Open Enough: Exploring the potential for the Internet of Things in citizen-led urban design

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2018

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Auckland University of Technology

An exegesis submitted to Auckland University of Technology in partial fulfilment of the requirements for the degree of Master of Creative Technologies (MCT).

Abstract

The Internet of Things (IoT) enables a new relationship between the digital and the physical, and creates new socio-technical possibilities. The impact of the IoT is expected to be significant in urban spaces. An issue with this is that the IoT automates many processes, reducing citizen's power to see how the tool functions, or adapt how they use it. This exegesis proposes that design methods can challenge these power dynamics by involving citizens in the design process through a participatory approach, creating opportunities for citizens to become the designers through open design methods.

This practice-led research aims to explore the potential of the IoT for citizen-led urban design through a practice-led active research process that draws on critical making and critical design. The practice looking at the DIY urbanism and the maker movement as modes of citizen-led open design and aims to create examples of open IoT projects for urban creativity.

Through interviews with people involved DIY urbanism in Auckland, New Zealand, the research finds opportunities in showing how the IoT can enhance connection, playfulness and empowerment. Two prototype projects – 'Mobile Street Furniture' and 'The Zeitgeist Machine' – are attempted and reveal the compromises, restrictions and complications of this stage of the IoT's development. A co-design session with creative urbanists using some basic IoT systems let the participants evaluate the creative potential for their own work. Seeing the potential value of the tool was a bigger influence on likeliness to use than difficulty, however, the difficulty did have an impact on their confidence in using the tool.

The research concludes that the uptake of the IoT for citizen-led urban design is dependent on whether the IoT is open enough for users to see how it works and imagine how to deploy it for their own purposes. 'Open enough' is a balance between an accessible level of development to manage the complexities, while keeping the flexibility to change and adapt it for imaginative purposes.

Table of Contents

Abstract i
Table of Contents ii
List of figures iii
List of tables iii
Attestation of Authorship iv
Ethics approval iv
Acknowledgements v
Introduction 1
Literature review 3
Methodology 10
Practice-led research plan 11
Interviews with Creative Urbanists 12
Projects – research through practice 14
Co-design workshop 22
Conclusions 28
References 30
Appendices 32

List of figures

Figure 1: Research methodology diagram.

Figure 2: Mobile Street Furniture prototype.

Figure 3: 3D printing of buttons of Zeitgeist machine

Figure 4: Physical construction of Zeitgeist machine.

Figure 5: Hardware setup of Zeitgeist machine.

Figure 6: The Zeitgeist machine prototype onsite at a public park.

Figure 7: Graph comparing qualitative criteria with likeliness to use the IoT systems.

Figure 8: Graph showing comparing the relative difficulty with confidence in using the IoT system.

List of tables

Table 1: Codesign: IoT relative complexity table.

Table 2: Codesign: Ideas generated from each round of brainstorming.

Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Signed  Date 14/06/2018

Ethics approval

This research received approval from the AUT University Ethics Committee (AUTEC) on 13 June 2017 for a period of three years until 12 June 2020.

An amendment was approved on 16 March 2018

Ethics Approval Number 17/156

All research was conducted in keeping with the regulations and guidelines of the approval.

Acknowledgements

I would like to thank the following people for providing guidance, technical expertise or participating in this project.

I'm grateful for the support offered by Colab at Auckland University of Technology, in particular my supervisors, James Charlton for his generous support, his persistent patience, and for helping me recognise the insights in the 'unexpected results', and Ricardo Sosa, for his enthusiasm for the project and encouragement to create something meaningful.

I would like to acknowledge the interview and co-design participants who gave their time, shared their experiences and imagination: Sean Taylor, Jaco van der Merwe, Margaret Lewis, Gareth Farry, Bhavesh Bhuthadia, Toby Falconer, Andrew Dixon, Alex Garkavenko and others. And special thanks to the community at the Te Atatu Peninsula makerspace, for advice and encouragement, and teaching me how to troubleshoot.

And of course, my family, partner, and friends, for their practical support, patience, and power tools.

I'd also like to thank Spark for their financial support granted through the Colab scholarship.

Introduction

This research looks at the creative potential of the Internet of Things (IoT) and whether it can be a tool for citizen-led urban design. The IoT creates new relationships between the digital and physical world, which is of particularly relevance to public urban spaces. However, current development of urban IoT uses a top-down approach and doesn't reflect the needs of citizens. This practice-led research uses critical design and critical making to explore the opportunities for developing the IoT in urban spaces through an open design approach. DIY urbanism and the maker movement are used as models of practice that embrace an open approach to technology and citizen-led design.

The IoT is a term used to describe a range of technologies that use advances in computation and networking to integrate the physical and digital world. The definition has changed over time as further development has changed what is possible (Atzori, Iera, & Morabito, 2017). Research into the IoT has mostly been interested in the technical development rather than the socio-technical impacts. Emerging technology, such as the IoT, is commonly seen as neutral and its effects as predestined, but culture and economics also play a part in shaping technology (Green, 2001). Consumers have some power, by choosing whether, and how, to use a new technology. However, consumers do not get a choice in what is made. In the case of the IoT, this can also cause problems because many IoT tools do not allow for consumers to see how the tool functions, or adapt how they use it.

Critical design and critical making can be used to respond to the mainstream development process by generating, creating and presenting alternatives, and reflecting on that practice (Dunne & Raby, 2013; Ratto, 2011; Sullivan, 2010). Design can also challenge the power dynamics by involving the user in the design process through participatory design and open design methods that create space and support for users to become the designers (Binder, Brandt, Ehn, & Halse, 2015; Fuad-Luke, 2009). There are examples of open design practices that are relevant to developing the IoT for urban spaces: The maker movement focused on open design of technology (Richardson, Elliott, & Haylock, 2013), and the DIY urbanism movement focused on the open design of urban spaces (Douglas, 2014).

The research aims to find out how the IoT could be useful for citizens who want to take part in the design of their urban environment with an aim of making both urban design and the

Internet of Things more open. This research uses a practice-led active research approach using critical design and critical making to explore the topic. The research begins with interviewing practitioners in the field of DIY urbanism to gain an understanding of the context of this practice in Auckland, New Zealand. Practitioners were interviewed about their projects and ways of working so that identify opportunities for the technology to support citizen-led urban creativity could be identified. From there the findings were combined with the affordances of the IoT to generate projects that explore how the IoT could add to citizen-led practice. The making process sheds light on the topic and the research evolves iteratively, encompassing two different prototypes and finally a co-design session with practitioners to explore designing for urban challenges with the IoT. The project aims to develop open design examples to show the opportunities and to challenge the deterministic view of the IoT. It is important that the designs generated are replicable and adaptable for others. In the end the question evolves to focus on how emerging technologies might start to be designed and adapted by users.

