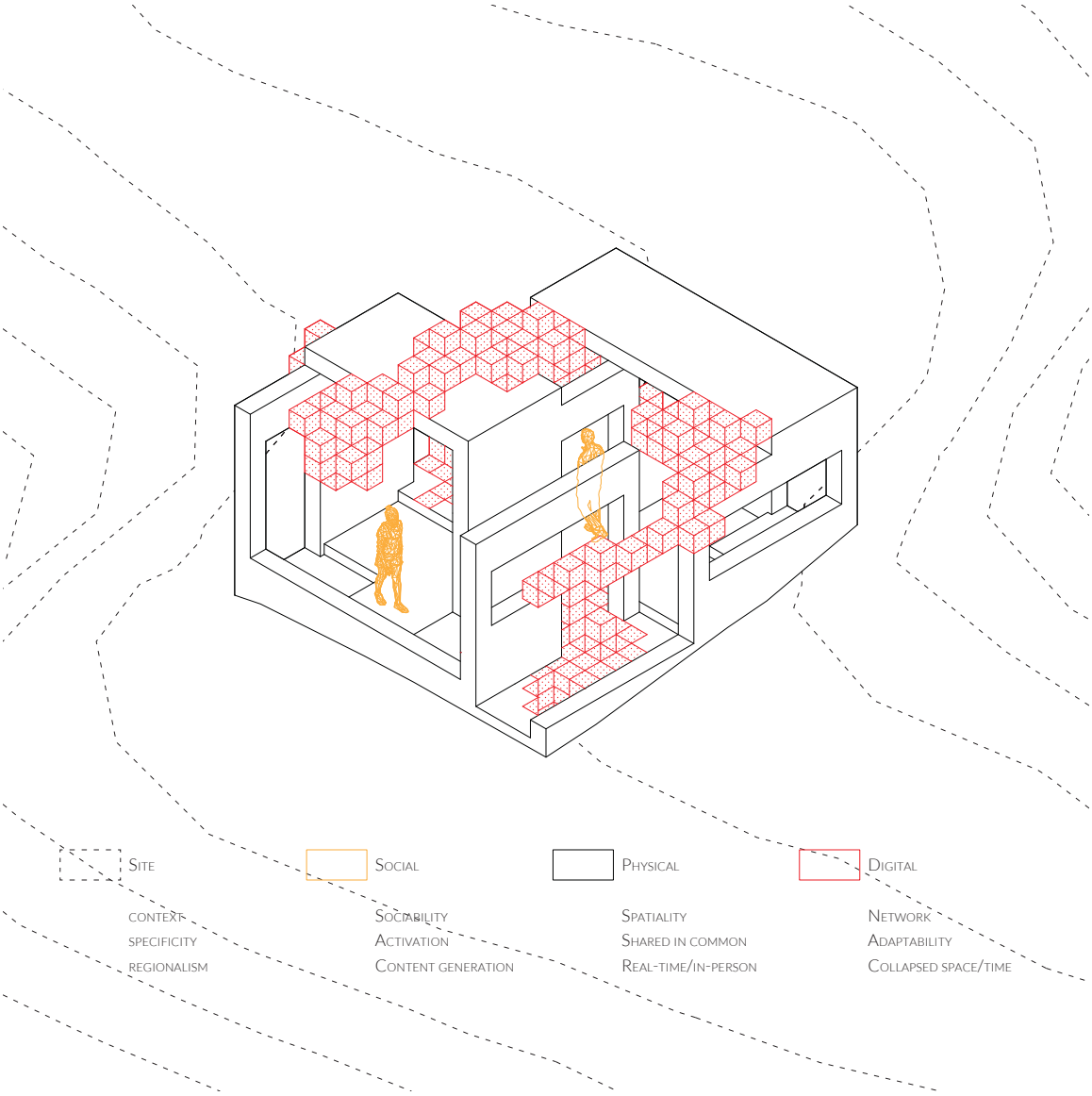


Diagram of strategy for proposed hybrid design interventions.

CASE STUDY: RAFAEL LOZANO-HEMMER

Zoom Pavilion, 2015

Zoom Pavilion (Lozano-Hemmer 2015)

Zoom Pavilion is an interactive installation that consists of immersive projection on three walls, fed by 12 computerized surveillance systems trained on the public. The piece uses face recognition algorithms to detect the presence of participants and record their spatial relationship within the exhibition space. Zoom Pavilion is at once an experimental platform for self-representation and a giant microscope to connect the public to each other and track their assembly. Independent robotic cameras zoom in to amplify the images of the public with up to 35x magnification: the zooming sequences are disorienting as they change the entire image "landscape" from easily recognizable wide shots of the crowd to abstract close-ups. The whole installation is in a fluid state of camera movement, highlighting different participants and creating a constantly changing animation. This piece emphasizes the temporary construction of connective space in relation to predatory technologies of detection and control. (Lozano-Hemmer 2015)

Pulse Room, 2006

Pulse Room (Lozano-Hemmer 2006).

Pulse Room is an interactive installation featuring one to three hundred clear incandescent light bulbs, 300 W each and hung from a cable at a height of three metres. The bulbs are uniformly distributed over the exhibition room, filling it completely. An interface placed on a side of the room has a sensor that detects the heart rate of participants. When someone holds the interface, a computer detects his or her pulse and immediately sets off the closest bulb to flash at the exact rhythm of his or her heart. The moment the interface is released all the lights turn off briefly and the flashing sequence advances by one position down the queue, to the next bulb in the grid. Each time someone touches the interface a heart pattern is recorded and this is sent to the first bulb in the grid, pushing ahead all the existing recordings. At any given time the installation shows the recordings from the most recent participants. (Lozano-Hemmer 2006)

CASE STUDY: JULIUS VON BISMARCK

Image Fulgerator, 2011

Although it appears to be a camera, the Image Fulgurator is a device that produces interventions in the photographs of others. It functions by generating an extremely rapid or "flash" projection of an image, which is triggered by other nearby camera flashes by means of an internal sensor. Different slides can be inserted into the Image Fulgurator to project various images onto objects. Julius von Bismarck has used the machine to project a cross onto the speaker pulpit of Barack Obama, Magritte's dove onto a portrait of Mao, the German insignia of the eagle onto policemen during May Day demonstrations, and the word "NO" over the Pope administering mass. The insertion of such signs and symbols into images taken by nearby photographers, initially remains invisible. The manipulation occurs at the moment the photograph is taken but is only noticeable on the final image. (von Bismarck 2011)

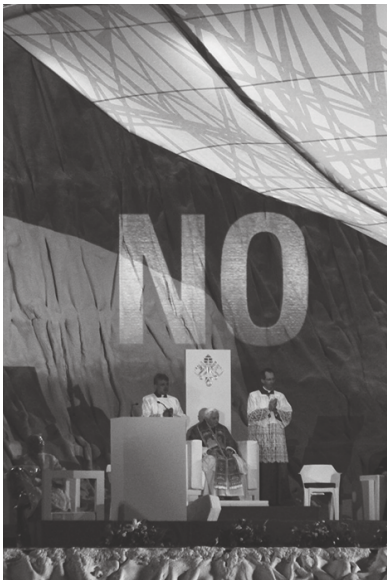


Image Fulgerator (von Bismarck 2011).

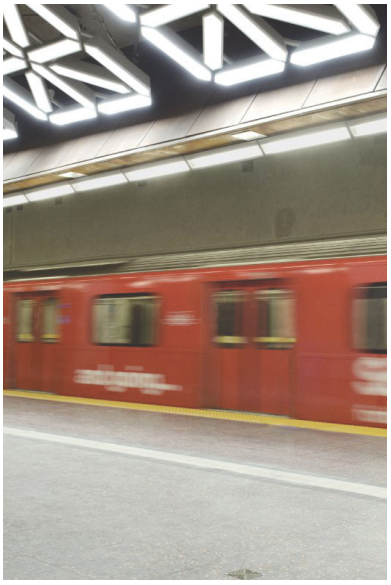
Top Shot Helmet, 2007

The Top Shot Helmet alters one's spatial perception. Wearers see themselves from above and must guide their movements and orient themselves from this perspective. The device consists of a round helmet, above which floats a helium balloon attached to the helmet with strings. The balloon carries a small video camera operated by radio signal, which points downward with a wide-angle lens. The view captured by the camera is projected onto a pair of video glasses in the helmet. Wearers of the helmet can only see the image produced by these glasses and must use this to make their way through a given space. By moving the head, the person wearing the helmet can turn and tilt the balloon and camera. A handle on the helmet makes it possible to adjust the height of the balloon and thereby adjust one's field of vision. (von Bismarck 2006)

Top Shot Helmet (von Bismarck 2006).

CASE STUDY: REALITIES:UNITED

LightSpell, 2017



LightSpell (Vitra 2013)

The project is for the Steeles West underground station designed by Will Alsop, and aims to create a hybrid of pragmatic illumination systems and art on the building. From the ceiling hang sixteen segment displays, similar to the digital displays of a radio alarm clock, and people can write texts and figures on them using quite normal keyboards available in the station. Their text appears immediately and illuminates the station regardless of what was written, with equal light intensity, because the computer dims the lamps accordingly. We planned the project based on the explicit exclusion of censorship, since limits should not be placed on creativity which should instead be encouraged. The segment displays, which are normally always seen on a screen, hang freely in the space like a type of digital chandelier. The idea behind this is that we don't add anything, but rather take the otherwise still pragmatically necessary technology – lighting – and use it in a different way. (Vitra 2013)

BIX, 2003

BIX (Realities:united 2003).

BIX constitutes an amorphous light matrix tailored to the complex shape of the [Kunsthaus Graz] and gradually fading away toward the edges, instead of offering straight and clearly visible borders. The installation's edges are hardly perceptible, as if the light patterns could dance freely on the building's outer skin, and the 930 lights seem to be rather "tattooed" into the skin of the building like individual spots of pigment … The BIX screen matrix acts as an architectural "enabler" enhancing the building's communicative possibilities considerably and offers significantly more than just a spectacular presentational touch. The media façade extends the communication range of the Kunsthaus Graz, complementing its programmatically formulated communicative purpose and becomes an important factor for the identity and image of the Kunsthaus. BIX remains an experimental laboratory until today. As the content producer, the Kunsthaus has the chance to continuously explore and develop methods for a dynamic communication between building and surroundings. (Realities:united 2003)

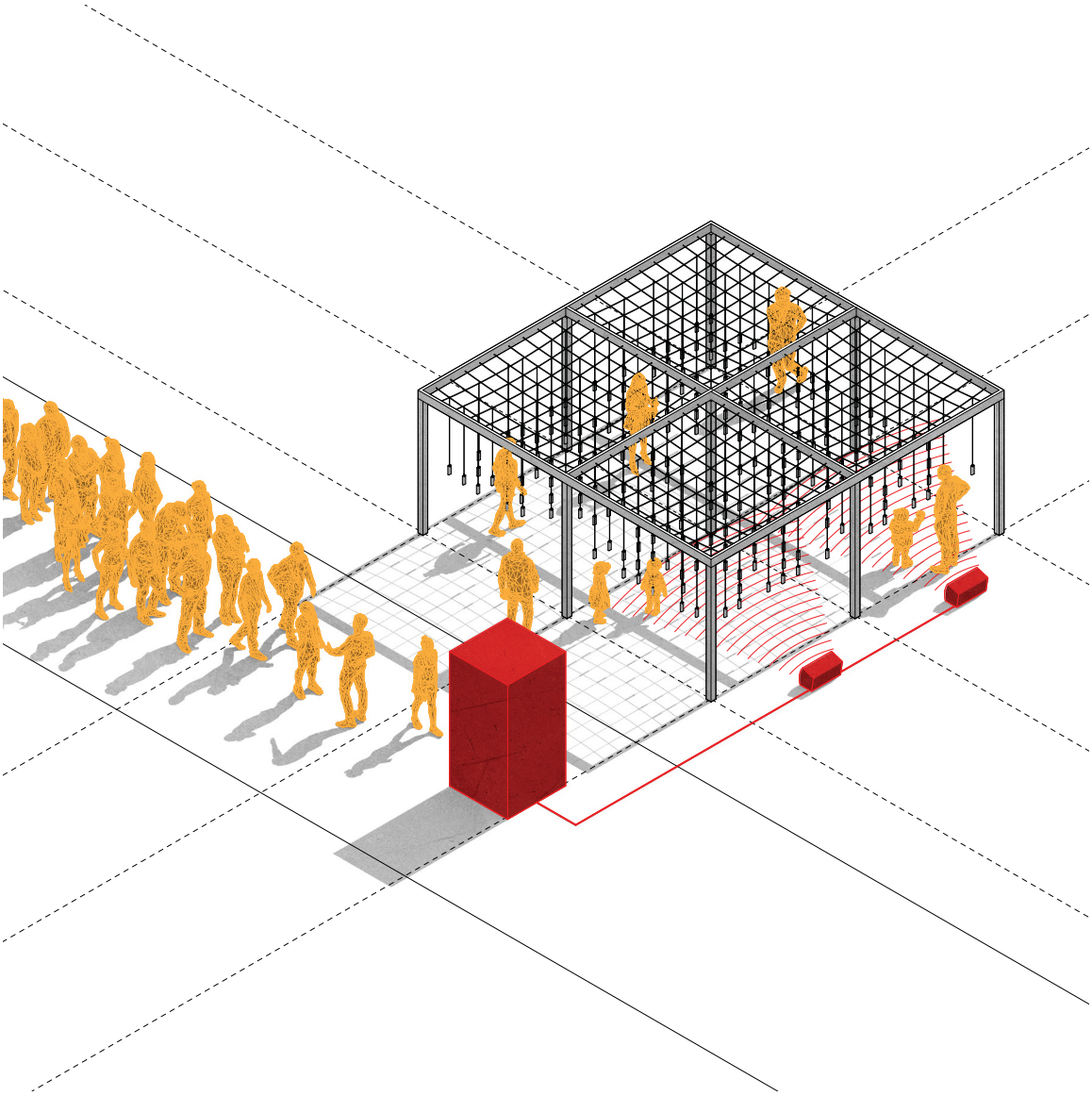
TEST CASE: NOCTURNE

The intervention strategy in this thesis was tested for the first time through Dalhousie's contribution to the Nocturne 2018 art at night festival. In the installation, participants were given a tag on which to write an identifying statement. Participants then recorded an audio clip of their response at a booth and hung their tags from twine in the structure. The audio clip was added to a looped track playing into the installation over speakers. The intention was to build a neutral framework that would then be activated by user-generated content. As the night progressed the structure filled with the archived physical and digital contributions of the participants.

Engagement with the installation was successful, with approximately 3000 participants over the course of the evening. However, an important lesson learned was the delicacy of balancing physical, digital, and social. Of all participants, under 200 recorded audio clips of their responses for the looped playback. While this was enough to fulfill the experience of a crowd of voices, the digital component of this intervention fell short of its potential.

In some ways, the installation could be seen as a spatial manifestation of social media. Social networks behave as 'neutral' platforms upon which users identify themselves, observe, and connect. The most common artifact across all platforms - the post - shares an insight into the particular world of the individual, whether it is a written statement, image, audio clip, video, or otherwise. The overall experience, even identity, of a platform is generated through the accumulated contributions of its users.

The tags and audio clips collected in the installation behaved similarly. Each one reflected something about the contributor. Passing through the tags was akin to scrolling through a feed. The key difference was the spatiality, adjacency, and site-specificity of this reimagined social network. Participants experienced this space together - with friends and strangers alike - surpassing the problematic echo chambers present in most social media (Arieff 2017, 35).



Sequence diagram for Nocturne 2018 installation.

Images of construction and assembly for Nocturne (credit: Julie Leungsuetying).

Images of final installation and participation for Nocturne (credit: Julie Leungsuetying).

CHAPTER 6: SITE

> The smart city vision tends to focus on infrastructure, buildings, vehicles, looking for a client amidst the city governments that procure or plan such things. But the city is something else. The city is its people. We don't make cities in order to make buildings and infrastructure. We make cities in order to come together, to create wealth, culture and more people. (Hill 2018)

The series of proposed interventions exploring hybrid space will be situated specifically within the public realm, in the city of Halifax. While Halifax, as a case study, provides specific bracketing within which to test the established hybrid grammar, it should be noted again that the application of this technology is global. The environmental, sociopolitical, and cultural specificities from one location to a next could lead to vastly different interpretations elsewhere.

As an example of site-specificity, public space in Halifax can be broken down into a taxonomy of six broader categories: the square, the park, the garden, the commons, the vehicle/pedestrian street, and the pedestrian street. The six categories may be further classified as nodal or connective, or as Gehl describes:

> Whereas the street signals movement: "please move on," psychologically the square signals staying. Whereas movement space says "go, go, go," the square says: "stop and see what's happening here." Both feet and eyes have left an indelible mark on urban planning history. The basic building blocks of urban architecture are movement space: the street, and experience space: the square. (Gehl 2010, 45)

Together, these nodal and connective public spaces create a rhizomatic network across the city, binding together private, commercial, and institutional spaces.

PUBLIC TAXONOMY

Square: a hardscaped space of civic congregation, framed by buildings, and often containing central monuments or similar. The formal nature of squares, coupled with their sporadic use, can leave them feeling uninviting for everyday occupation.