This exegesis starts with a literature review of the definition of the IoT and an exploration of different socio-technical perspectives on the relationship between emerging technologies and citizens. The literature review also covers how design approaches can alter this relationship. The design background contributes towards the research methodology and research plan. In the practice section of the exegesis the activities are presented in sequential order with interviews followed by two research prototype projects and the co-design workshop. Finally, the conclusion reflects on the findings in relation to the research question.

Literature review

The Internet of Things

The term 'Internet of Things' has evolved over time. It was first used in the context of Radio Frequency Identification (RFID) chips and described the possibility of tagging all physical items so that they can have both a physical representation and a virtual one (Ashton, 2009). Since then, usage of the term in practice has expanded to describe an increasing variety of hardware and software system that enable a data transfer between objects. It may describe one or many objects connected to each other and/or the Internet through Wi-Fi, Bluetooth, Near Field Communication (NFC), Satellite, Long Range Wide Area Network (LoRaWAN) or RFID. IoT objects may sense the physical world, may perform a physical function, or both. They can process the data they sense, and feed it back into the system, or it can be fed into another system in a different location.

There have been various attempts to define the IoT more precisely. The Institute of Electrical and Electronics Engineers (IEEE) definition states that the IoT must include sensing, actuating, computing and communication (Xing & Baiocchi, 2016). However, Atzori et al say that this is too limited, and that a grouping of technologies cannot be considered to be IoT unless it comprises a large open system of diverse, autonomous objects interacting with people and each other and sharing global data. Borgia, on the other hand, says the IoT is simply the combination of a set of existing technologies rather than a definable technology all of its own (2017). Others define the IoT by what it enables: Bordel et al's defines the IoT as objects that cooperate to reach a goal (2017), and Ng and Wakenshaw view the IoT as an enabling of a new physical-digital materiality (2017).

Considering the variety of definitions, it can be seen that Internet of Things describes a new socio-technical relationship with objects, rather than a specific technology. The term 'Internet of Things' is therefore flexible enough to incorporate new and future technologies (protocols, hardware and processing systems) and constantly be redefined as the relationship and possibilities develop. For the purpose of this research, the IoT will be taken to refer to:

The possibilities that are enabled by integrating physical objects and spaces into the digital world, and by inserting the capabilities of the digital world into physical objects and spaces.

Research into the IoT has primarily concentrated on the technical challenges of connecting devices, scaling the ability to manage the device and data, and the various applications being developed by technology companies in the race to become a dominant player in this field. However, the social impacts and possibilities of the Internet of Things have received less attention (Nolin & Olson, 2016).

Socio-technical change

Different socio-technical theories adopt differing viewpoints about how technology and society affect each other. There is a common perception that technology shapes and moulds the future, and that people and society have no real power over this (Miller, 1997). This view assumes that not only is technology functional, unbiased, and predestined, but also that we can rely on advances in technology to solve social issues (Green, 2001). This view is most prevalent among developers and promotors of technology and is reflected in the development and investment in the IoT being driven by predictions about its future ubiquity (Haigh, 2014). It is also reflected in expectations that the IoT will solve social issues such as pollution, waste, overcrowding, and traffic problems (Borgia, 2014). This view of the relationship between society and technology has been labelled as technological determinism by critics, who see the relationship as more nuanced.

Such critics of socio-technical change argue that society and technology each affect each other in a reciprocal way (Green, 2001; MacKenzie & Wajcman, 1985; Pinch & Bijker, 1984). In this view, society choses which technologies to adopt, and impacts on the economic decision of which new ones to fund and develop. In “Grundrisse: Foundations of the critique of political economy”, Marx points out this balance in saying that while consumption comes after production, there would be no motivation to produce without the expectation that it will be consumed (1973). The development of a new technology is preceded by a belief that it will create value for the user, in this way the consumer has some influence on what is developed.

A problem with the deterministic view of technology, is that it hides the power relationships behind the creation, management and ownership of the technology. Nolin and Olson see the current direction of development of the IoT as problematic in that developers unwittingly becoming social engineers through control of the rules within the software (2016). With the

automation of processes through the IoT there is a loss of active decision making by consumers. Claeys and Criel say through the automation of actions in the IoT, it is a problem if the rules for those automations are hidden within the computer programme (2009). The consumer therefore needs to see, control and define the behaviours of the system.

The consumer of a product has some power through choosing whether and how they use any new technology. However, the producer still has the more powerful position in being able to decide what to develop. Technology is one of the forces that shape social behaviour, along with laws, social norms, market influences (Lessig, 1998). With the increasing legal, economic and social influence of large technology companies, this influence multiplies to reduce the choices available to consumers. For example, with the software licencing of IoT devices, consumers are losing control over how they can use and adapt the products they have purchased (Schultz, 2016). As technology has the power to form paths that guide behaviour and society, Axup says there is a collective responsibility for producers, government and users to decide what is desired and socially acceptable (2009).

As well as the problematic aspects of the IoT, theorists also see opportunities to challenge the power relationship between developers and consumers. Axup suggests that new technologies can change the power structures in society if they are open enough for people to use in their own way (Axup, 2009). Sundmaeker expects artists and designers to contribute to this by exploring how the 'architecture' of the IoT can make meaning and create experiences for individuals and the wider society (2010). Claeys and Criel also see participation at the technology architecture level as important for IoT tools to adapt and evolve with the users' needs (2009). They suggest that the socio-technical gap, between what the producer creates and what the consumer wants, is an opportunity for user participation.

One way of challenging the deterministic view of IoT development is to use design to propose alternatives. These next sections look at alternative design approaches as both a critical background to technology design and a methodology background for the practice-led approach for the research. The design approach can affect the power relationships between producers and consumers of technology as well as the urban environment.

Critical design

The design process can be used to explore alternative possibilities for the Internet of Things. As Sullivan notes, design is a process of exploring and expressing alternatives (2010). The design process is therefore a way of exploring the particular situation and seeing many possible outcomes, rather than just one. For Ratto (2011), critical making is a way of exploring socio-technical theories through the practice of making and reflecting. Critical making is also how Somerson and Hermano describe the process of developing ideas and creating new knowledge through the process of thinking, making and reflecting (2013). Dunnigan notes "In critical making, the very process itself opens up new possibilities for deep expansive thinking and the serious inquiry that stimulates discovery." (2013, p. 98). Therefore, through making and reflecting, the research process can discover the opportunities and limitations of the Internet of Things.

As well as generating alternatives, design can also be directed at specifically challenging main-stream perspectives. Critical design is a tool for examining and provoking discussion about an issue (Dunne & Raby, 2013). It is a form of design activism that is about challenging mainstream or accepted realities by imagining and presenting an alternative reality. Instead of creating functional or aesthetic designs, critical design creates artefacts for conceptual and critical purposes. In exploring the relationship between the social and technical, Burdick suggests using both critical design and critical making to generate new digital affordances that can question both current and future technologies (2015).

Critical design fits into a broader category of design activism. Fuad-Luke describes design activism as "design thinking, imagination and practice applied knowingly or unknowingly to create a counter-narrative aimed at generating and balancing positive social, institutional, environmental and/or economic change" (2009, p. 27). Other methods that can help develop the IoT as a more open system. These include bringing users into the design process through participatory design approach, or using open design processes, that share the knowledge and tools for users to take control of design and production such as the maker movement and DIY urbanism.

Design methods and power

Participatory design methods are an established approach that challenges power structures. These methods provide an alternative to the traditional top-down design method by redistributing the power to include the users in the design process. Over the last decade, new communication technologies have aided participation of customers and citizens in design and decision making. Companies have seen the creative potential of consumers as co-creators (Fuad-Luke, 2009), and citizen-initiated and government-initiated platforms have changed the power relationship in civic issues (Silva, 2013). Some methods that are already being used to explore participation in relation to the Internet of Things are in crowd-sensing and crowd-sourcing (Silva, 2013) (Salim & Haque, 2015) (Binder et al., 2015).

One approach to participatory design is to create an open infrastructure for participants to complete a design, or create their own design (Binder et al., 2015; Fuad-Luke, 2009). Manzini says with this approach, the role of the design expert is now to support the design process for others (2015). This open design approach is based on making designs available for users to use, adapt and contribute back to the design community. In this way, the consumer is also the producer, so the design can develop through their adaptations. The technology and community of the open design approach makes participation easier through access to knowledge (Ratto, 2011). For both Manzini and Fuad-Luke this level of participation creates new systems of production and consumption (Fuad-Luke, 2009; Manzini, 2015). Having many designers means a greater variety of designs are produced, and results in a more open selection process of which designs will be adopted and developed upon.

In urban design there are specific opportunities for participatory design. Participatory design creates a sense of ownership of the design process of public urban spaces, allows a better assessment of local needs, and improves the long term impact (Houghton, Foth, & Miller, 2015). Salim and Haque see opportunities in the IoT for citizens to become active producers of data and urban knowledge, and to define the space between digital and public space (2015). While there is value in including the public in the design process, citizens do not always feel inspired to participate. Urban design researchers have been exploring new guerrilla research tactics to encourage participation through methods that are designed to be fun and inspiring (Caldwell, Osborne, Mewburn, & Crowther, 2015). For a design process to be open, it must be accessible and inviting for the intended participants. Binder et al. suggest that to be successful there needs to be a compelling invitation to participate (2015).

IoT tools can be part of engaging participation in urban design. Salim and Haque also say that for public engagement in urban IoT projects, the tools need to help citizens engage with the design problem (2015).

Participatory and open design approaches can be used for both the design of urban spaces and also the design of IoT tools. These approaches give more power to the user by involving them in the design process. There are examples of two different types of citizen-led movements that can be combined to influence the design of citizen led urban IoT. One is based on open design of technology – the maker movement, and the other is the open approach to urban design – DIY urbanism.

Open urban design

In DIY urbanism, there is already a developing social practice of open design in urban spaces through. DIY urbanism developed as a practice for citizens to take charge of their physical environment (Douglas, 2014). Practitioners are citizens who seek to 'improve' the urban landscape by enhancing unused space, adding to the infrastructure and engaging the public in expressing their own views about the design of urban spaces. "These actions represent a simple willingness (and perceived right) to reshape the built environment on one's own terms" (Douglas, 2014, p. 12). DIY urbanism opens up the public space to new ideas about how the space is used. It challenges ideas of authority over public space, and demonstrates the agency of citizens to redefining the space according to their needs.

Another citizen-led practice, the maker movement, presents a similar attitude. The maker movement is a practice of taking back the means of production through sharing knowledge and tools (Elliott & Richardson, 2016). The maker movement involves using new technology such as 3D printing, robotics, coding and electronics, as well as traditional craft tools and processes. It challenges the producer-consumer model through the development of open-source hardware/software and by enabling individuals to develop skills for the design and production of their own products. The maker movement already intersects with DIY urbanism in two spaces, the creation of artefacts for DIY urbanism sites, and the creation of community spaces where materials and tools are shared.

These movements have already embraced the benefits of technology to enhance and support their goals (Fuad-Luke, 2009; Richardson et al., 2013). Douglas discovered that DIY urbanists were often significantly influenced by seeing examples of what others had done, typically through online sources (2014). These movements have been able to grow through social networks, enhanced by social media, providing inspiration, instructions and advice for other practitioners.

Since DIY urbanists and makers are already early adopters with established open design methods, and experience in the urban environment, there provide significant opportunities for co-development that will inform the development of a citizen-led IoT in urban settings. As the IoT has been seen as a tool that could increase participation in civic design, these practices have potential to be part of shaping the development of that technology through their usage and adaptation of it for this purpose.

Summary

As much of the current research on the IoT has primarily concentrated on the technical challenges, this research seeks to understand the socio-technical factors. It looks at how the design process can affect the development of an emerging technology and specifically how a critical design approach can reveal the possibilities of the IoT in urban spaces.

The power relationship between producers and consumers can be disrupted by including users in the design process. One way of doing this is making a system that allows the user to become the designer through open design. This research aims to use an open design approach for creating examples of projects that are replicable and so can be used and adapted by users.

In urban design there are specific opportunities for both participatory design and the IoT, and an opportunity to bring them together. This research looks at the urban space for the design context. Since there are already developed practices that look at the design space through DIY urbanism practices, and the technology space through the maker movement tools, the research will build on these practices. Through the practice of critical making and critical design, this research aims to create examples for the creative potential of the IoT for citizen-led urban design to inform alternative modes of practice.

Methodology

This research uses a practice-led method that draws on critical making and critical design to explore the creative potential of the IoT for urban creativity.