Map of public space on the Halifax Peninsula.

Park: a natural or softscaped space commonly used for recreation. Capable of varying dramatically in size, parks may contain treed areas, circulation paths, seating, and grassy areas for sport, exercise, or leisure. Urban parks provide crucial points of decompression across a city, and should ideally be within a ten-minute walk of residents (Gehl 2010, ix).

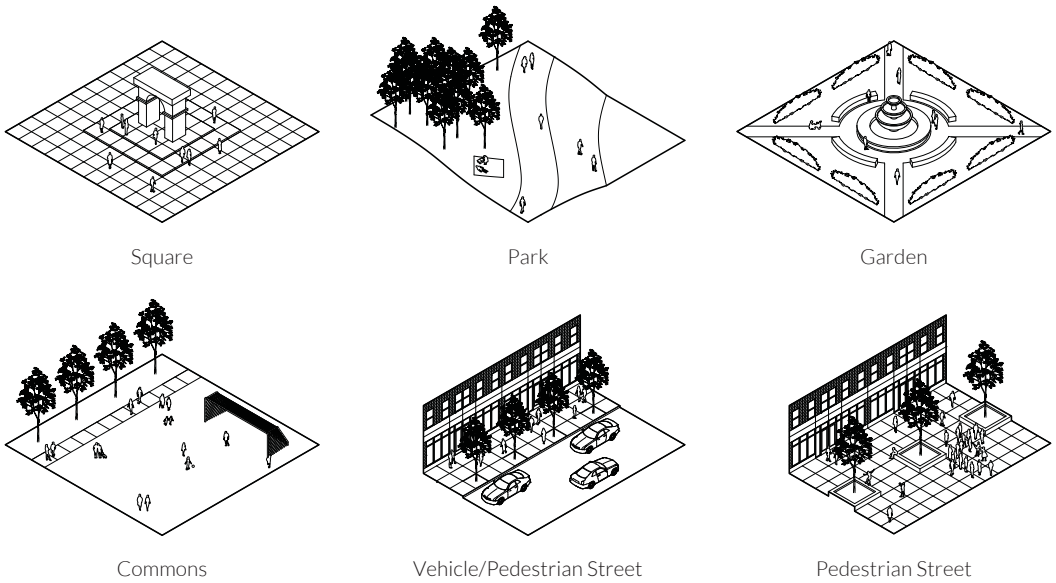
Garden: a place where a wide variety of plants are cultivated for scientific, educational and ornamental purposes. Like parks, public gardens often contain a mixture of green spaces interspersed with paths. However, the stricter code of conduct in gardens limits the range of recreational activities permitted or even the hours of access.

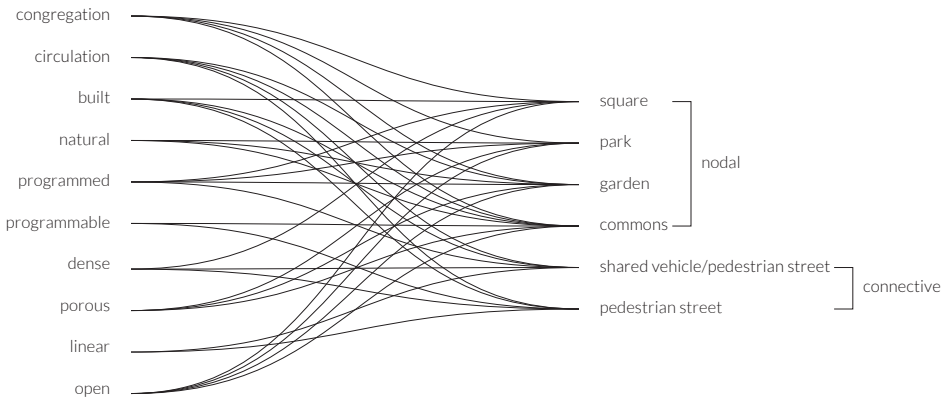
Commons: a general term for shared resources in which each stakeholder has an equal interest (Hess 2006). In the case of urban commons, this typically refers to an unprogrammed piece of land available for the public to use as they see fit.

Vehicle/Pedestrian Street: a public thoroughfare in an urban environment shared by both vehicles and pedestrians. Typically, the focus of this space is dominated by vehicles, with marginal attention paid to the quality of life for the pedestrian.

Pedestrian Street: a public thoroughfare in an urban environment used exclusively for pedestrian traffic. In the absence of vehicles, the qualities of the space shift to the human scale, with comfortable dimensions to incorporate areas of rest, greenery, and attractions, as well as areas of circulation.

This taxonomy will be used to inform potential sites of intervention and, in relation to these categories and their attributes, ensure variety across the points of insertion. As Tierney says: “It is impossible to understand space without understanding how people use and move through it” (Tierney 2013, 27).





Taxonomy of public spaces and their characteristics on the Halifax Peninsula.

HALIFAX: PUBLIC REALM

> Cities must urge urban planners and architects to reinforce pedestrianism as an integrated city policy to develop lively, safe, sustainable and healthy cities. It is equally urgent to strengthen the social function of city space as a meeting place that contributes toward the aims of social sustainability and an open and democratic society. (Gehl 2010, 13)

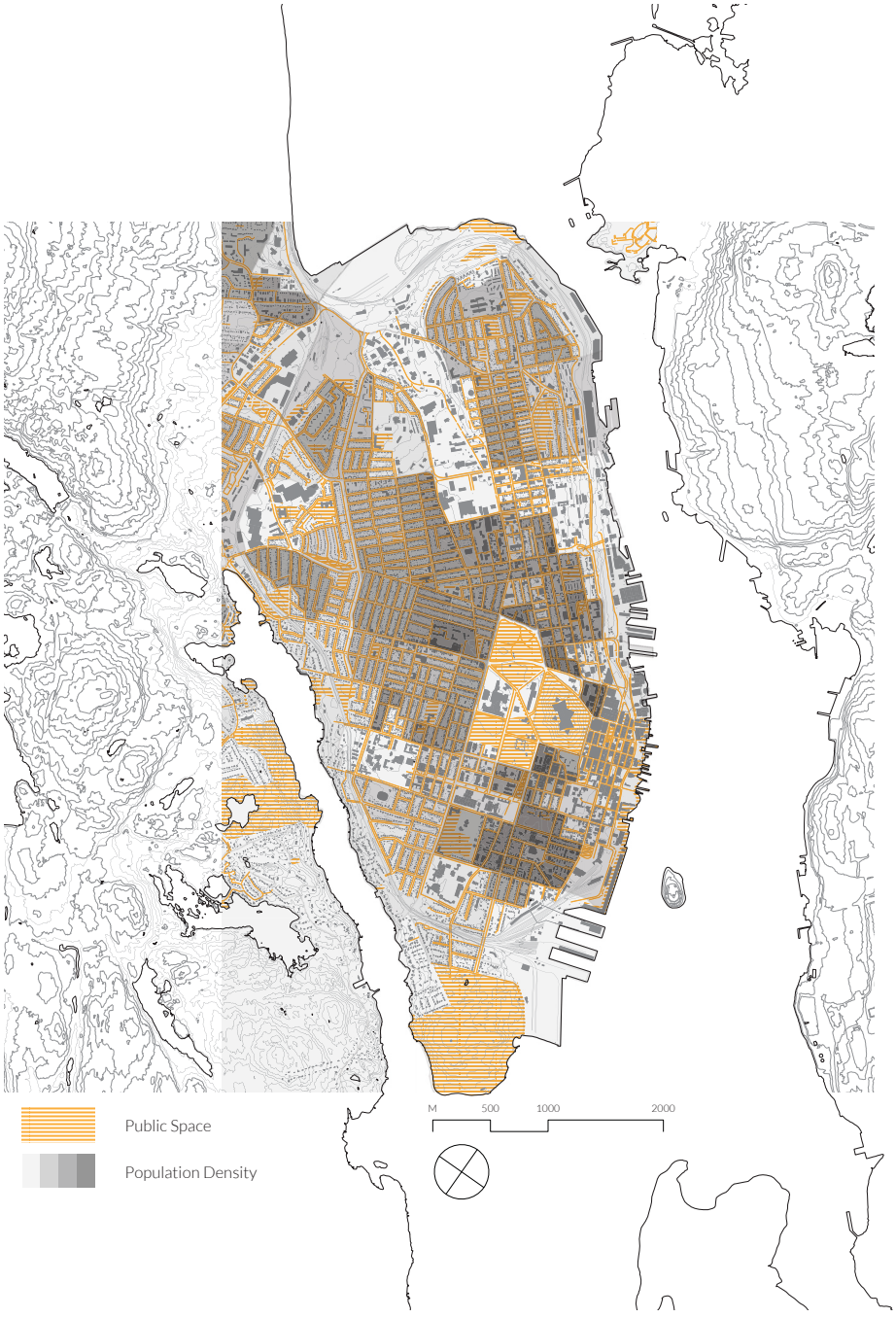
To the end of enhancing the quality of public life, the walkable scale between public spaces and surrounding neighbourhoods and amenities is especially vital. Today, the vehicle-centric nature of urban planning has severely impacted this quality. Gehl states: "increasing car traffic has swept city life off the stage or made travel by foot totally impossible" (Gehl 2010, 33). The arrival of the car dramatically destabilized public life at a human scale, dividing and isolation the city from the perspective of the pedestrian. If the goal of our hybrid interventions is to foster a more social public, the focus must be at the scale of the pedestrian and in the conditions that best sustain them.

By overlaying population density on the map of the Halifax Peninsula, we clearly see the Halifax Commons highlighted as a site of high impact potential. The centrality of the Commons, accessibility by transit, as well as its walkable proximity to dense residential areas, provide a vital opportunity for interventions intended to enhance social life. The size and diversity of spaces within the Commons will also allow for the desired variety of design.

HALIFAX: COMMONS

> The most valuable things in the world are those which can be bought and sold by nobody but are accessible to everybody. (Hemment 2013, 24)

Broadly, the Commons provides unique opportunities in the exploration of hybrid space. As a concept, a commons raises interesting questions of governance and ownership, individual rights and autonomy within hybrid space. In "Digital Public Space," Jill Cousins states:



Map of public space and population density on the Halifax Peninsula.

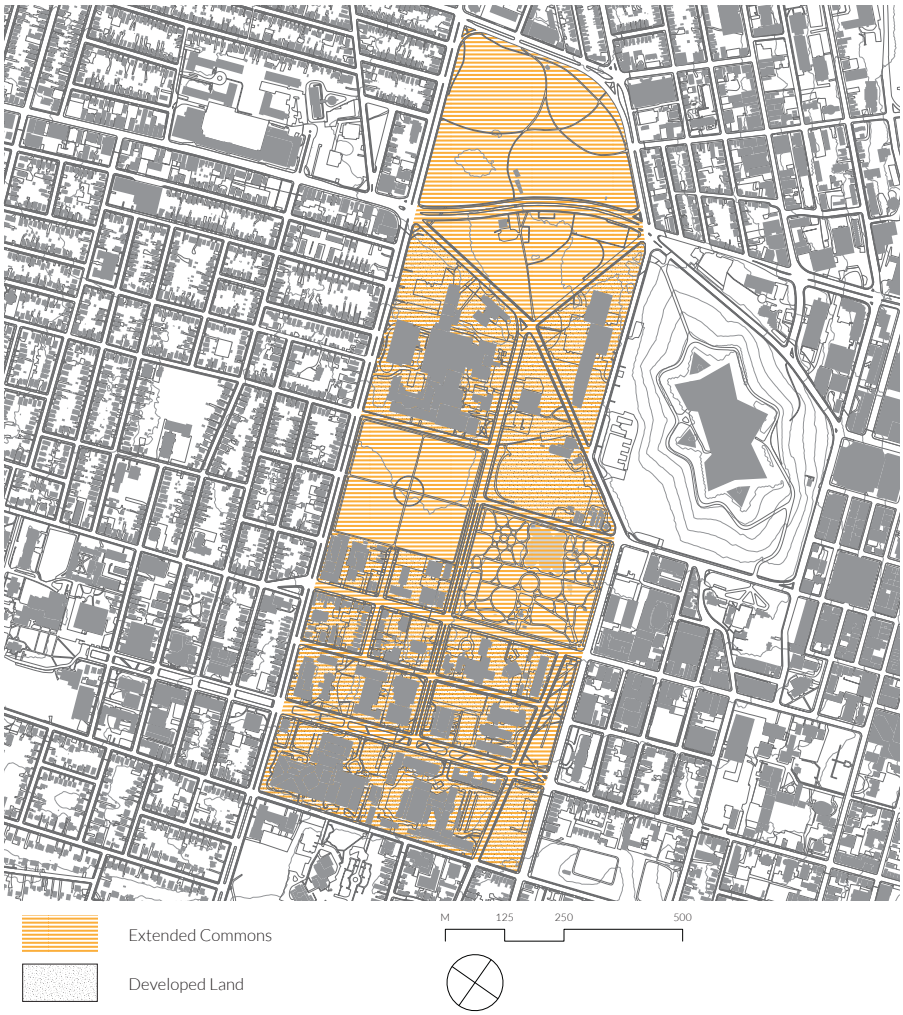
> Underpinning the foundation of the commons is a set of resources in the public domain that are owned collectively or 'held in common' and shared openly among a community. The key values of a Cultural Commons are participation and reciprocity. (Hemment 2013, 12)

Much like Tierney's definition of public, the commons also exists as a social construct of interactions and bonds between members of society. The democratic underpinnings of a commons strive toward the full potential of public space, particularly in urban settings. Once again, social networks define a more conceptual understanding of space as commonality.

Online, the notion of commons is much harder to delineate. James Bridle states that "digital space is always owned in some way: there is no true commons online" (Hemment 2013, 9). Jaron Lanier takes this line of thinking one step further in describing the illusion of autonomy, equity, and democracy in social media platforms as the "antigora":

> These corporate squares are the anointed antigoras. They are the places where commoners gather online, acting as if they were first class citizens, still effectively innocent of the fact that they are under intense surveillance and subject to stealthy behavior modification by algorithms … a constant stream of suggested behaviors are placed in front of people, and on a gradual, statistical basis, the crowd acquiesces. (Arieff 2017, 34)

While the problem of privatized interest controlling the digital public realm may fall beyond the scope of this thesis, it is important to acknowledge its ramifications for hybrid space. Finding a way for sanctioned organizations to behave as stewards of the digital public domain, as an alternative to current corporate and/or governmental monopolies, may bring us closer to the heterotopic ideals of commons in hybrid space. Perhaps in designing our hybrid experience with these ideals in mind, the development of policy might follow suit. As Andrew Hiskens states: "You can't simply build communities, but you can help people work out how to connect" (Hemment 2013, 21).



Map of the greater Halifax Commons.

CHAPTER 7: DESIGN

> Three things make cities delightful: unpredictability, spontaneity, and chance encounter. (Gehl 2010, 23)

Historically, the Commons was much larger than it is today; extending from Cunard Street down to South Street, and from Robie street east to South Park and North Park Street. Portions of this space have been traded and developed into various institutional and commercial projects over the years. The remaining public spaces must be maintained and curated to best serve the needs of the populace. Across the broader site, six points of insertion have been selected for a proposed intervention:

Vehicle/Pedestrian Street: redesign of bus stops as hubs for the city's various information networks: city data, transit, wayfinding/information, community bulletin boards, etc.

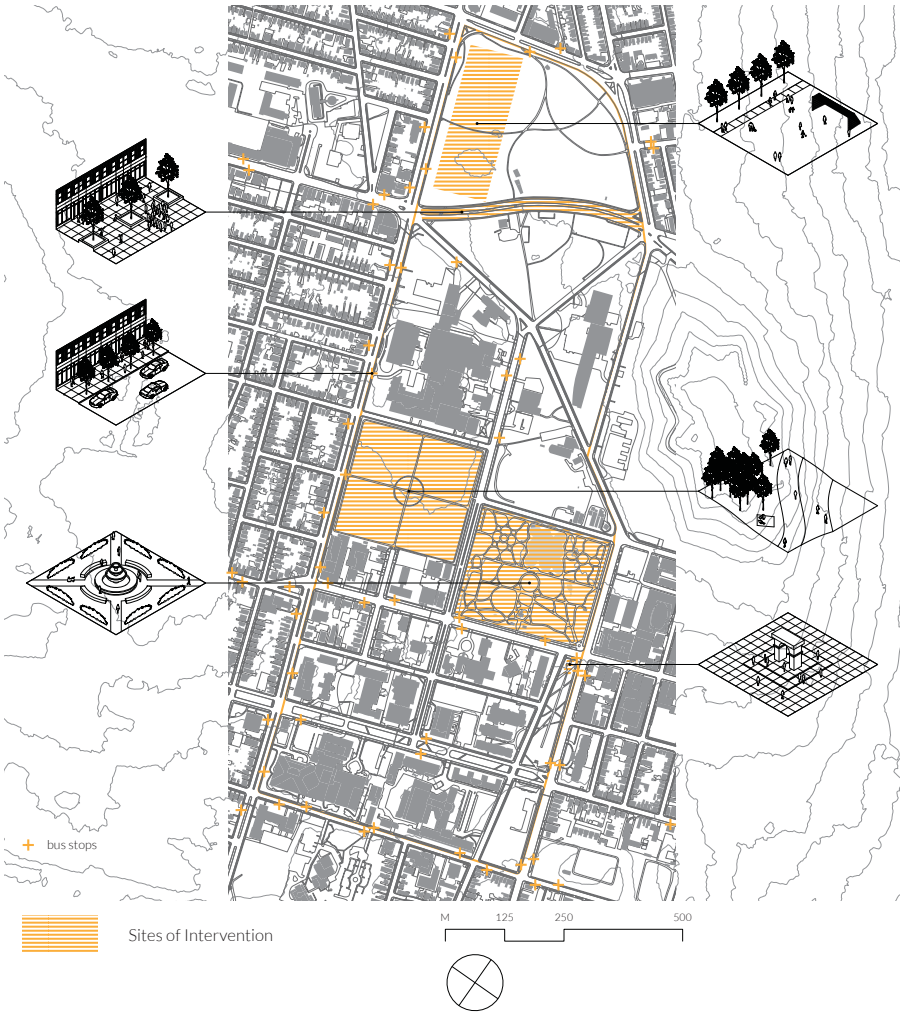
Garden: public space as a digital sculpture garden, with a rotating roster of local public art to continually renew interest in public engagement.