Practice-led research is about learning through the process of creative and reflective practice (Smith & Dean, 2009). It can be used to explore the creative potential of a new medium and so inform the design process by working with emerging technologies in a critical way. Unlike practice-based research it is not concerned with the outcome of the design process as such, but rather with the process itself. An action research approach is used to advancing knowledge about practice. This is an interactive process, one that uses problem solving actions and implements them in a collaborative context. Theorising and reflection happens throughout the data collection and design process.

This research combines the three different modes of research in art and design defined by Frayling as research-for-practice, research-through-practice, and research-into-practice (1993). Research-for-practice is the process of gathering specific knowledge related to the design project to inform the design outcome. Research-through-practice is the process of making discoveries through the making process, reflecting on those outcomes and articulating what was discovered. Research-into-practice is looking at the experience of designers, and the design process.

The methodology used here employs critical design and critical making as central to the research. Critical design focuses on the design and evaluation portion of the process, to generate alternative perspectives and present them for evaluation, whereas critical making focuses on the learning that comes from the making process and learning through reflecting on the process. As this research uses an action research approach, each stage of the research is reflected on and creates the basis for the next stage of the research (see figure 1).

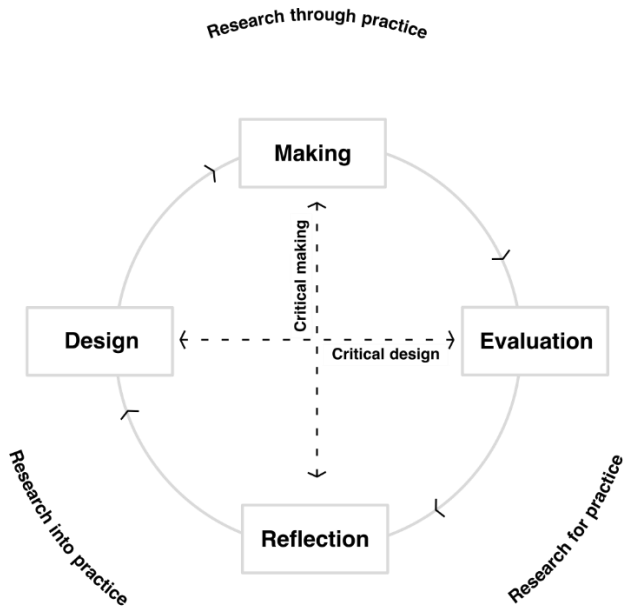

Figure 1: Diagram showing this practice-led action research methodology

Practice-led research plan

The research starts at the research-for-practice stage of the cycle. The first research activity involved interviews with creative urbanists in order to understand the context and design opportunities within Auckland's urban spaces. The findings from the interviews are used to inform the design of the prototype projects.

Reflection on the interview finding identified opportunities for advancing and supporting the DIY urbanism practice and consideration of how the IoT can be used to enhance such practice. This involved generating concepts for combining the IoT with DIY urbanism practices to meet the aims of the creative urbanists.

As active research, reflections on the findings of each stage determine the direction of the following research activities. Two project prototypes – Mobile Street Furniture and The Zeitgeist Machine – were developed to learn about combining DIY Urbanism concepts with the IoT. Each project involves designing, making, evaluating and reflecting. These prototypes are designed with an open design approach to ensure they can be replicated and adapted as examples of IoT projects for creative urbanists. Prototyping then tests both the feasibility of the idea and also its experience in a public space.

After reflecting on the prototypes, a co-design session with creative urbanists is used to explore how the IoT can balance being 'open enough' – both accessible and adaptable – for creative engagement. The participants explore, design for and evaluate a selection of IoT systems. This is used to determine how the IoT can be effectively used for citizen-led urban design.

Interviews with Creative Urbanists

To understand the context of creative urbanism in Auckland the research started with interviews with five Auckland-based practitioners. Participants were identified through their involvement in DIY urbanism activities or community makerspaces and were invited to participate. These practitioners were engaged with collaborative street art, outdoor maker events, yarn bombing, street games, pop up parks and street parties.

The interviews covered their own journey into creative urbanism. Each interviewee was very passionate about the issues that drew them to creative urbanism. There was often a personal journey that brought them into roles where they found support for their practice.

The hypothesis for this phase of the research was that some aspect of their processes, such as better interaction or communication, could be amplified or supported with IoT technologies. No practitioner was currently using the IoT in their projects, though some did use social media to promote their projects and events. The interview questions asked about the process of creating a new project, from concept to completion. Two things became clear from this. The first was that they rarely did the same type of project twice. The projects were very place-based and situation dependent, rather than process-based, and consequentially the practitioners were usually adapting and creating something different each time. This meant there wasn't a clear repeatable problem to solve. The second was that the creation of any specific project was generally a relatively simple activity for them. The harder parts were managing relationships and council approval processes.

The most difficult part of the process for all practitioners was being able to demonstrate the value of these creative projects. The urbanists spent a lot of their time developing and managing relationships, finding funding and resources, and going through council approval processes for health and safety, traffic management, etc. DIY urbanism usually doesn't

involve asking for permissions however, while the creative urbanists were keen to iterate and work autonomously, they also saw value in following rules that would make sure their activities were safe and would have a better chance of success. Each expressed the difficulty of being able to measure the success of their project when the outcomes were intangible. Their perception was that although council were positive about community-led ideas, they struggled to translate this into validation of community needs. The practitioners wanted to be able to measure and evaluate the experience to address this obstacle.

The interviews also explored the aims and motivations of the practitioners in order to suggest ways in which the IoT could support their work. The main themes were derived from what the practitioners wanted their projects to achieve:

Connection

While the creative urbanists were aware of the diversity of groups in Auckland they also noted the isolating effect of a large city and the limited opportunities to meet others and understand the different experiences of other groups. Projects like Griffith garden[1] created a space for workers and homeless to share a space over lunch. And street-based events invited apartment residents to meet others in the area. They wanted the experience to be welcoming.

Playfulness

A significant motivator for the creative urbanists was that their projects were able to surprise and delight the people who experienced them. They wanted their project to be unexpected, fun – something that interrupts routine experiences. Of additional value were moments when members of the public would make remarks such as "I didn't know you could do this in a library", or moments when someone learns a new skill and surprises themselves. The temporary nature of the projects was a factor in this. Being able to iterate, adapt and not take the project too seriously helped keep the projects playful and fun. Practitioners often wanted the experience to be unexpected or surprising.

Empowering

A large part of the project design was creating space for members of the public to participate in the design and activities in the space. This was seen in the collaborative mural[2]

[1] www.fortheloveofbees.co.nz/the-griffiths-gardens/
[2] http://www.splice.org.nz/splice-blog/heartfulart

painting organised outside the library on construction hoardings. Events in South Auckland were planned with the input of each local area. 'Stuck in the maze'[3] invited members of the homeless community to share their story and host the maze experience. For a few of the creative urbanists it was also about creating the space and supporting other people in the community to be involved in what they wanted to see happening in their community. They wanted the experience to be collaborative.

These three themes were adopted as part of the criteria for the project concepts, along with 'accessibility' in regard to the relative ease of replicating or adapting the project, based on the open design approach intended.

Reflection

The research for design produced unexpected findings. Instead of presenting some opportunities to enhance the creative practitioners' processes, the findings suggest there are more opportunities in showing how the IoT can enhance connection, playfulness and empowerment, and improve the ability to demonstrate the value of creative urbanism projects.

Consequently the next phase of the research was to explore how those issues could be addressed through the affordances of the IoT. This involved brainstorming ideas, and learning through building prototypes to test the ideas through practice.

Projects – research through practice

To identify creative possibilities within the IoT for creative urbanism a synthesising ideation process was used to combine the affordances of the IoT, the experience desired by the urbanists and types of guerrilla urbanism. See Appendix C for the ideas generated by this process.

The project ideas were evaluated using the criteria identified in the interviews. The following sections are about the two projects prototyped in this stage of the research and the reflections on what was learned through that process. The aim of each project was to learn about the creative potential of the IoT in citizen-led urban creativity through the process of making prototypes. These prototypes were designed as open design projects that could

[3] www.thebigidea.nz/showcase/216349-the-no-choice-choice-stuck-in-the-maze

serve as examples of the creative potential of the IoT, so that creative urbanists could replicate and adapt them for their own use.

Project 1: Mobile street furniture

The research aim of this project was to create an example of an IoT project for DIY urbanism. In order for the design to be open, it needed to be both accessible and replicable so that other creative urbanists could use and adapt the design. This project was based on the idea of a more iterative, participatory and playful approach to street furniture. Pop up street furniture has been a feature of DIY urbanism through the placement of furniture when none has been provided. This may be ready-made furniture or DIY furniture. It can be part of a pop-up park or event, but can also be a stand-alone project situated in places where people wait, such as bus stops or around food stalls.

The concept for a mobile street furniture project was to provide furniture that members of the public could move around to where they wanted it. It included a tracking device so that the project and others could see where the furniture was, and therefore where more street furniture was needed. The project also included the ability for the concept to evolve as others could create mobile street furniture and include the tracking data to the online map.

Consideration of how to invite participation in the project was part of the design process. As pointed out by Salim and Haque, and Binder et al, the way people are introduced and invited to interact affects the level of public participation in urban computing projects (2015; 2015). It was important that the public could quickly grasp the concept and feel they had permission to move the furniture around. Since the furniture was designed to move, the instructions needed to be part of the furniture. A street art aesthetic of stencil type was used and the furniture project was given the label: “Mobile Street Furniture: Move as needed”. ‘Mobile’ hints at the idea of both moveable as well as having a mobile connection. For the first prototype I selected an outdoor beanbag (see figure 2). Typically beanbags are freely moved around a defined space, as being both light and soft they are physically easy to relocate. The user-friendly nature increasing the ability for the public to interact.

Figure 2: Mobile Street Furniture prototype.

However, this prototype ran into some technical barriers around the selection of a communication protocol. The concept required that furniture be tracked over time without constant battery charging or replacement and a tracking system that could locate the furniture to within a few metres of where it was. Three options for tracking were considered: Bluetooth, GSM, and GPS. Each places limitations on either the battery life or the preciseness of the tracking. Trackers like the 'Tile'[4] that use Bluetooth typically allow for a battery life of around one year, however the tracker tag needs to be within a range of 30 metres of the receiving device. The product system also has the ability to use the network of users to find lost items. Tile apps running on other tile users' mobile phones can also pick up the signal of the tracked item and relay it back. So for an item to be located, someone with the app would have to walk within a short distance of it. This option could work well if there were sufficient numbers of users in Auckland using the app, however the data is not

[4] www.thetileapp.com

extractable from the Tile system so that it can be shared and published. As a result it is not possible to publicly track the furniture with this system.

GSM avoids this problem by triangulating the position via cell-phone towers. This allows the location to be tracked to a suburb, but generally not the exact spot. The batteries last around 100 hours, or 4 days. Both the location and battery life are not ideal for the Mobile Street Furniture concept. GPS, on the other hand, can show the location within metres if the item is outdoors. However, battery life for GPS trackers are generally only 24 - 48 hours and would require significant maintenance.

A tracker made by XY Findables[5], a competitor to Tile, seemed to avoid these issues. It allows access to the tracking data and is a GPS tracker with a predicted 11-day battery life. While the battery life was still not optimum it was workable. However due to production issues and delays it was not a feasible option to include this system in the research.

Reflection

The promise of the IoT suggests that affordances like accurate tracking are low cost, practical and available. Through this design process it became clear that there are a lot of compromises involved in selecting technology platforms, each placing their own limitations over what the IoT can be used to do. A good understanding of the constraints of each technology option are necessary for the design of useful applications.

As the current state of tracking technology is not at a stage where it can support this concept, the decision was made to explore uses for more established protocols. The next concept used WiFi and mobile internet as the communication system for the IoT concepts.

[5] www.xyfindables.com

Project 2: Zeitgeist machine

This second project also aimed to create an example of an IoT project for DIY urbanism. This time using WiFi protocols and mobile internet that are more established and now available in low cost components. Instead of tracking, this project was aimed at addressing the issue of participation by providing a tool for assessing community needs.

The concept was to create a voting button that could be used in a fixed location to engage people using the space by posing questions about the use of the space, thus measuring the 'Zeitgeist' of that space. Only people within the physical space could have a say. The data from this would then be transmitted via mobile internet back to a website displaying the real time results. The challenge was also to design the tool in a way that could be replicated by other creative urbanists and adapted for use in other spaces.

Like the Mobile Street Furniture project, the Zeitgeist machine needed to invite participation. Building on some of the design decisions from the furniture project, the project used bright colours, was temporary, and used stencil spray-painted instructions. As there were no 'suitably playful' buttons available so a design was modelled in 3D and printed on a 3D printer in a makerspace. Commonly available components and materials were used to construct the rest of the machine (see figures 3 and 4).

Figure 3, 4, 5: 3D printing of buttons; physical construction; and hardware setup.