Square: a standardized square designed as a 'chatroom' space, linked to identical squares in sister cities, where avatars of people visiting the square of a connected city appear and interact.

Commons: a kit of modular event infrastructure, paired with digital media, that can spread out over the commons temporarily or store away to make room for other activities.

Park: a reinterpretation of the cemetery as a park and archive for digital avatars of those who have passed away, with whom people can converse to learn from their preserved history and knowledge.

Pedestrian Street: a pedestrian street to reconnect the north and central commons, acting as a hardscaped stem and community hub that services the green spaces.



Map of the greater Halifax Commons with proposed sites for intervention.

VEHICLE/PED STREET: TRANSIT NETWORK

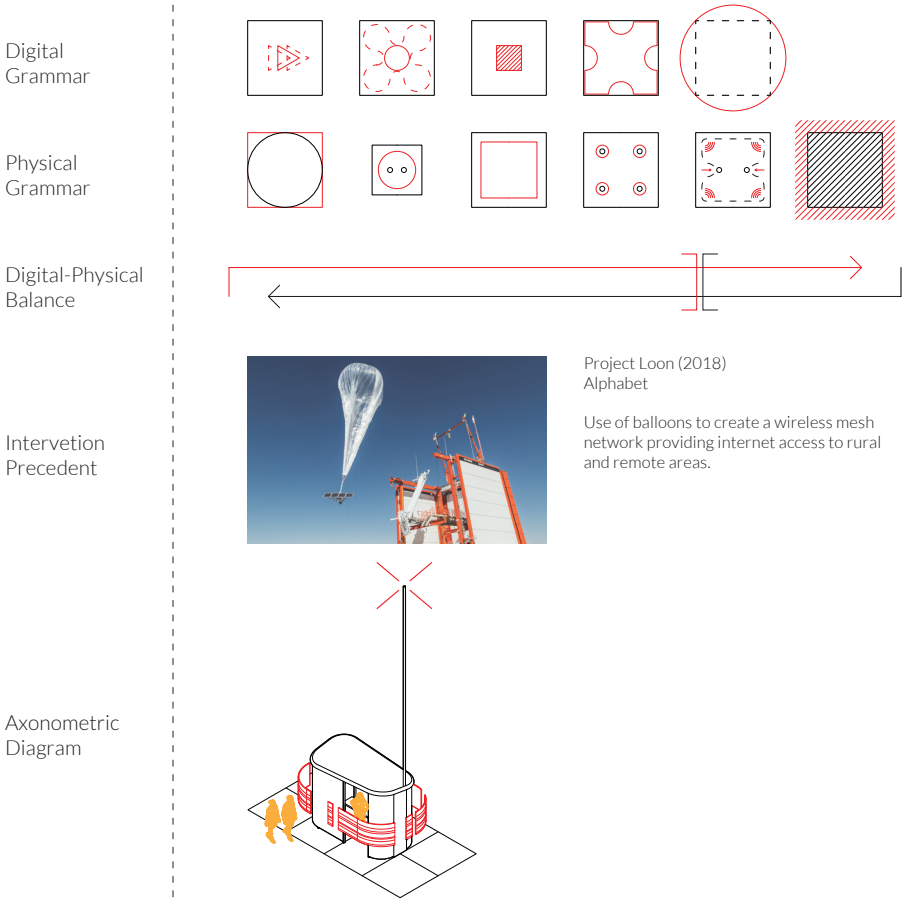
> The contemporary city is based on a pattern of dispersal where individuals construct their sense of place from a series of physically disconnected locations or nodes connected by transport and communication channels. As such, the contemporary city has evolved into a nonhierarchy of places and networks. (Tierney 2013, 27)

The vehicle/pedestrian streets of the city act as a rhizomatic network connecting all other public and private places. As such it is well equipped to act as the interface for all other urban networks.

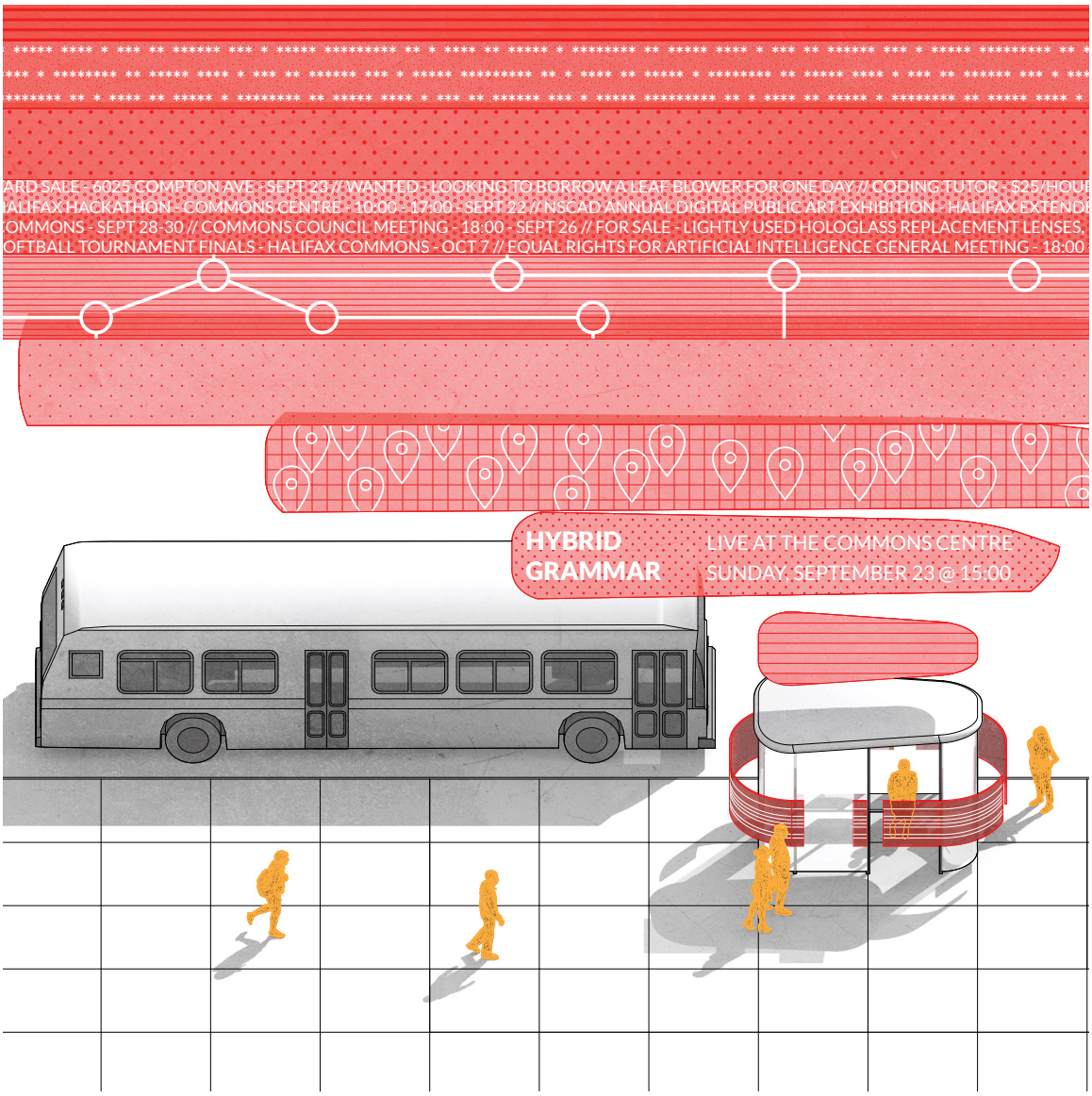
Building off Halifax's existing transit system, this intervention proposes to redesign bus shelters as 'kiosks' through which the public can access curated streams of localized information. Much as a social media news feed is curated to the interests of a user, the bus shelters will behave like physical tethers to geolocate relevant data. Represented network information could include transit, smart city data, civic information and wayfinding, and community bulletin boards.

When a newcomer arrives in Halifax, they can sync up to relevant layers of information based on their interests and location. In a similar fashion to an object like the green book in the United States, these relevant layers of information could cater specifically to the needs of someone from a minority group (Mars 2016). As an example, a trans person new to the city could link up to overlays of information highlighting queer-friendly neighbourhoods and establishments nearby.

Referring back to the grammar, this intervention draws heavily from the encyclopedic. Temporal information generated by the community is accessed as content mapped to the surfaces of a bus shelter. The physical design of the shelter is permanent, scaled somewhere between communal and intimate, and suggestive of a particular, information-centric overlay of digital content. Through their repetition across the city, the shelters become a ubiquitous entity reflective of the wireless network that supports mixed reality.



Design chart for the vehicle/pedestrian street intervention (Alphabet 2018).



Concept drawing of the bus shelter information kiosk.

GARDEN: PUBLIC ART

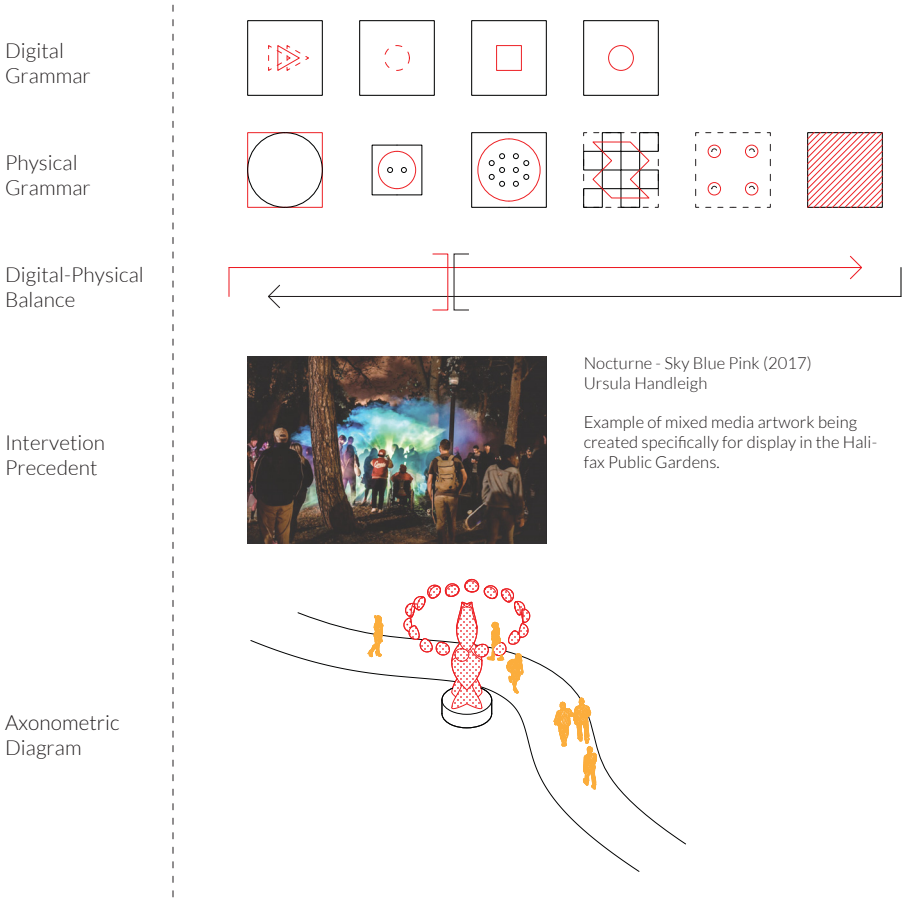
> In a high-tech society, cultural institutions usually follow the technology industry. A new technology is developed for military, business, or consumer use, and after a while cultural institutions notice that some artists are experimenting with that technology and so they start to incorporate it in their programming. (Manovich 2006, 26)

Art is often in the vanguard of technological experimentation, exploring and pushing the limitations and intended uses. The art world has been among the earliest adopters of mixed reality technology, using it to craft unprecedented hybrid experiences like those presented in the case studies.

Drawing specifically from the idea of a sculpture garden, the intervention for the public garden imagines all of the city's green spaces becoming a platform for hybrid public artwork. While art, broadly speaking, pushes not only technological adoption but also critical societal discourse, public art often presents as neutral, expensive, and ultimately mundane. Due perhaps to the permanent and public nature of these works, there is less liberty to make a strong statement lest it receives public backlash.

Digital and hybrid public art hold more significant potential to be dynamic, critical, ephemeral, and lower-cost. Things that would be physically and financially impossible to achieve in the physical world, like a ten-storey jellyfish swimming about the high-rises downtown, are entirely within the realm of possibility as a digital model in mixed reality. Should an individual not wish to interact with a particular artwork, they could turn off that layer of digital content, allowing for customization of each person's experience.

This medium will allow for so much more whimsy and surprise in the public realm. One can imagine walking down a sidewalk overgrown with alien plant life that shrinks away as people move through, only to come across an interactive hybrid sculpture that casts ambient audio recordings from an entirely different location in the city. The art world is where mixed reality technology will take its first steps toward hybrid space.



Design chart for the garden intervention (Parker 2018).

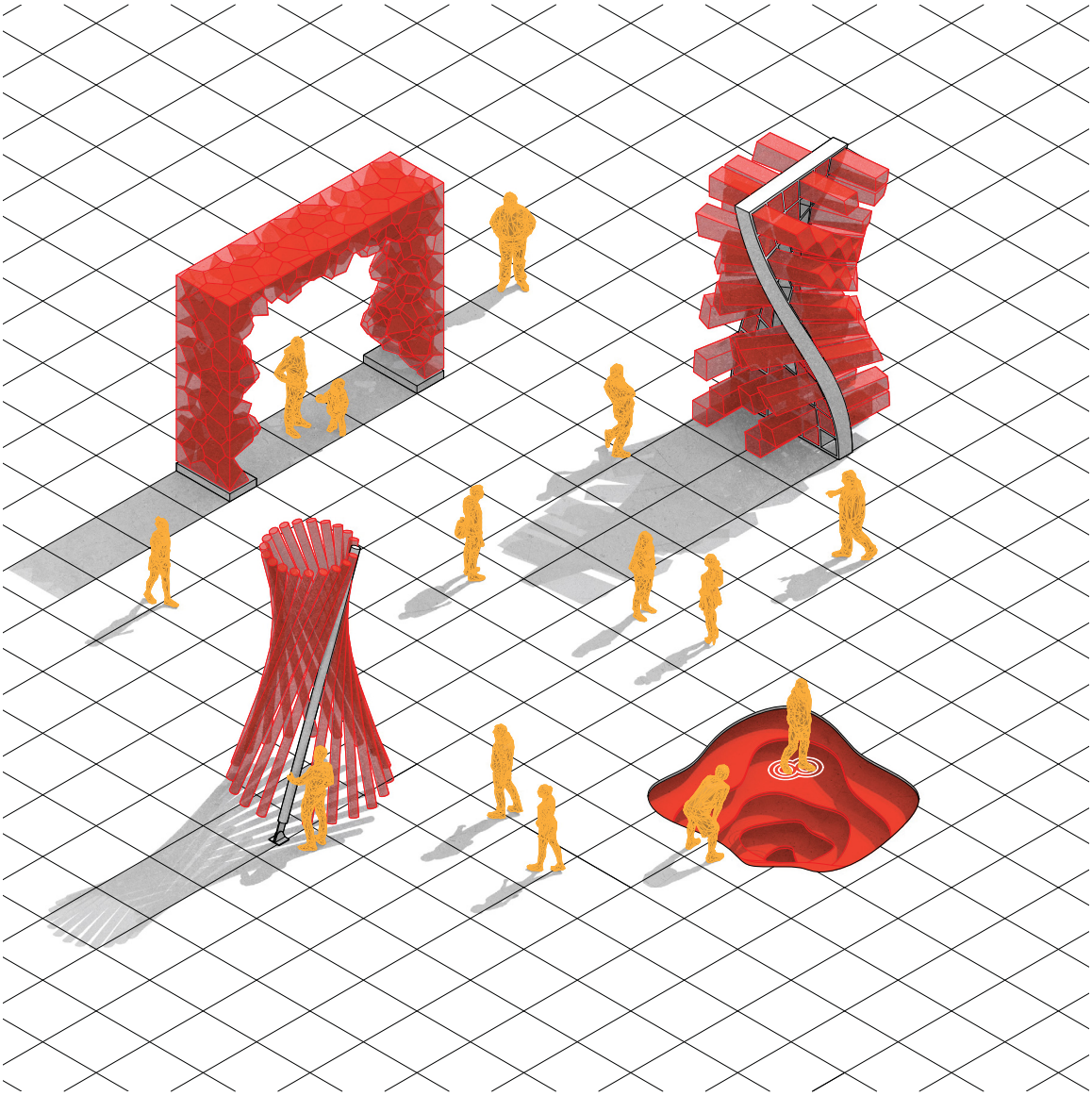


Diagram of hybrid public artworks.