For the electronics and programming accessible, options were selected so that they would be easily replicable. The ESP8266 mini from Wemos[6] was used as the development board (see figure 5). These cost around $5 and are very popular amongst hobbyists because of

[6] www.wemos.cc

their lost cost. This popularity has also generated a large amount of support and example projects that are shared online. They can also be used with beginner-friendly and open source programming languages like Arduino[7], the most user-friendly for people with no programming experience and Micropython[8]. Using this open source software, code was adapted from several different project examples shared online to implement the Zeitgeist machine.

Finding code to adapt to count the number of button presses was relatively simple and provided a latency that could be used to prevent rapidly repeated button presses from being counted. However, a decision needed to be made over whether to calculate the button presses on the hardware (edge) or in the database (cloud). If the hardware was switched off or lost power, it would lose the count and restart the count from zero when powered up again. If it was all online, the count would miss data if the connection was interrupted. Since the power source would be more reliable than the connection, the data was calculated at the edge and the running total sent to the cloud.

Some issues arose when trying to replicate the networking of the device through to a website. Many of the examples featured APIs and web sockets that had closed down, or couldn't be used outside a home network. Some examples like IFTTT[9] could trigger activities from data, but weren't suitable for sending data. There were paid channels suitable for commercial projects, but these came at too high a cost for use in small one-off community projects.

Google does however provide a range of tools which are more stable. By connecting Pushing Box[10], Google Scripts and Google Sheets to collect the data from the device and a dynamic Google Chart via an application programming interface (API) the results could be displayed on a website. However each step introduced a time lag, making the website not precisely real time. This was significantly more complicated than anticipated. And while it was achievable for one prototype to use it, the process had a lot of room for error and too many steps for anyone else to replicate the design, therefore requiring a higher level of technical

[7] www.arduino.cc
[8] www.micropython.org
[9] www.ifttt.com
[10] www.pushingbox.com

confidence and competence. The hardware and programming combination required frequent troubleshooting, as it was difficult to tell where problems originated.

The completed Zeitgeist Machine prototype was tested in a local park. The question posed was about how residents used the park: “Today I’m walking through the park: to get somewhere, for exercise, for fun”. It included instructions for how to find the results online. It was placed near a pathway and next to a play and exercise area (see figure 6). It was left there for six hours and engagement was observed both in the park, and via the website. From the park observations, it was evident that people noticed it and were attracted to interact with it. It collected thirty-three responses over the test period, approximately one third of the people walking through.

Figure 6: The Zeitgeist machine prototype onsite at a public park.

Two issues were identified by observing people using the system: Participants seemed to expect some indication that their input had been recorded – a sound or a light would

potentially have given them that reassurance. In observing the responses online, if the data showed no change, there was no way of knowing if no one was interacting with it, or if something was wrong with the device. Addressing these two feedback mechanisms would improve the functionality of the design.

Reflection

As with to the Mobile Street Furniture prototype, the technical challenges were more difficult than expected. Although the prototype was functional, the complexity of the networking, and some of the hardware troubleshooting, made it unsuitable as an example project for a creative urbanist to replicate as intended.

At present the IoT seems not to be capable of supporting these types of citizen-led projects. Though recently larger technology companies such as Google and Amazon have recently launched beta versions of IoT cloud management systems. While these are not open systems, they are free, or available at a very low cost. As these sorts of services grow they present an opportunity for more stable and accessible systems to be used by creative urbanists.

Given these two attempts to create IoT projects from scratch had yielded limited results due to the technology's state of development, it appears that this level of development is currently beyond the reach of non-technically minded people. The next stage of the research focused on the use of more developed IoT systems and gauge their accessibility.

Co-design workshop

The co-design workshop was developed as a result of the findings and reflections from the prototype projects. The session invited six creative urbanists to explore some basic IoT systems and evaluate whether they could see the creative potential for their own work. Two participants were from the interviews, and four were new participants from the same participant profile were selected. The aim for this activity was to look at whether IoT systems would be easier to develop from, rather than building from scratch. There were two parts to this workshop. The first was an opportunity to learn about and set up three different IoT systems. And the second to brainstorm how the IoT could be applied to urbanism challenges.

The participants worked in two groups, one with a higher ability in programming and electronics and one with a lower ability. They worked together to set up and test each system using the written instructions. This gave them an opportunity to get a feel for the complexity of the tool and also to start understanding the possibilities and constraints.

The systems chosen represented a range of complexity in electronic and programming setup: The NFC stickers being the least complex as they required no hardware setup, and the programming is managed via toggles on a mobile app. The Google AIY voice kit[11] was designed to encourage more experimentation with the Google voice API and has a kitset approach to hardware assembly. Set up requires a moderate level of skill in order that is can be integrated with a Google account. The DIY IoT button was built from electronic components, and had a greater possibility of error. It required some set up and coding to integrate it with the IFTTT API. IFTTT involves a simple process of selecting options from dropdown menus.

[11] aiyprojects.withgoogle.com/voice

Table 1: IoT relative complexity table.

	Hardware setup complexity	**Programming setup complexity**
NFC tag stickers with Android app	1	1
Google AIY voice kit with RaspberryPi	3	3
DIY IoT button with IFTTT	5	3

The second part of the workshop was a co-design session. For this the participants were paired with someone of a similar technical ability and collaboratively generated ideas through three rounds of brainstorming. For each round, the participants were given the same scenario to design for, but each group was given a different one of the IoT systems that they had just explored to incorporate into the designs. The groups shared their best or favourite idea at the end of the round. In the next round the groups changed which tool they were designing for, and all designed for a new scenario. By sharing, the participants could hear the variety of ideas generated for the same scenario, but incorporating different IoT systems.

The three scenarios were:

- Roadworks are taking place in front of a group of shops. How can we keep the shops alive during this time?
- What are ways of encouraging walking, cycling and public transport use?
- A public square is just being used as a thoroughfare, how can you encourage people to use the space and spend more time there?

The participants were given the criteria for the designs, identified earlier: Accessible, empowering, connecting, playful. The same criteria would also be used by the creative urbanists during the evaluation of the tools.

Table 2: Ideas generated from each round of brainstorming.

	Roadworks are taking place in front of a group of shops. How can we keep the shops alive during this time?	**What are ways of encouraging walking, cycling and public transport use?**	**A public square is just being used as a thoroughfare, how can you encourage people to use the space and spend more time there?**
NFC and app	NFC sensors on a table that could trigger white noise when a phone is placed on it – neutralising construction noise	A scavenger hunt with stories hidden within NFC stickers. People can tap NFC stickers with their phone and collect the stories while they are walking.	A real life video game where a player can move the character by their own movement around the square and tapping on NFC tags.
IoT button and IFTTT	A board placed at the entrance to the area affect where customers could send a request to a shop to confirm they are open, and so worth the customer's effort to get through the road works.	Using a button as a metric for pedestrian experience. Being able to change the light sequence for a faster crossing at lights, or being able to measure how anxious the pedestrian is.	A group game where a large group needs to move across the space to play and to activate new resources. The more people in the team, the better the team does, so it encourages the groups to involve more people in the game
Google AIY kit	An interface on the street corner for the public to be able to ask where they can find a particular item. There would be a database of the products sold in the area and it would be able to direct them to the right shop.	A dance path. People ask for a specific dance and the voice kit plays music and tells them the moves.	A feedback portal for the public to be able to share what is working well in a particular place and what needs improvement. Voice lets the feedback be heard more empathetically.

Being able to experience and test the tools beforehand gave the participants a better understanding of what the IoT could do. This helped them understand the constraints and think of roughly suitable urban experiences based on how the systems worked. The co-design process forced the participants to use the IoT systems in the design of solutions for challenging urban scenarios. More significantly it asked whether they now would use these systems in their own projects.

At the end of the workshop the participants completed an evaluation of the tools. For each tool they were asked:

- How easy or difficult did you find learning about this tool?
- How easy or difficult was it to come up with ideas using this tool that were empowering for communities?
- How easy or difficult was it to come up with ideas using this tool that connected people and places?
- How easy or difficult was it to come up with ideas using this tool that were playful?
- How likely are you to start using this tool for your own projects?
- Are there any ideas using this tool that you or others came up with today that you would use in your own projects?
- What would stop you from using this tool in your own projects?
- How confident do you feel about using this tool in the future? (From 'I feel confident enough to use them myself for a project' to 'I would want someone else to do it for me'.)
- They were also asked to rate their experience level with programming, electronics and creative urbanism.

The difficulty level of the tool, and the perceived accessibility, didn't have a strong impact on how likely the participant said they were to use the tool in the future. This was affected more by the qualitative criteria, showing that the potential value of the tool was a bigger influence on likeliness to use (see figure 7).

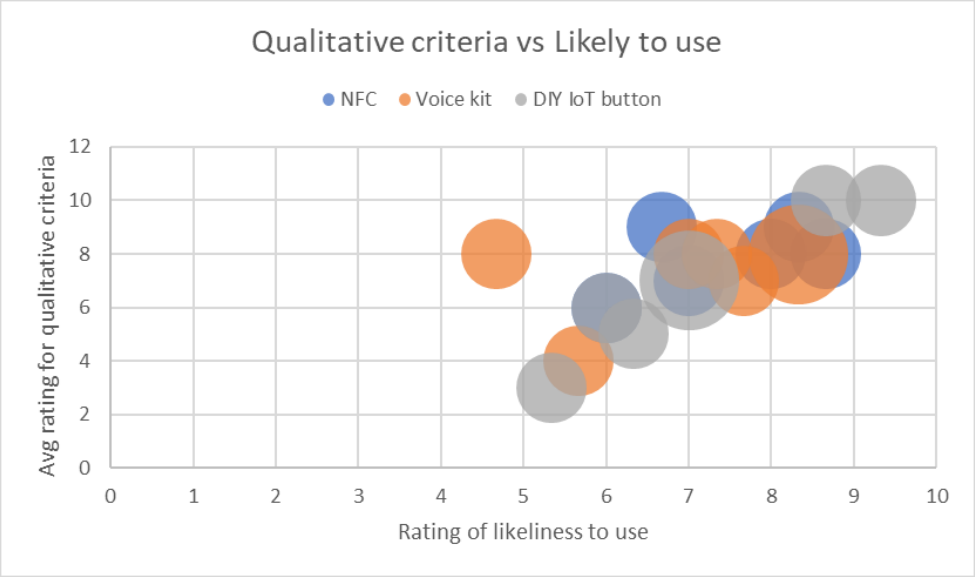

Figure 7: Graph comparing the average rating of how easy it was to design for the qualitative criteria - empowering, connecting and playful, with the participants indication of how likely they were to use the tool.

However, the difficulty did have an impact on their confidence in using the tool (see figure 8). This was about whether they felt they could use it straight away, would need to learn more, get help, or have someone else do it for them.

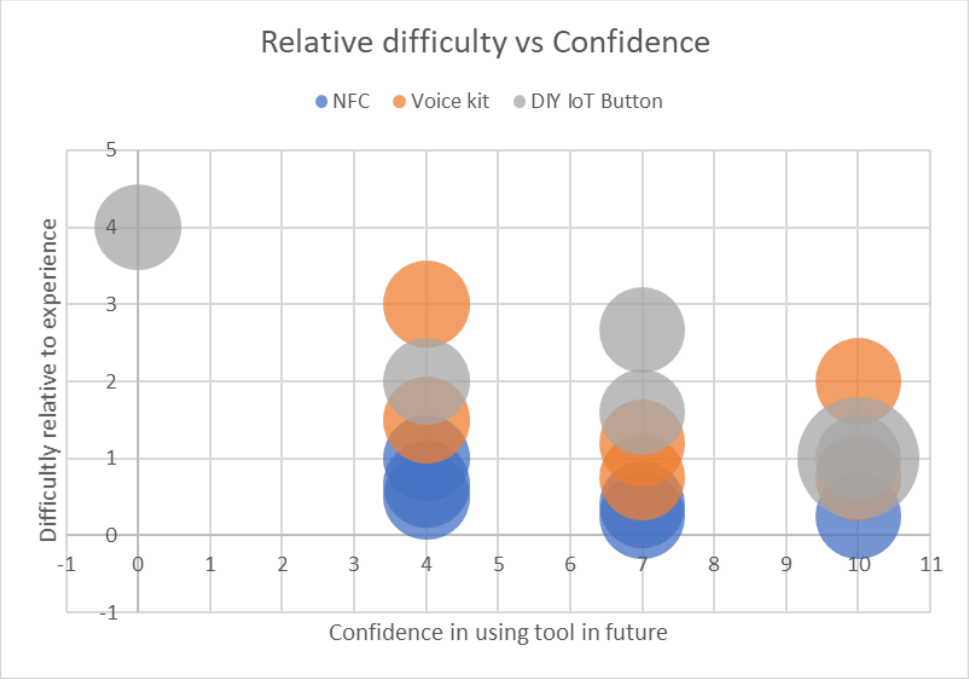

Figure 8: Graph showing comparing the relative difficulty (the set difficulty divided by the participant's experience level), and their confidence in using the tool.