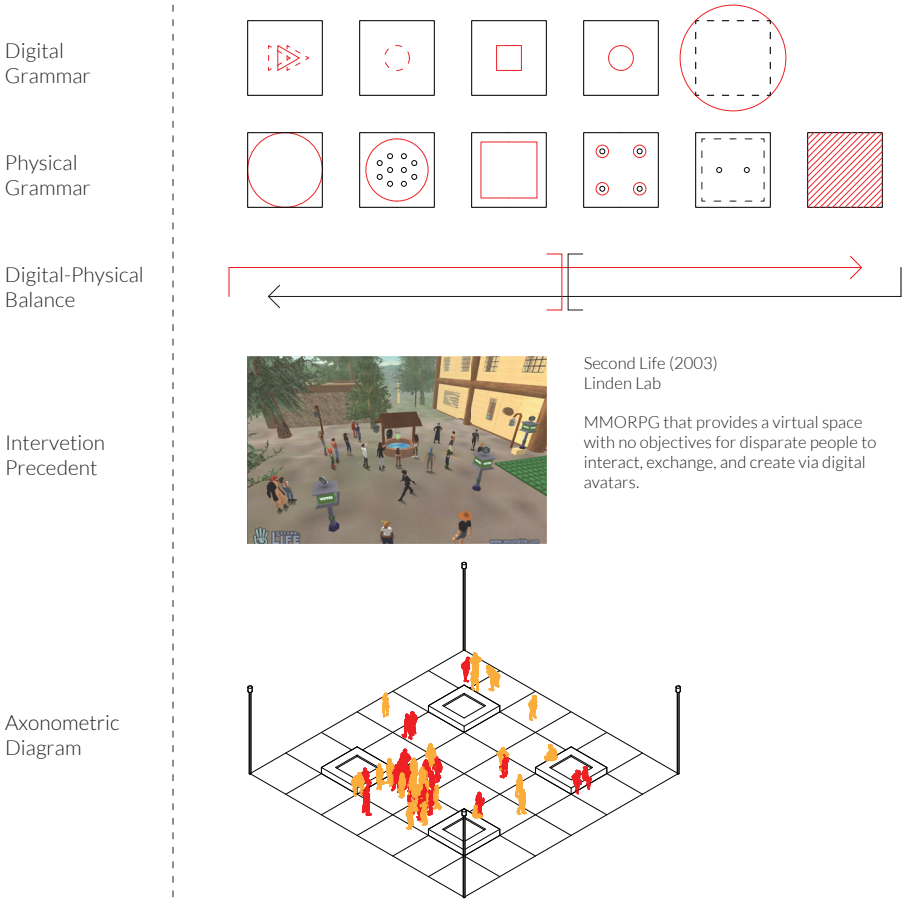
SQUARE: CHAT ROOM

> You can't simply build communities, but you can help people work out how to connect. (Hemment 2013, 21)

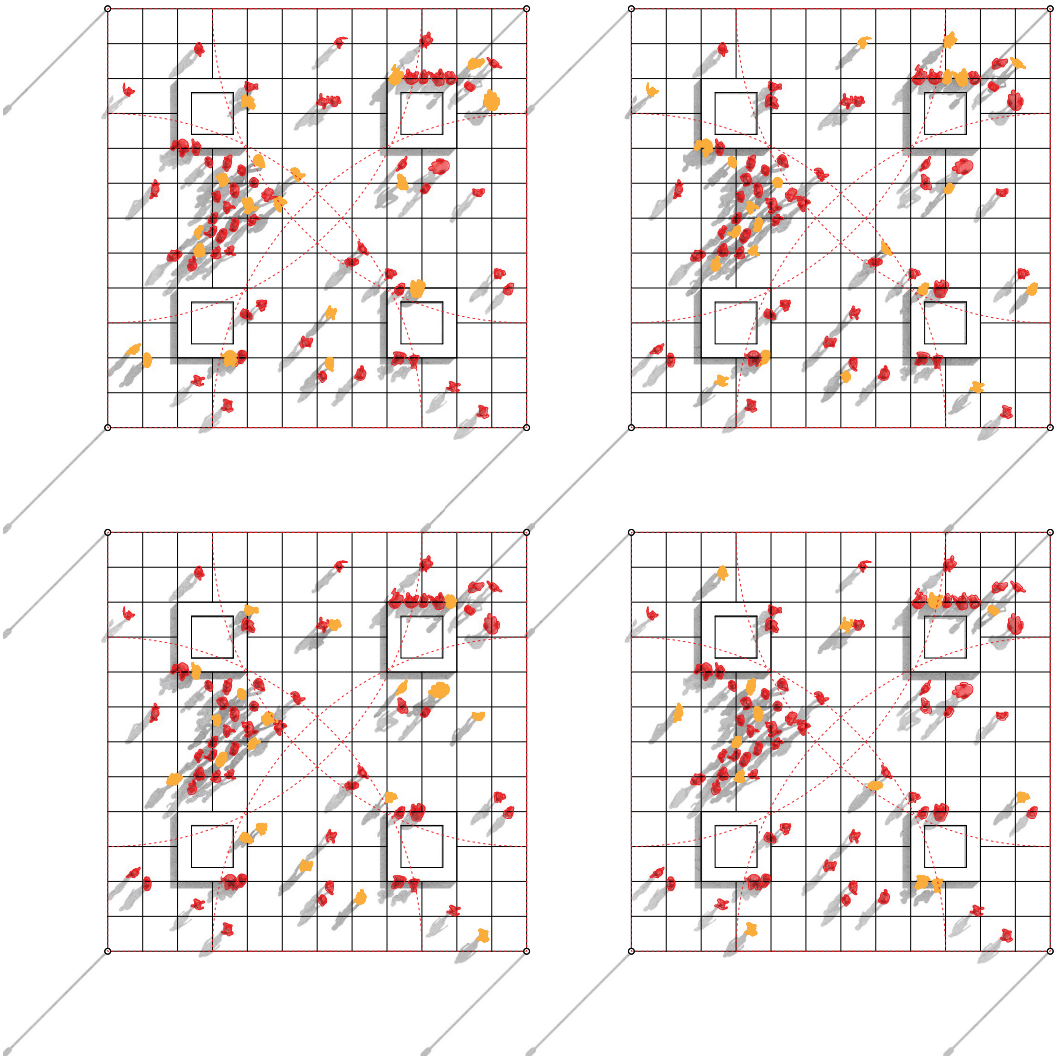
Chat rooms are a prime example of how Tierney's networked public developed beyond the spatial and media publics (Tierney 2013, 36). The ability for geographically distant people to participate in synchronous conferencing, be it a text-based chat room or massively multiplayer online role-playing game, connected people in an unprecedented way (Corriea 2014). In many ways, city squares are the spatial public precursor to the chat room: a place where friends and strangers can congregate and interact.

This intervention proposes the public square as a chatroom, where physical and digital people can gather to socialize. A square with a standardized design is mapped in real-time by cameras on poles along the perimeter. The digital mapping of this square in Halifax is synced up to squares of the same standard design in Halifax's sister cities: Hakodate, Japan; Campeche, Mexico; and Norfolk, Virginia, United States. As an individual enters the perimeter, their likeness is replicated in real time as a hologram in each of the linked squares around the world. In a space like this, a tai chi instructor could be leading a session for an international class comprised of physical and digital people, or dancers in separate cities could perform a synchronized, overlapped routine while standing in the same place.

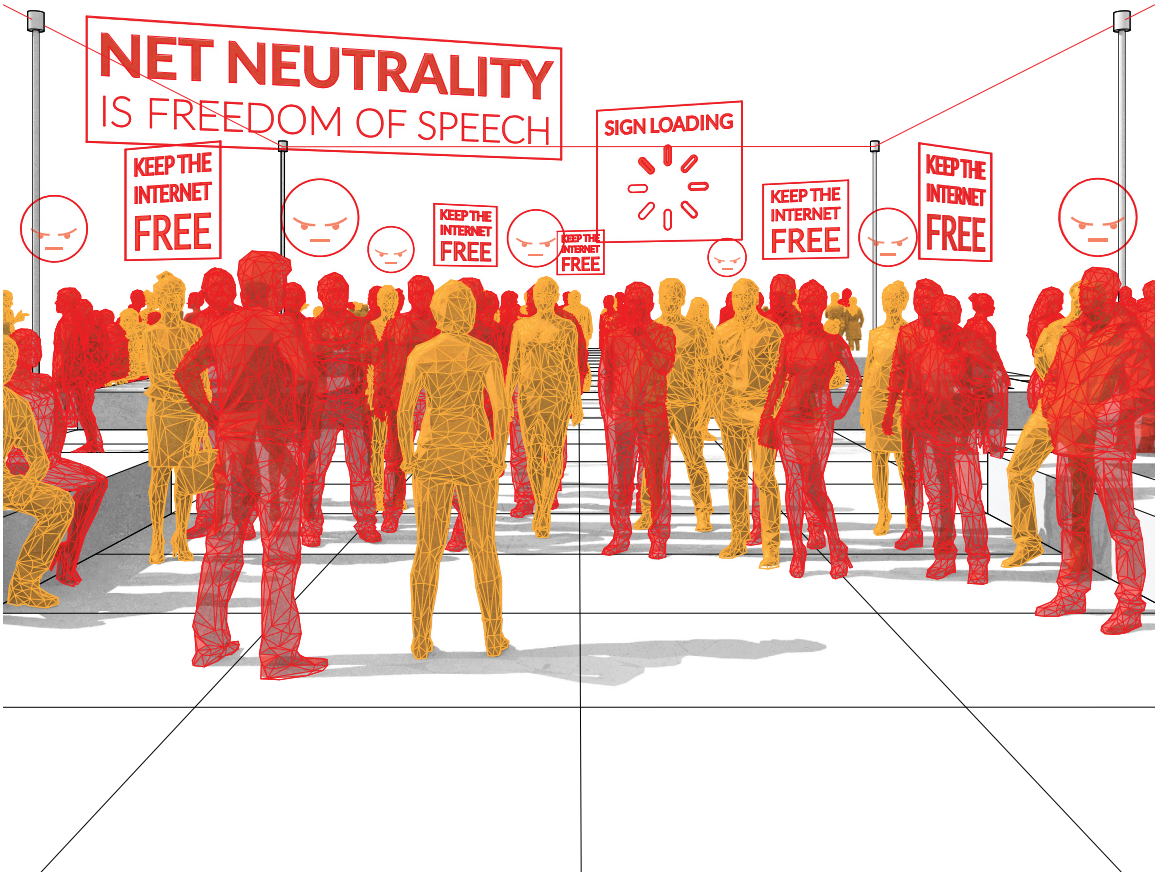
In many ways, this is the purest example of a hybrid public as described in chapter four. It combines the strengths of the networked public, by collapsing distance to allow instant communication between disparate locations, with those of the spatial public, by preserving the site-specificity and physicality of in-person engagement. It draws from the temporality and generated content of the digital grammar, and the communal scale and blank potential of the physical grammar.



Design chart for the square intervention (Corriea 2014).



Concept Diagram of networked public squares.



Vignette of an intercity protest in a chat room square.

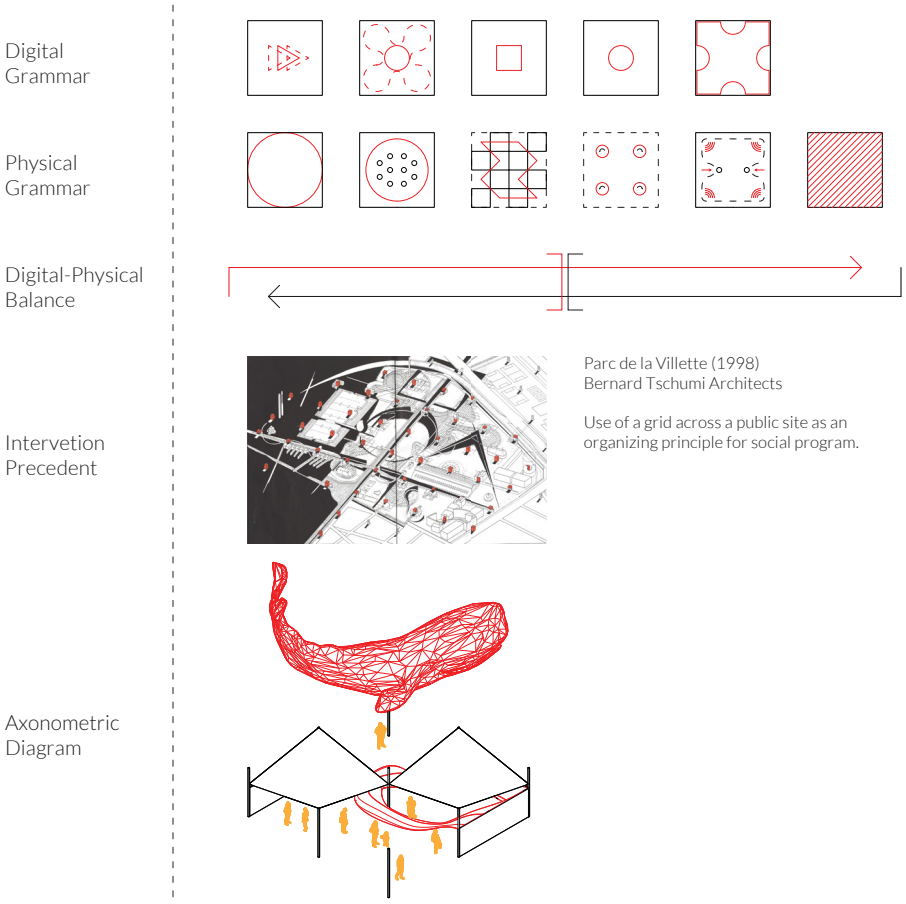
COMMON: EVENT KIT

> The public is an empty term unless we make the public into a common: something we share, care and produce together. (Hemment 2013, 28)

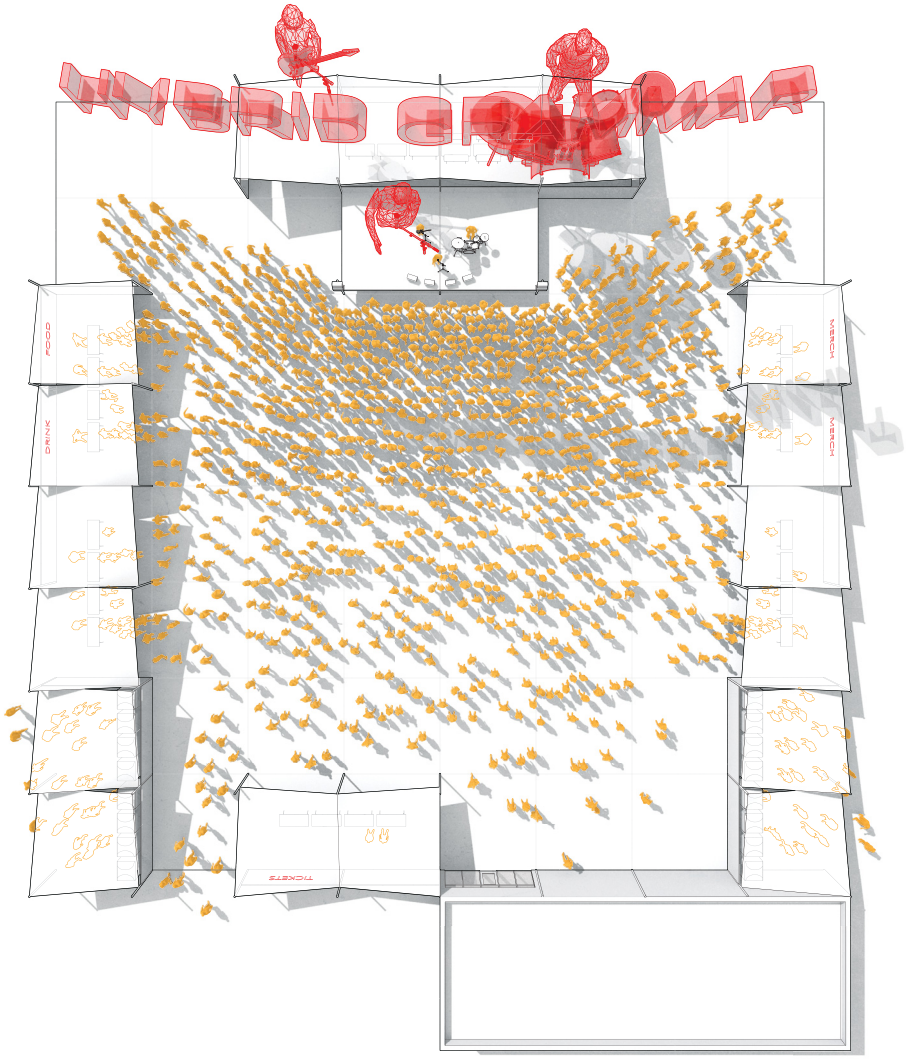
As mentioned previously, the Halifax Commons has a history of shrinking with development over time, gradually limiting the amount of remaining shared, programmable, public space. In response, this intervention proposes the design of a modular kit of parts to assemble as infrastructure for hosting a wide range of events. The site is gridded with an array of concrete piles, flush with the ground, from which the kit can be secured. Poles, rigid partitions, and tensile covers can be combined to shape an open expanse of the commons around a particular program. When an event is over, the kit disassembles and stores away into a support building with a small footprint on the periphery of the Commons, allowing the space to return to everyday sport and leisure activities.

Since the palette of the kit is kept neutral enough to adapt to shifting programmatic needs, the specificity of the event is established through digital augmentation. In the examples on the following pages, we see the kit configured to host a concert, a market, and a game of laser tag. The concert employs digital signage and wayfinding, and larger-than-life special effects above the stage. The market allows each vendor to fluidly ornament their stall with their branding without requiring extensive physical signage. The game of laser tag uses the layout of the physical partitions to situate a tower in an open space for the defending team, digital barriers throughout the rest of the playing field, and a large, floating scoreboard visible from all points in the game.

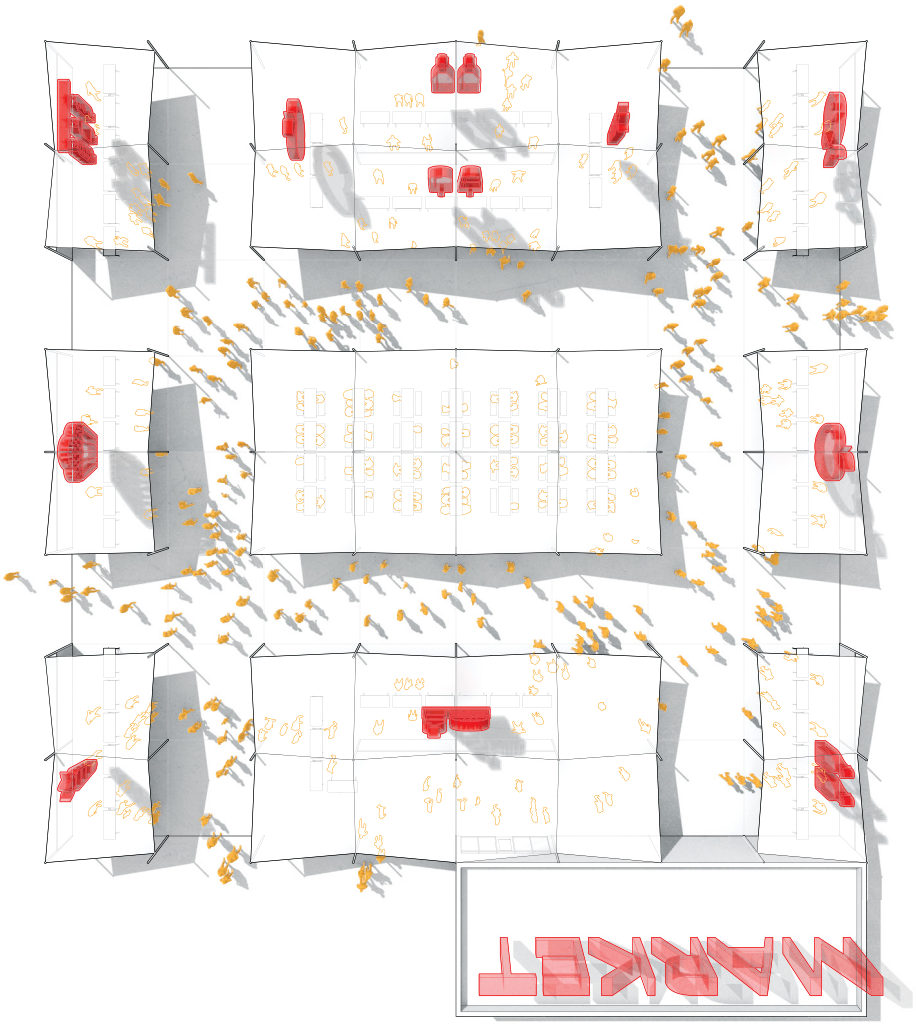
This intervention attempts to match the design of the physical to the fluid and dynamic nature of digital content. The physical grammar draws foremost from modularity, using temporary and rectilinear assembly. The digital grammar has a full range to explore the temporality and spatiality of digital content in response to the flexibility of the physical.



Design chart for the common intervention (Tschumi 1998).



Event kit configured as a concert.



Event kit configured as a market.

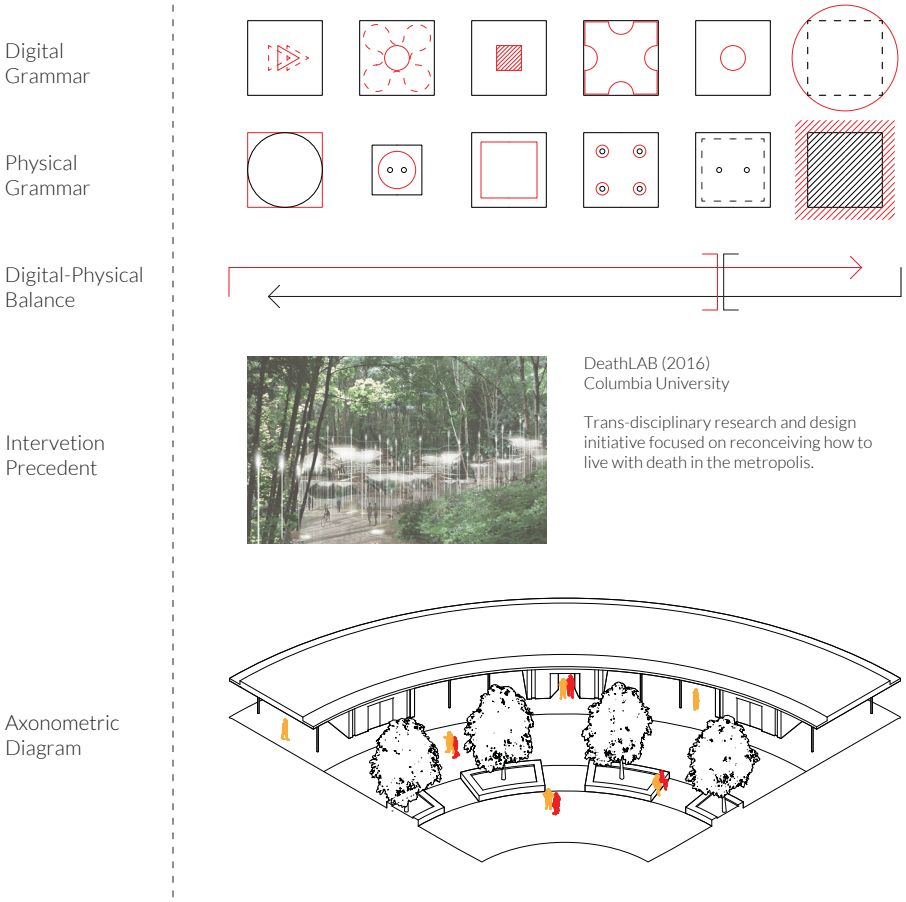
Event kit configured as a game of laser tag.

PARK: SOCIAL ARCHIVE

> A digital archive is not a closed space, nor a museum of dusty objects, but, through the premise that digital data is fluid, is an active and dynamic one, wherein every interaction with any piece of content, plus the paths, journeys and connections through the content space itself, will be stored as part of the growing pool of knowledge. How a piece of data is used is as fundamentally significant as the piece of data itself, and reveals dynamic, responsive and powerful shifting patterns of information that grow and evolve. (Hemment 2013, 10)

Parks vary dramatically in scale, shape, and design. They can be vast wooded expanses with walking trails or a small memorial park with a statue, some benches, and a bit of vegetation, just enough to open some breathing room between buildings. This intervention looked to an underappreciated but culturally rich space, somewhat lateral to our conventional understanding of a park: the cemetery. In particular, Halifax's Camp Hill Cemetery.

Inspired in part by the DeathLAB research at Columbia University, this intervention reimagines cemeteries as green spaces with a central archival pavilion where digital avatars of those who have passed away are stored (Rothstein 2016). First, a process of recording and transference will occur, to create an avatar imbued with an individual's knowledge and identity before they pass away. This process could be as outlandish and thorough as a machine that copies the structure of a brain into a binary format, or a more rudimentary artificial intelligence that "learns" a person through a mixture of analyzing their social media footprint and interview sessions. However it occurs, these avatars can be understood as interactive records of the factual information surrounding a person's life, appearing in their likeness. Similarly, the existing tombstones in the cemetery prior to this redevelopment are scanned as a digital overlay across the park. Preserving the memory of the cemetery as it was, visitors walk among these holograms as they navigate the paths of the park.

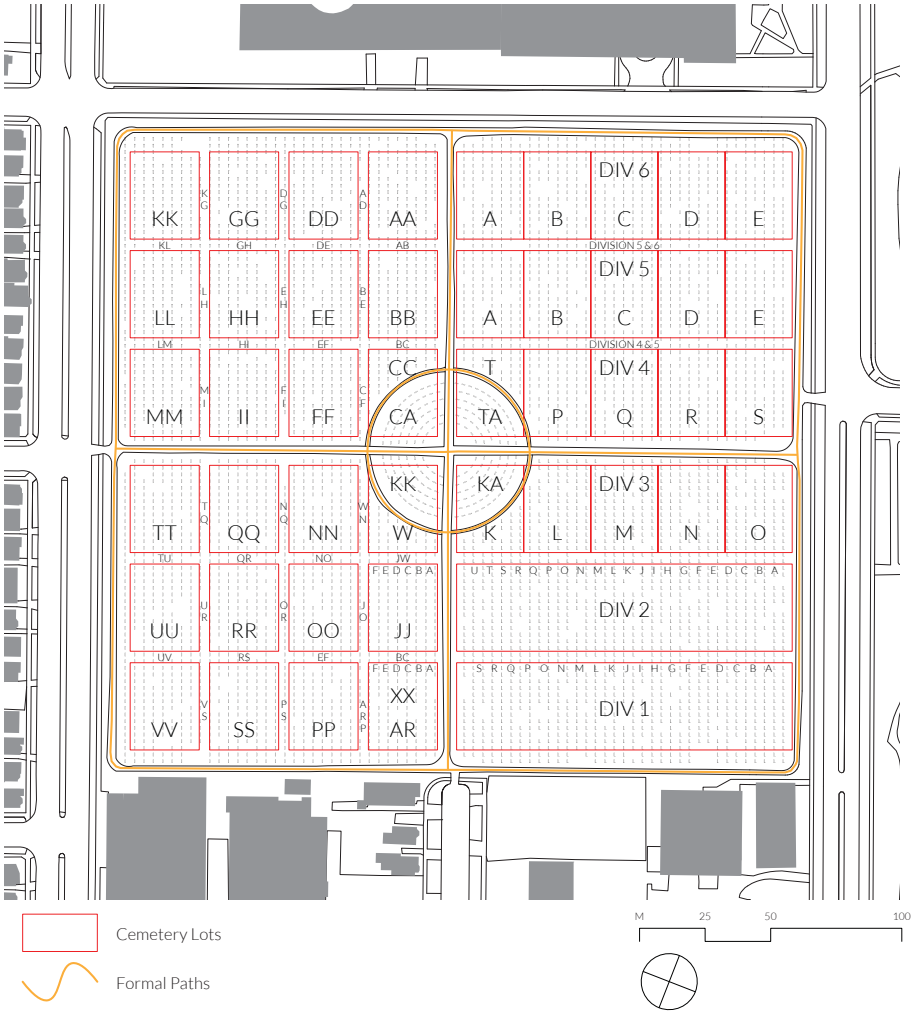


Design chart for the park intervention (Rothstein 2016).

To replace traditional burials, ancillary buildings on the south perimeter of the site will offer a process called resomation, or alkaline hydrolysis (Sullivan 2019). As an environmentally friendly alternative to cremation or traditional burial, the body is submerged in a high-alkaline water solution that quickly breaks the body down into a mixture of water and bone ash. If the family chooses, this mixture will be poured out ceremoniously into a reflecting pool at the center of the pavilion and diffused out through the park grounds. Rather than a specific resting place, as with a headstone or urn, the entire park and all of its vegetation becomes the resting place of the deceased, while their memory and legacy is stored in the database accessed through the rooms of the pavilion.

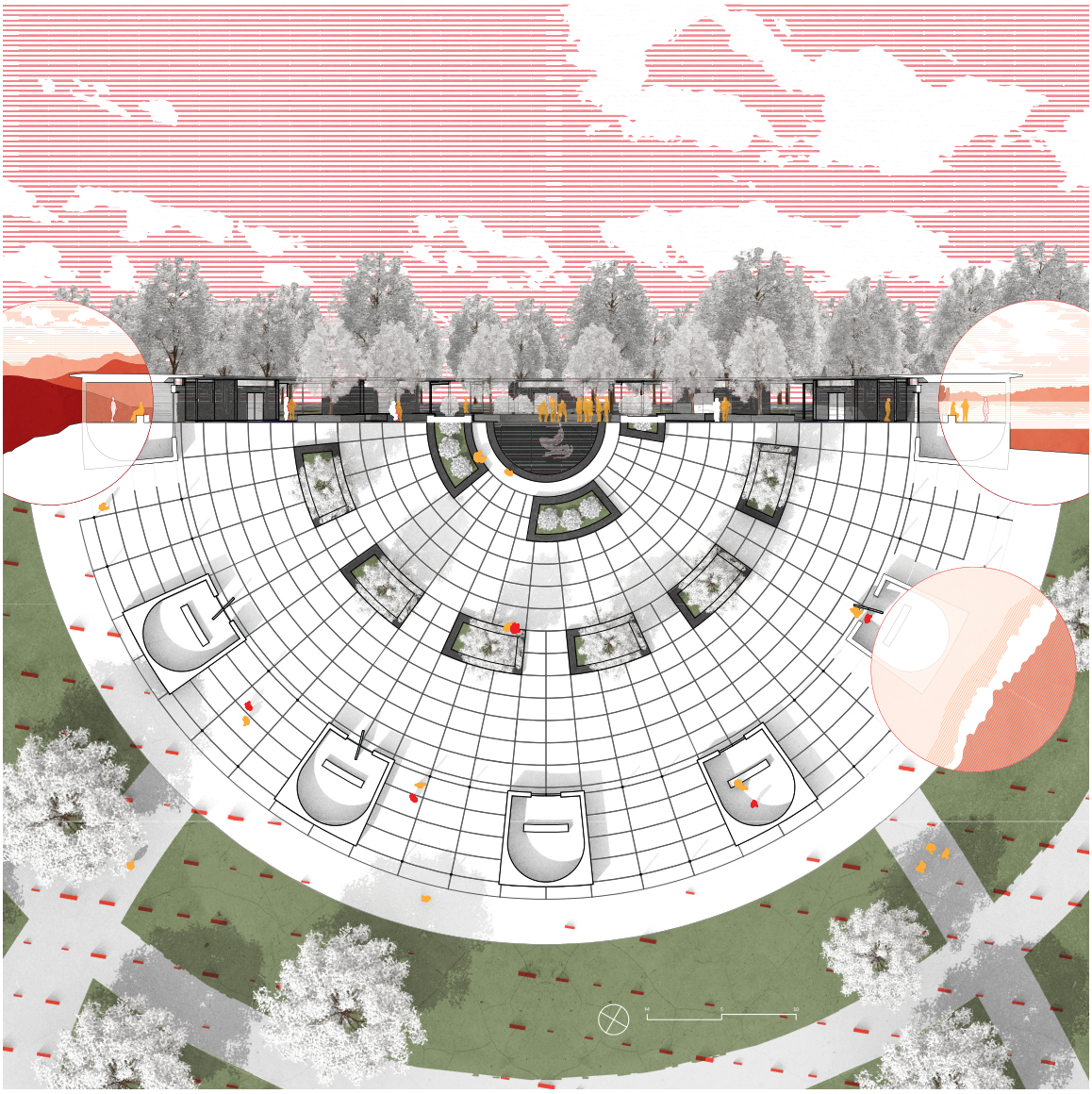
In practice, a visitor walks through the park to the central pavilion. Passing through the outer ring, they may then enter one of the inward-facing rooms. The curvilinear grammar of the pavilion parallels the cyclical nature of life. Once inside, the visitor interacts with a localized user interface to find and "check out" an avatar that they wish to speak to, like a book from a library database. From here, the visitor can choose to leave the room with the avatar and walk the grounds as they speak, or remain in the room for privacy.

The spartan interior consists of white walls that curve around in front of a central bench. When an avatar is called upon, the walls of the room fade away to reveal an immersive digital environment beyond representing a place that was important to the deceased. This could be the interior of a childhood home or a scenic view of a lakeside. To contrast, the exterior of the pavilion comprises of dark materials with a focus on tactility. Stone faces and heavy wooden doors highlight the sense of touch. As something far more difficult to emulate digitally than sight or sound, tactility becomes something to celebrate in the physical. The contrast between experiences inside and outside are suggested and directed by the physical grammar. On the digital side, this intervention draws heavily from the encyclopedic. This version of a cemetery shifts our relationship with death to one of cultural preservation and celebration, treating the accumulated knowledge of a person's life as the immense resource that it is.



Existing site plan for Camp Hill Cemetery.

Proposed site plan for Camp Hill Cemetery.



Central pavilion plan and section.

Vignette entering the park.

Vignette entering the central pavilion.

Vignette entering an archive room.

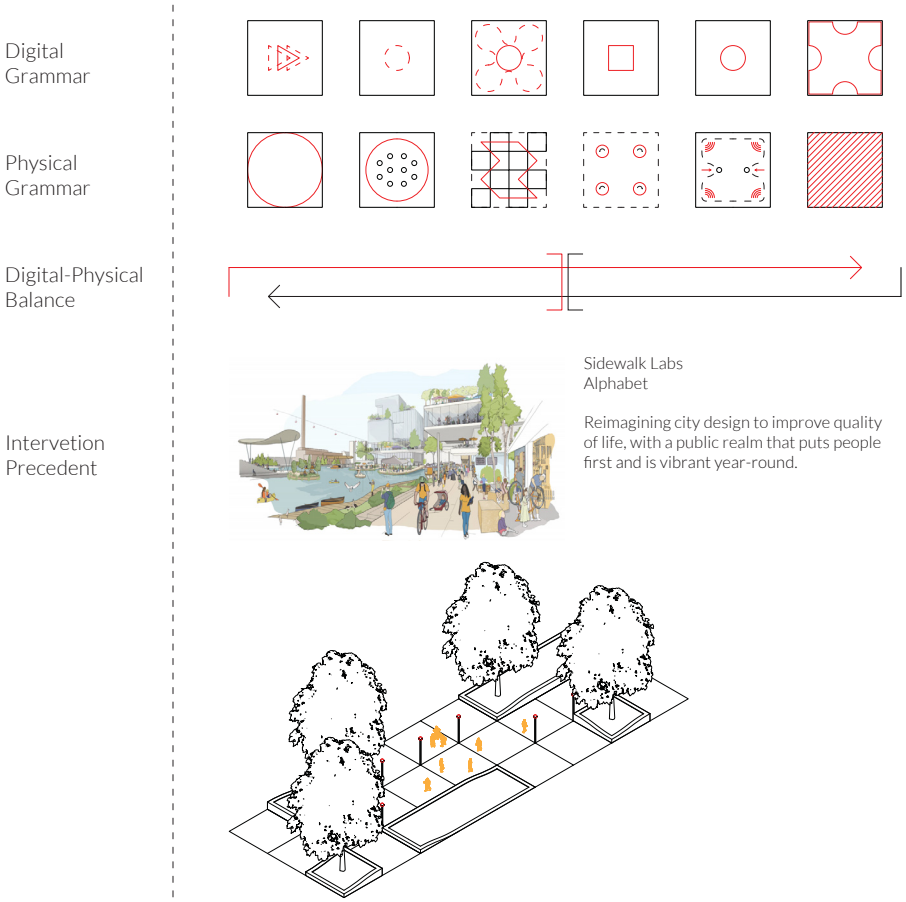
PEDESTRIAN STREET: CULTURAL CANVAS

> Faced with the choice of walking down a deserted or a lively street, most people would choose the street with life and activity. (Gehl 2010, 32)

The final intervention builds off of the modular event kit from the common and its ideas about reprogrammable space. In contrast to the suggestive specificity of the experiences in the park cemetery, the pedestrian street is about fostering a cultural hub at the center of the Commons. The existing North and Central Halifax Commons are bisected by Cogswell St, an underutilized thoroughfare (Upland 2018, 10). This intervention proposes to turn Cogswell into a pedestrian street, providing a hardscaped spine to reconnect and support both halves of the commons, without further diminishing the remaining green space.

Much of the existing common favours sports, notably baseball, with marginalized areas that feel inviting for other leisurely or cultural activities. By developing the street with the grid from the event kit, this space caters to a variety of new civic activities, while still maintaining the flexibility and programmability at the core of the commons. The center of the pedestrian street hosts a cluster of permanent infrastructure: the existing skating oval and building; two support buildings with storage for the event kit, public washrooms, and space for food services; and a community center to replace the existing Halifax Pavilion - a small all-ages club used primarily as a music venue.

This cluster of four buildings creates a pinwheel that frames four “rooms” of outdoor activity space. Two projections in line with the support buildings expand the hardscaped grid outward to accommodate larger events in the northeast and southwest “rooms,” while the other two host existing baseball fields. Throughout the site, this intervention employs rectilinearity, modularity, and blank space to allow for greater variability from the digital grammar. The principle is to foster freedom of expression through user-generated content.

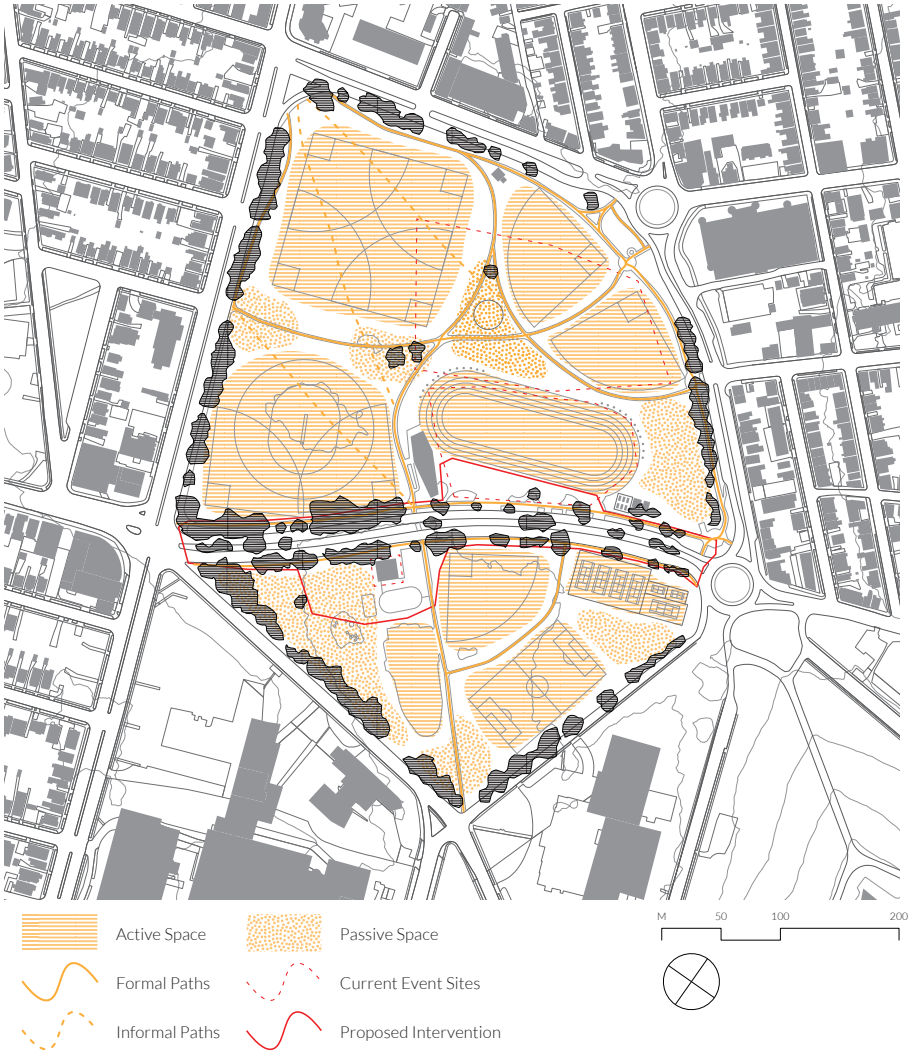


Design chart for the pedestrian street intervention (Alphabet 2019).

The community centre continues this theme of open, adaptive, and modular space at a building scale. The north/south walls of the building provide blank faces for digital murals, while the east/west faces comprise of repeating bays with slatted screen exteriors that fold up into awnings, and glass rolling door interiors. Together, these provide an adjustable porosity that allows program in the building to spill out and connect with the outdoor grid and event kit. In plan, an open ground floor employs a similar grid and kit to the street. Using partitions, the room can be divided and shaped as need be for different events.

One key feature of the modularity in this intervention is the potential for more direct interaction between the physical and the digital. Using space syntax, an area of research outlined in Appendix A, layouts and activity patterns can be analyzed and quantified in ways that could then inform how digital content populates a space. As an example, in the context of an exhibition in the community center, the placement of partitions can be analyzed for isovist data - the openness or visual complexity of a given location in space. In turn, the isovist data can be used to define the shape of a digital dropped ceiling floating above the gallery. Large, open spaces are accentuated by a higher ceiling, while smaller spaces are made more intimate with a lower ceiling. Harnessing data sets like this could provide numerous similar opportunities for responsive, real-time interaction between both halves of hybrid space.

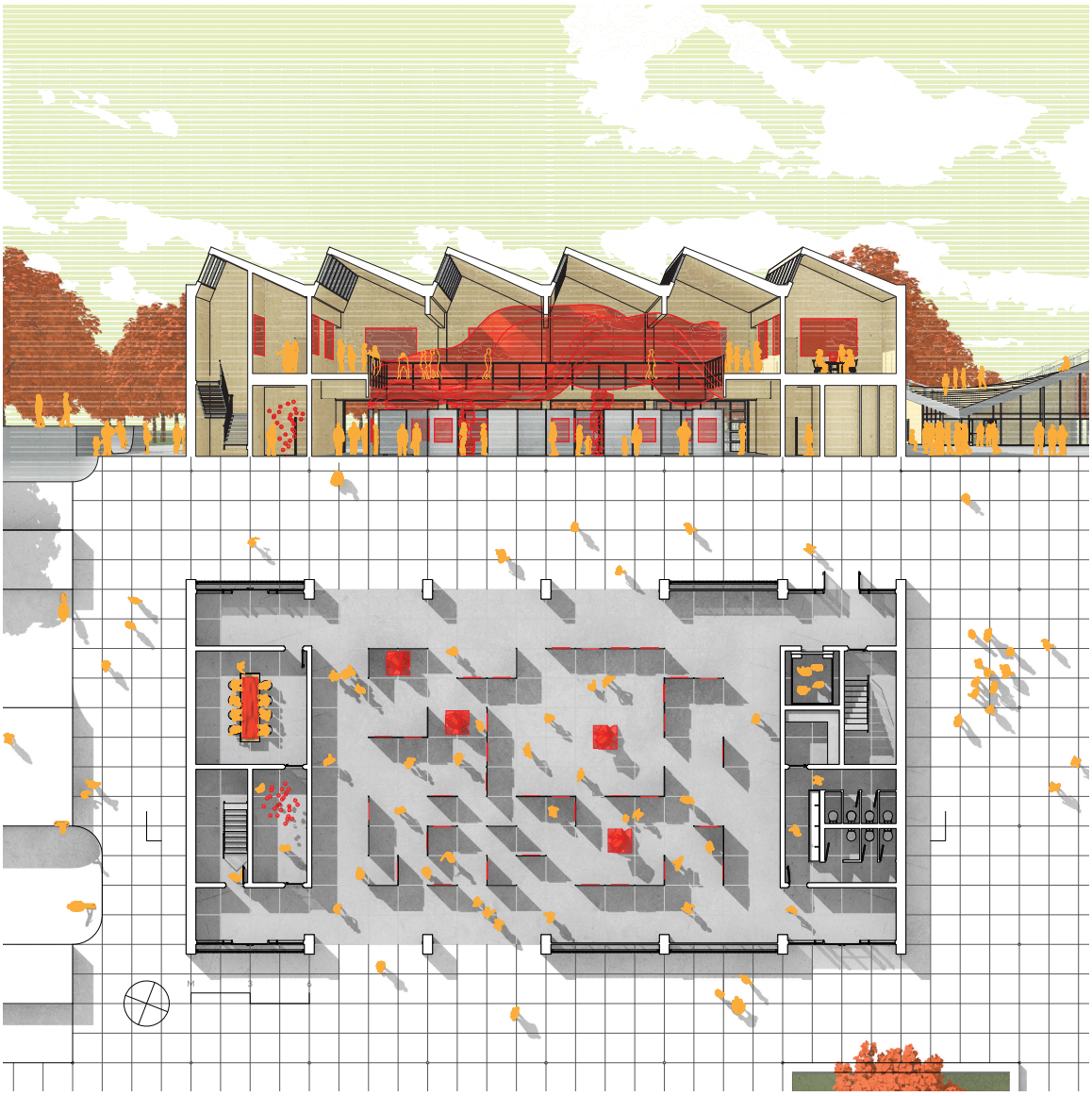
McLuhan states that “The hybrid or the meeting of two media is a moment of truth and revelation from which new form is born” (McLuhan 1964, 55). His argument rings truest in the pedestrian street intervention, where digital and physical come together to create a versatile stage for experimentation. Broadly, this is what each intervention attempts to do: speculate on the potential designs of our near-future when disparate media collide.



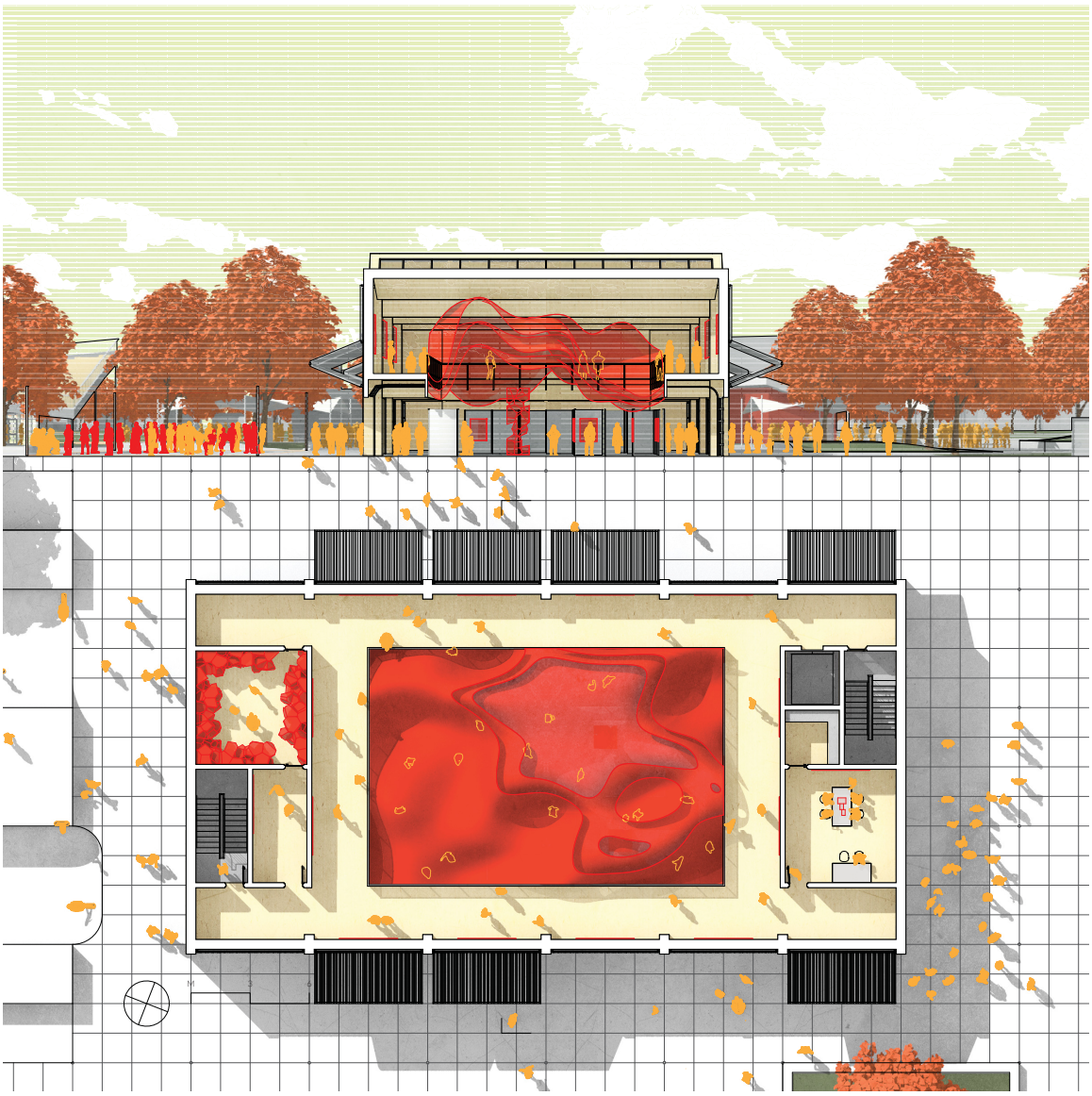
Existing site plan for the Halifax Commons.

Proposed site plan for the Halifax Commons.

Central Hub activated by a variety of events.

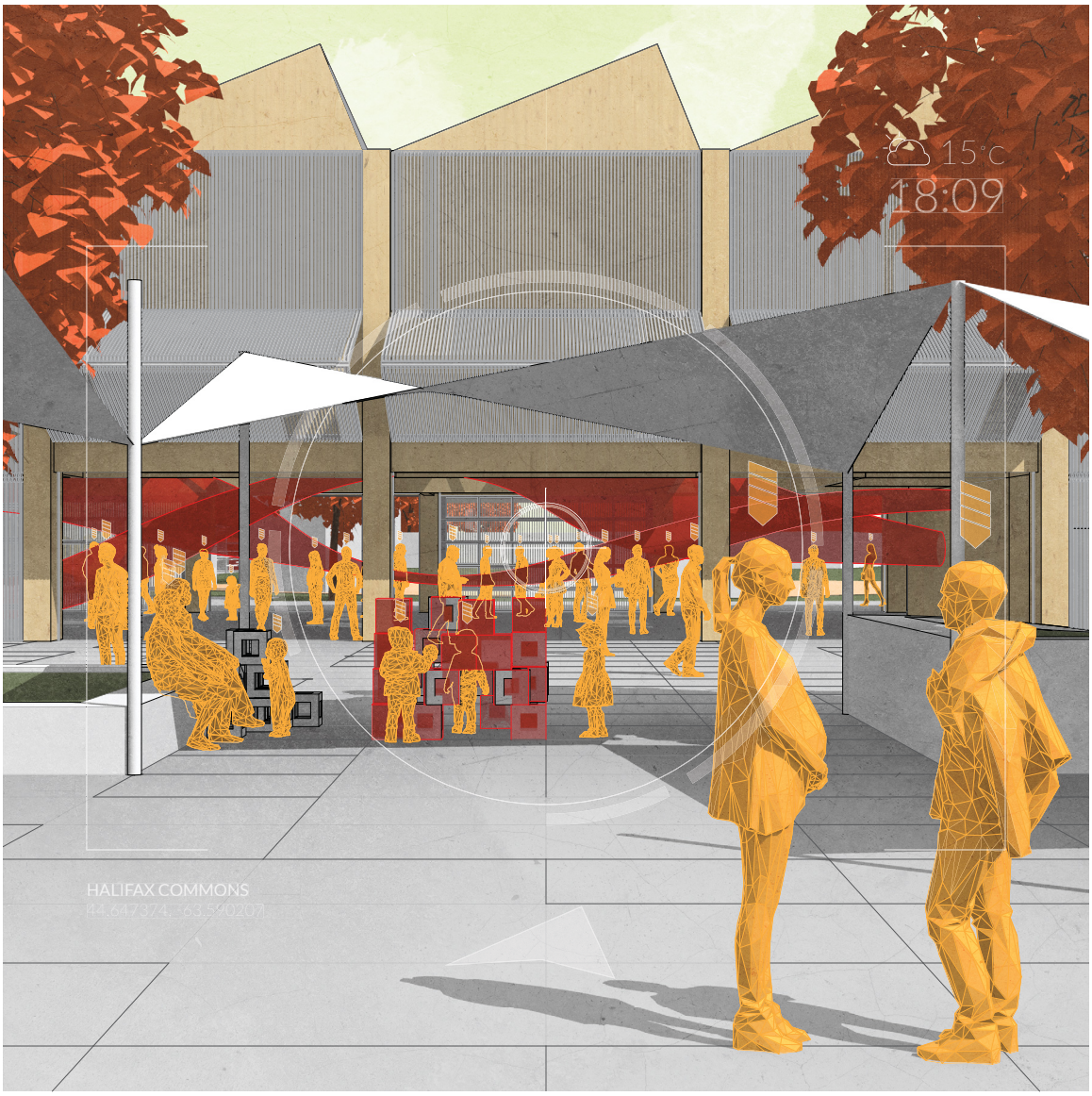


Community centre, ground floor and long section.



Community centre, second floor and cross section.

Vignette entering the pedestrian street.



Vignette approaching the community centre.

Vignette approaching one of the support buildings.

CHAPTER 8: CONCLUSION

> It's easier to see the direction of change than the pace of change. (Murray 2017)

In "Augmented Reality Law, Privacy, and Ethics," Wassom states: "Augmented reality is simply a medium; what society chooses to publish in that medium will be a reflection of the messages that society wishes to convey" (Wassom 2014, 180). However, if McLuhan's phrase "the medium is the message" is to be believed, it is equally important that we take an active role in shaping this new medium as we do the content (McLuhan 1964, 7). Defining parameters for both the platform and the content will prove essential in shaping a sustainable and democratic hybrid future.

Just as computers were once prohibitively expensive outside of industrial or institutional work, early mixed reality technology is too impractical for mass-adoption. However, if the history of technological innovation and proliferation indicates what is to come, MR is no longer a question of if, but when. To this end, the design of a physical and digital grammar intends to stimulate discussion through the design process. Sites of greater potential impact, like the public sphere, are especially valuable for testing the intersection of society and hybrid space. The grammar in this thesis presents one example of how we might govern hybrid space based in mixed reality, which is just one of many technologies with the potential to drastically change how we live.

Tim Berners-Lee's world wide web turned 30 this year (Berners-Lee 2019). In three short decades, his creation has fundamentally changed the way that we live our lives and structure our societies. Comparatively, architecture has changed very little. A house today looks and functions almost identically to a house built thirty or even sixty years ago. We live in a time of exponential growth. Technology, and in turn society, are evolving at an unprecedented pace. It is crucial that we begin to understand and prepare for the ramifications that these changes will bring. More than ever, we need to design architecture for tomorrow, instead of today.

APPENDIX A: SPATIAL SYNTAX

Through a directed study with Dr. Derek Reilly, I am collaborating with members of Dalhousie's Graphics and Experiential Media (GEM) Lab to explore the application of space syntax to the adaptive/responsive placement of digital content in augmented reality (AR) user interfaces. The purpose of this research is to answer two questions: how can immersive experiences beyond room scale be designed once, but be deployed in many different physical environments; and how can personal information spaces adapt to changing physical environments? The specific objective of this research is to prototype a system that applies theories of space syntax to adaptively map AR content to the space of the user, as experienced through a head-mounted display.

The University College London (UCL), foremost researcher in space syntax, describes the concept as such:

> Space syntax is a set of techniques for analyzing spatial layouts and human activity patterns in buildings and urban areas. It is also a set of theories linking space and society. Space syntax addresses where people are, how they move, how they adapt, how they develop and how they talk about it. ("Space Syntax" 2019)

Space syntax can be further broken down into four components, in sequence:

Representations of space: expressed as either the geometry (ie. point, axial line, segment, convex space and isovist) or the function (ie. room, hall, closet).

Analysis of spatial relations: configuration-based relationships between a collection of spaces (ie. the centrality/connectedness of a space in relation to all others).

Interpretive models: models developed to explain/simulate different spatial and socio-economic phenomena (ie. favoured circulation paths informing land usage and further enforcing their favouring).

Theories: relationships between spatial and social patterns, applied to find broader commonalities or tested against space syntax tools to see how the patterns change (ie. cross-cultural universalities of spatial layout/usage). (“Space Syntax” 2019)

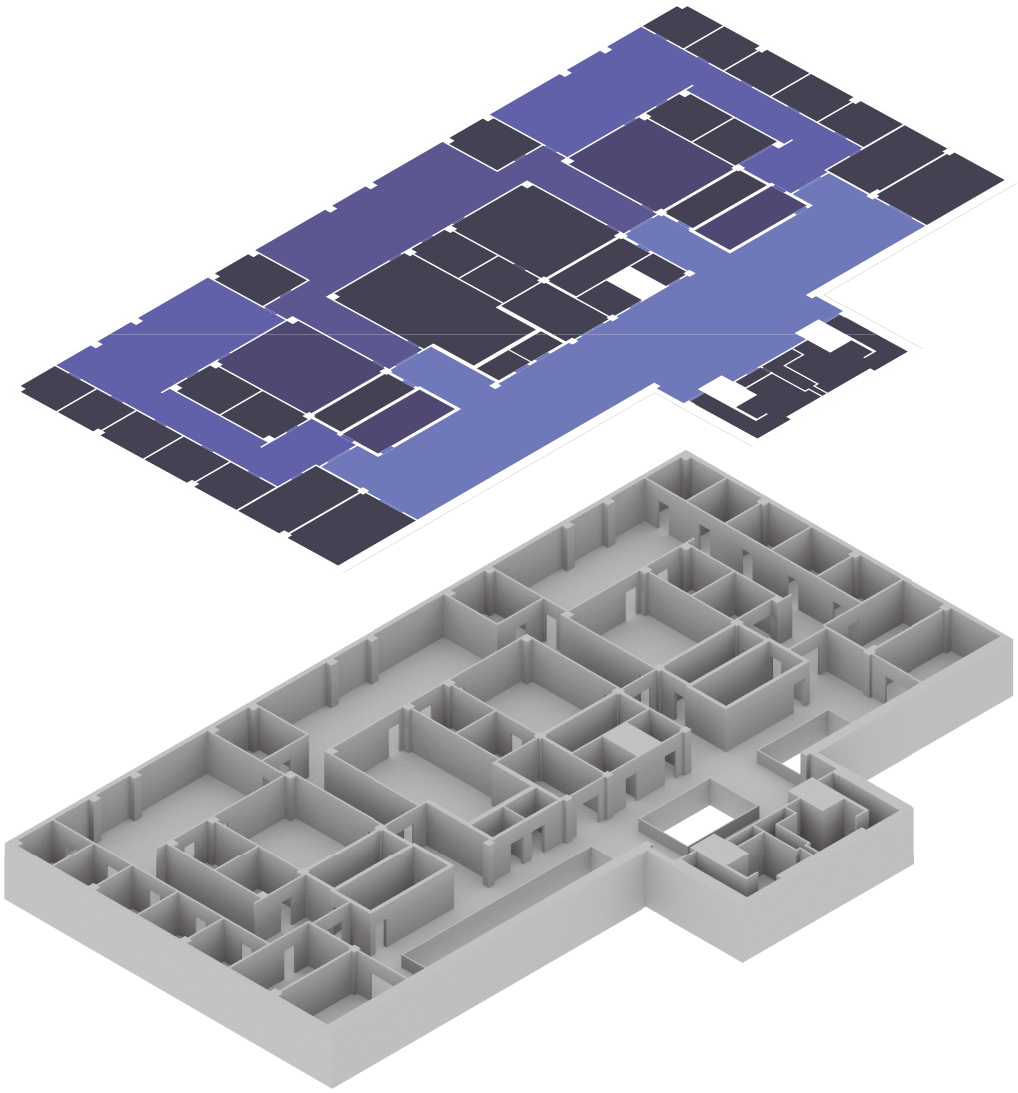
To contextualize this sequence with an example, the placement of a water cooler in an office could require an open and visible space (representation of space) with the highest centrality/ease of access (analysis of spatial relations). However, if the space matching these criteria is close to workspaces, water cooler talk may become a regular distraction for nearby employees (interpretive model), as such the parameters of the water cooler placement can be adjusted to consider workspace proximity alongside centrality (theory).

PROCESS

To begin research and experimentation, we selected the fourth floor of the Mona Campbell building as a test site. The first step was to build a 3D model of the floor layout in which to apply certain space syntax analyses. Working from original CAD drawings for the building for accuracy, I developed a simple model of the floor and walls (see opposite). For this first iteration, windows were treated as part of the opaque plane of the wall and furniture was omitted to direct the focus on fixed elements.

Connectivity Graph:

For our first layer of analysis, we broke down the Mona Campbell floor plan into a circulation diagram. Each room was represented as a line off of which each adjacent room connected. Using Qgis, we produced a connectivity graph that ascribed each line (room) a value based on the topological distance calculated from the line outward to every other line. (“Space Syntax” 2019) This value is derived from the the depth of nodes in a justified graph from the perspective of each room. One possible use-case for this data would be in the creation of a randomly generated scavenger hunt. The ‘trophies’ could be specified to only generate in rooms with low connectivity values, making them harder to find.

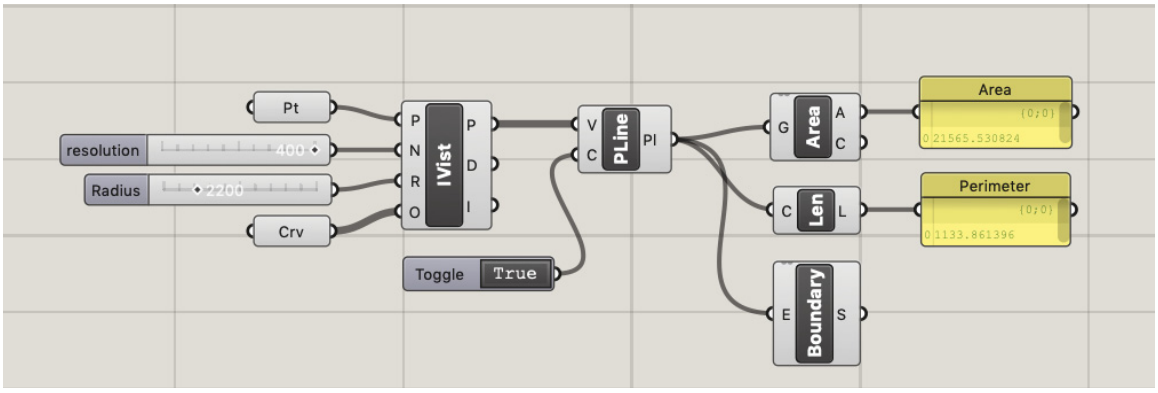


3D model of the connectivity between rooms on the fourth floor of Mona Campbell Building.

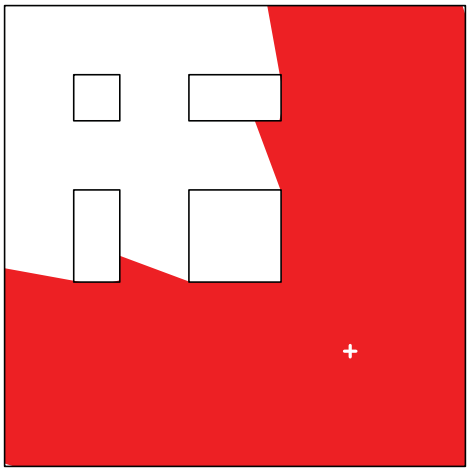
Isovist Analysis:

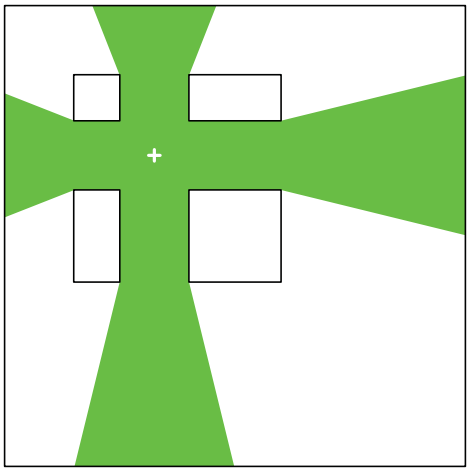
For our second layer of analysis, we performed an isovist mapping of the Mona Campbell floor plan. An isovist is a collection of all points visible from a given coordinate in space. (Nagy 2017) If the connectivity graph was based in a functional understanding of rooms as units, isovist analysis concerns itself purely with the geometry of space. Using Grasshopper, an isovist shape is calculated by inputting a vantage point and a collection of obstacles (the opaque surfaces in a space). From the vantage point, a number of radial lines are projected outward until they intercept an obstacle. An outline is then created by connecting each of these points of interception.

The ensuing shape can then be evaluated by two different criteria: the openness of the vantage point, and the visual complexity of the vantage point. The openness of a given point comes from the area of the isovist, while the visual complexity comes from its perimeter. The two diagrams opposite illustrate this concept in a simple floorplan. The red isovist form shows a point of high openness in the space. Comparatively, the green isovist form shows a point placed in a much tighter space but with high visual complexity. In the same scenario of the scavenger hunt, once a trophy's room had been assigned by the values of the connectivity graph, its location within the room could be determined by a point with low isovist values in openness and visual complexity.



Grasshopper script for the analysis of the isovist of a single point.





Top: diagram of an isovist with high openness. Bottom: diagram of an isovist with high visual complexity.

Here, we have a set of diagrams demonstrating this analysis applied to Mona Campbell. In the top diagram, we see the openness of the floor plan described in a gradient from red to black; in the middle diagram, we see the visual complexity of the floor plan described in a gradient from green to black; and in the bottom diagram, we have a composite of the openness and visual complexity overlaid on one another. These diagrams are achived by creating a grid of points across the floorplan, between the obstacles (walls). The isovist is calculated for each of these points, and the resulting values for are and perimeter are scaled to a range of 0 to 1. This range translates to the colour gradients displayed in the diagrams, but could just as easily be used to in their numerical form when designating parameters for the placement of digital assets.

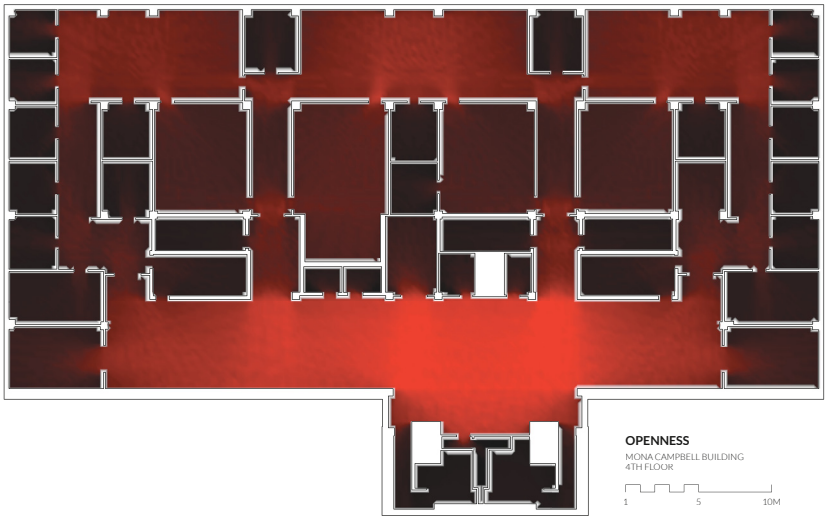
While the openness and visual complexity diagrams can be read with little additional explanation, the composite diagram can be understood following these metrics:

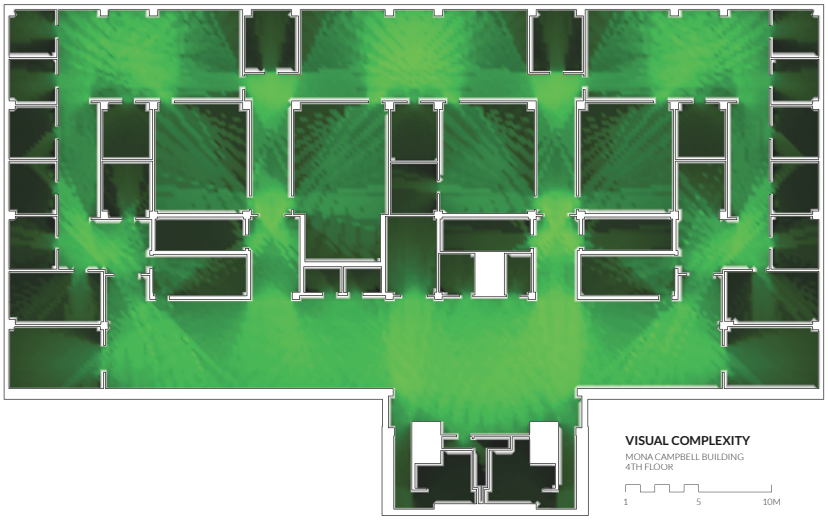
Yellow areas (high Red and Green channels): both very open and visually complex, for example the large open area to the left of the obstacle.

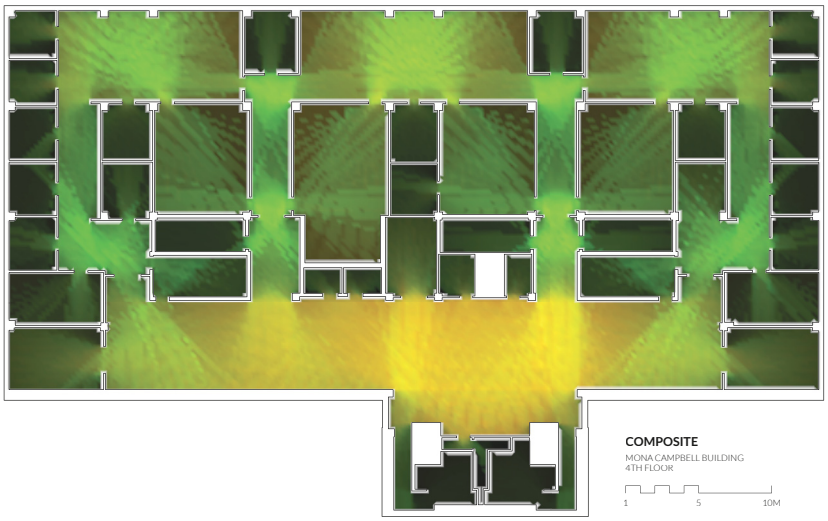
Orange-ish areas (higher Red than Green): open but have lower visual complexity, for example the area at the upper left of the plan.

Darker yellow/mustard (higher Green than Red): less open but have high visual complexity, for example the area in the lower left of the plan.

Black areas (low Red and Green channels): both very closed and visually not complex, for example the areas directly next to the flat faces of the obstacle.







Top: openness floor plan diagram. Middle: visual complexity floor plan diagram. Bottom: composite floor plan diagram.

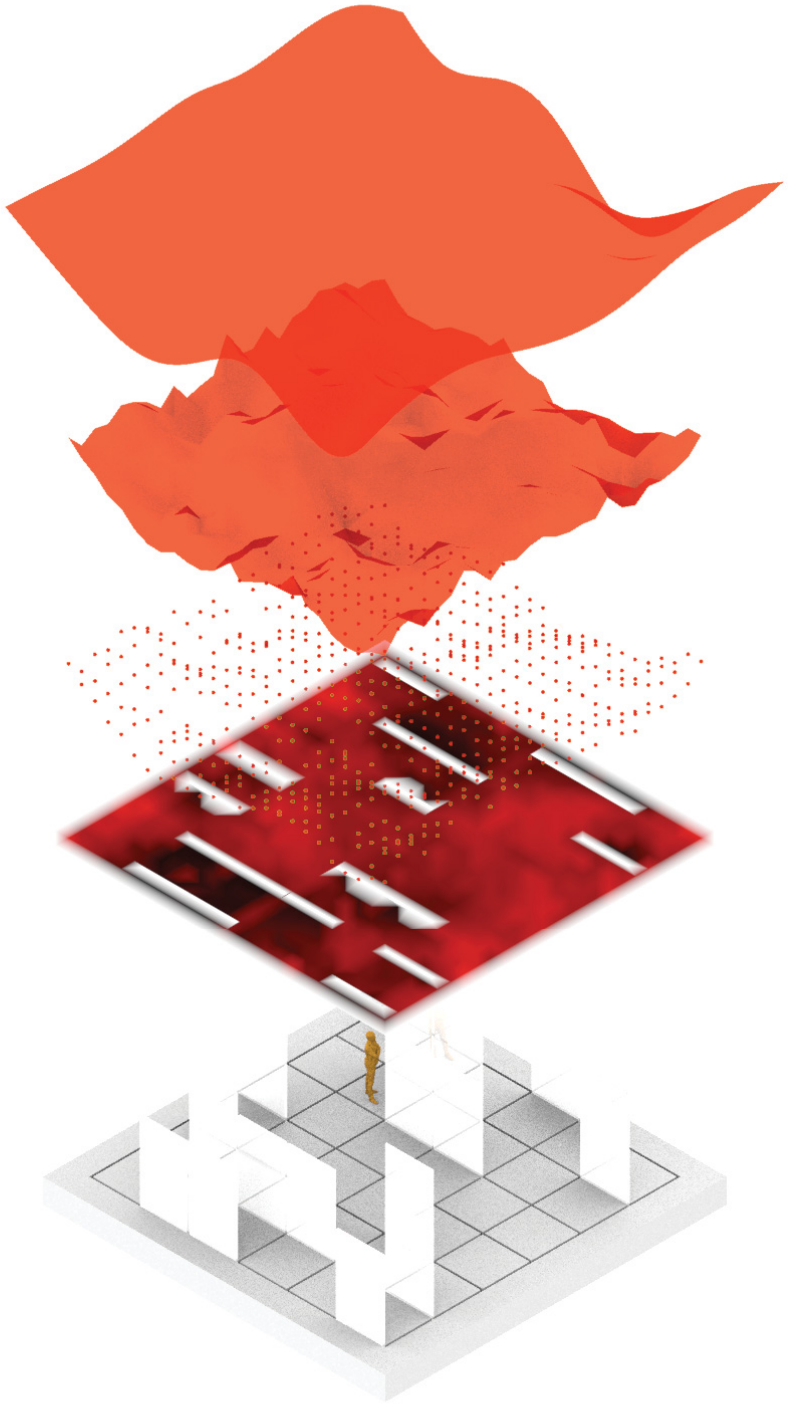
CONCEPT MODEL

As a means of applying isovist data to a real-world example of hybrid space, I developed a concept model based off of the community centre in the pedestrian street intervention. The model acts as a proof of concept for responsive interaction between a mutable physical space and accompanying digital content.

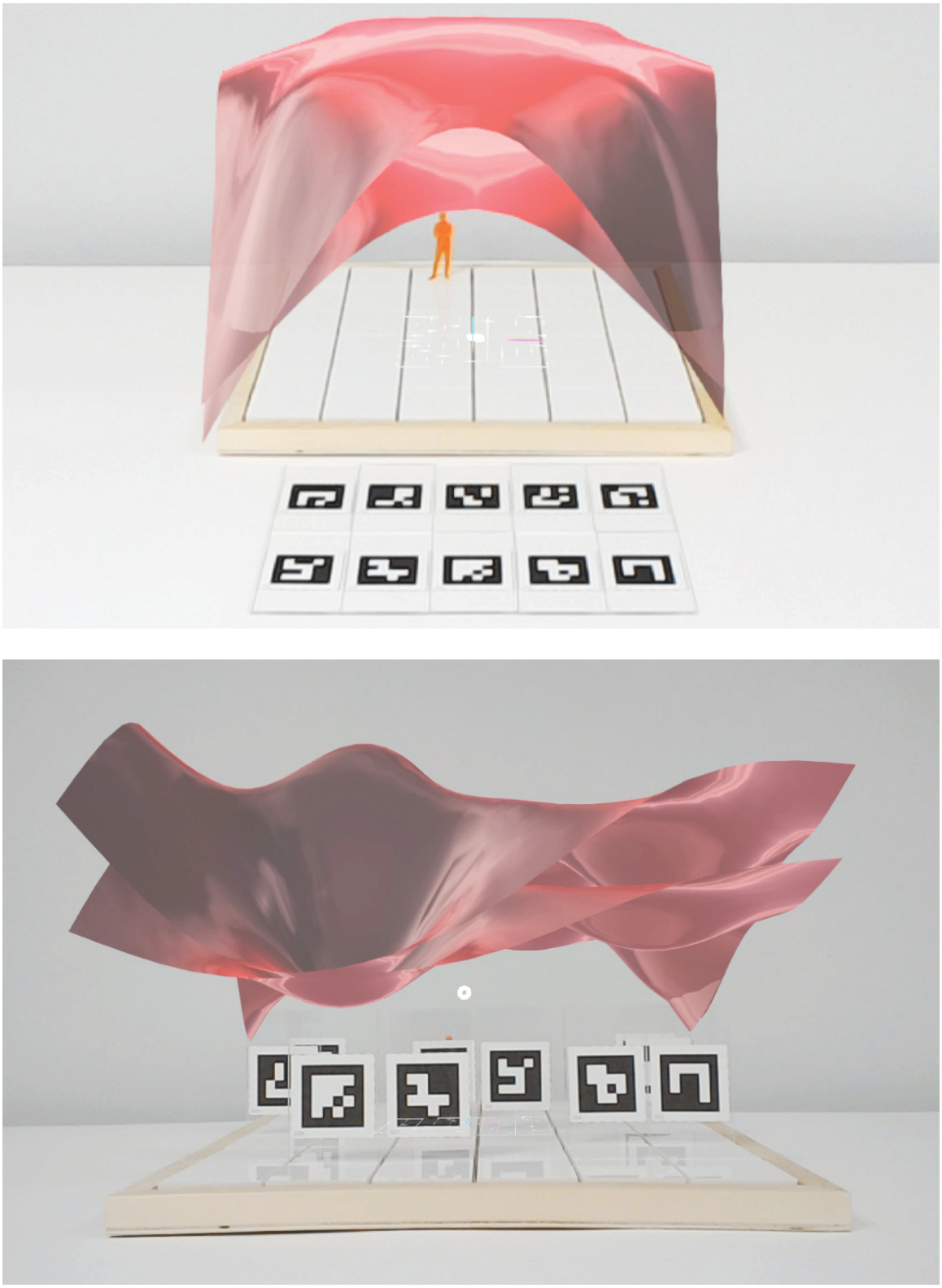
The physical model consists of a gridded base, representing a room, with tracks into which partitions can be placed to create various configurations. As partitions are added or reconfigured, the isovist data for the "room" changes. In the following diagram, we see the isovist data represented with a colour gradient, as shown previously. The array of isovist points across the base are moved in their vertical axis by a factor of their respective isovist values. This topographical point cloud, representing the openness of the space in 3D, is then used to shape an undulating surface. This surface provides a responsive digital ceiling above the "room." According to the configuration of the partitions, open spaces produce grand, vaulting sections of the ceiling, while smaller spaces produce lower, more intimate sections.

The model functions through the use of the Microsoft Hololens AR headset in conjunction with aruco markers placed on the model partitions. These markers are recognized by the cameras on the Hololens and recreated in a digital version of the model, using Grasshopper and Rhino. The digital model recalculates isovist data for every adjustment of the floor plan, based on the placement of the partitions. The resulting surface is then shared back to the hololens to appear above the physical base.

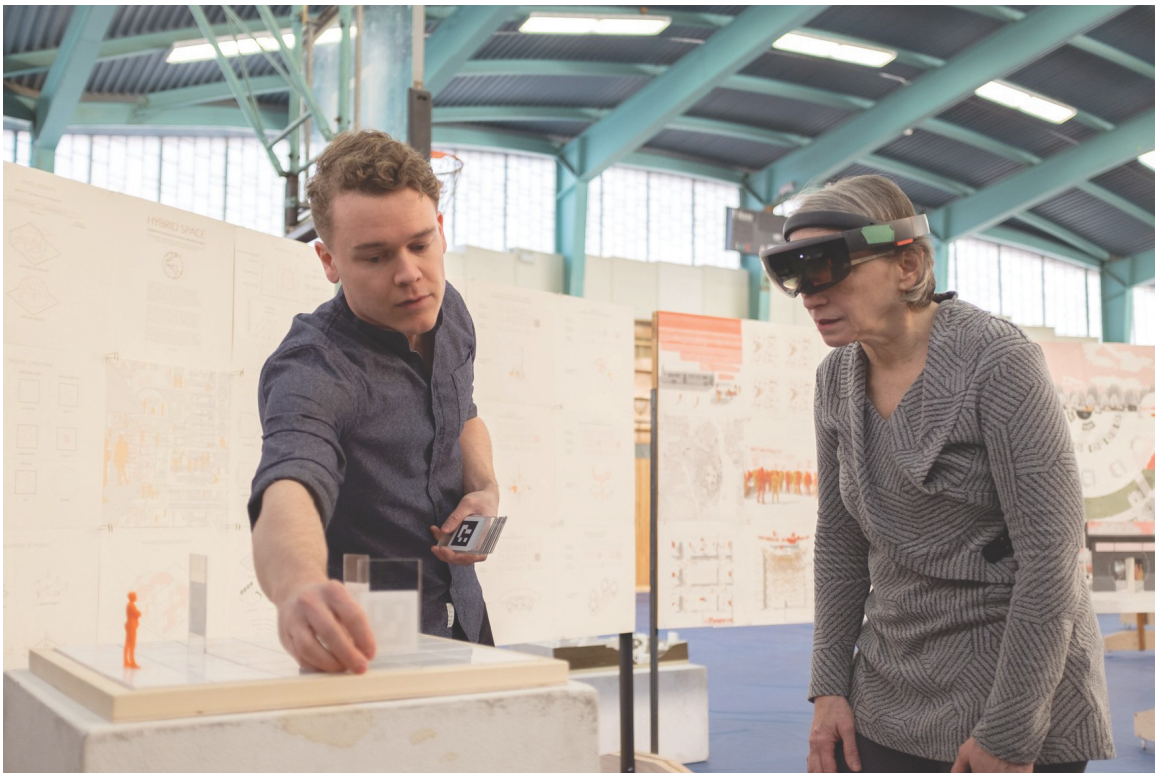
In considering these hybrid alterations to our physical environment, it will be important to understand how a user engages with the integrated digital content. Choosing to implement a digital ceiling, in the example of this concept model, impacts our sight, but not our touch. By focussing on content beyond a user's reach, but within their field of sight, the illusion of hybrid integration can be better maintained. The following pages document the concept model in use.



Exploded axonometric diagram outlining the steps to generate a digital dropped ceiling from the placement of physical partitions.



Top: concept model before partition placement. Bottom: concept model after partition placement.



Live concept model demonstration during thesis defence, using the Microsoft Hololens (credit: Brad Farrish).

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