During a discussion session after the evaluation participants were asked whether the concept or technology came first. Participants said that the experience of learning about the constraints of each IoT system helped them see how the system could fit within their practice. One participant said that without understanding the tools people can articulate the problem but not the solution, "If you don't know what it can do, then you don't know these options are there." Another commented that "As a creative, you need some restrictions. So knowing that NFC tag needs to be right on the phone meant different uses."

When asked whether they felt the different IoT systems affected the concept, they did feel there were differences in what they designed. Though the DIY IoT button and the NFC tag were similar in how they worked they created different experiences. A participant said "For me it was different. A button implies that there must be a display or feedback so someone that doesn't have a phone can push a button and get something in front of them. Someone who has a phone has some sort of display." Another agreed, "They solve different problems. A button is less technical an interface, but tags using your phone is a higher level of competency".

Reflection

There appear to be two different aspects to increasing usage of the IoT in citizen-led projects. One is that the perceived usefulness of the tools has an impact on whether it will be used, the other is about how easily and autonomously someone can deploy the tool. The results of the co-design session indicate that perceived usefulness appears to be the biggest driver, one that in turn drives the motivation to learn. Through the experience of building, testing and creating concepts participants were able to see the potential uses for the IoT for their own projects.

Conclusions

This research explored the potential of the IoT for citizen-led urban creativity. It was hypothesised that an open design approach would generate projects that could demonstrate the opportunities of the IoT for creative urbanists.

Interviews with creative urbanists revealed opportunities for the IoT to support urban projects through supporting the aims of the projects to create connection, playfulness and empowerment rather than supporting specific parts of the practitioner's process.

Through the two prototype projects, limitations were discovered in the current stage of IoT development. In the *Mobile Street Furniture Project*, it was discovered that the technology for tracking objects was not at an accessible stage for that concept. There are still significant issues around power supply and battery life that need to be addressed. From the *Zeitgeist Machine* it was found that it is currently too complex for a beginner to create a whole IoT stack at this stage. While the project did generate engagement with the public and was robust enough for a prototype, the complexity made it unsuitable as a project for creative urbanists to replicate.

Following on from the prototype projects, the co-design session found that through play and brainstorming DIY urbanists were better able to imagine possibilities for the IoT tools. Through their evaluation of each tool, it appears that they would use the tools that were valuable for their aims, regardless of accessibility, but would not feel as confident doing it themselves.

Therefore, a significant factor for realising the potential of the IoT for citizen-led urban creativity, is finding the balance of accessibility and openness. At the most open end, more knowledge and problem-solving skills are needed by individuals to be able to use the technology. On the controlled side, there is no ability for the user to adapt the technology for their own needs. Starting from basic components and needing to set up an IoT network means the user needs to constantly monitor it to check nothing has malfunctioned. There needs to be a level of development that creates relative stability but is also designed for the user to access and control the actions of the IoT device. Having tools that are at a midway level of development makes them accessible enough to be adapted for alternative uses.

The uptake of the IoT for citizen-led urban design is dependent on users being able to see the potential through experience, examples and exploration. Being able to imagine uses for the IoT provides the motivation to push the technology in the direction that they want it to go. Examples and tangible experience transform the IoT systems from being a concept into being a tool. Being able to see the potential was the most important factor influencing the desire to use it. However, the determining factor of whether it will actually be used may rely on whether the motivation to learn results in knowledge and confidence. The IoT tools need to be accessible enough to spark imagination and adoption. This will help build the demand for and adaptation of the IoT for citizen-led IoT.

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Appendices

Appendix A

- Ethics approval letters

Appendix B

- Participant information sheets
- Consent forms

Appendix C

- Protype project ideas

AUTEC Secretariat

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13 June 2017

Ricardo Sosa
Faculty of Design and Creative Technologies

Dear Ricardo

Re Ethics Application: **17/156 The creative potential of the Internet of Things for citizen-led urban design**

Thank you for providing evidence as requested, which satisfies the points raised by a subcommittee of the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 12 June 2020.

Standard Conditions of Approval

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. You are reminded that it is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

For any enquiries, please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: ntx7309@aut.ac.nz

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16 March 2018

James Charlton
Faculty of Design and Creative Technologies

Dear Ricardo

Re: Ethics Application: **17/156 The creative potential of the Internet of Things for citizen-led urban design**

Thank you for your request for approval of amendments to your ethics application.

The amendment to data collection protocols for Phase 11 (co-design session) of the study is approved.

I remind you of the Standard Conditions of Approval.

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. If the research is undertaken outside New Zealand, you need to meet all locality legal and ethical obligations and requirements.

For any enquiries please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: ntx7309@aut.ac.nz; Ricardo Sosa

Consent Form

Project title: ***The creative potential of the Internet of Things for citizen-led urban design***

Project Supervisor: ***James Charlton***

Researcher: ***Heather McLay***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 21 February 2018.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that notes, video and photos will be taken during the workshop.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I permit the researcher | artist to use the photographs that are part of this project and/or any drawings from them and any other reproductions or adaptations from them, either complete or in part, alone or in conjunction with any wording and/or drawings solely and exclusively for (a) the researcher's portfolio; and (b) educational exhibition and examination purposes and related design works.
- ○ I understand that any copyright from the recordings of the codesign workshop is deemed to be owned by the researcher that I do not own copyright of any of the recordings.
- ○ I understand that any copyright material created through the co-design workshop is jointly owned by the participants and I am able to use the ideas generated from the workshop.
- ○ I agree to take part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

Participant's signature: .....

Participant's name: .....

Date:

I give approval for my comments to be attributed to me. (A copy of the relevant sections of the research will be made available for checking).

Participant's signature: .....

Participant's name: .....

Date:

Approved by the Auckland University of Technology Ethics Committee on type the date on which the final approval was granted AUTEC Reference number type the AUTEC reference number

Consent Form

Project title: ***The creative potential of the Internet of Things for citizen-led urban design***

Project Supervisor: ***Ricardo Sosa***

Researcher: ***Heather McLay***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 6 June 2017.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that notes will be taken during the interviews and that the interview will also be audio-taped.
- ○ I understand that photos of projects or my work area may be taken with my permission.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I permit the researcher to use the photographs that are part of this project and/or any drawings from them, and any other reproductions or adaptations from them, for (a) the researcher's portfolio; and (b) educational exhibition and examination purposes and related design works.
- ○ I understand that the photographs will be used for academic purposes only and will not be published in any form outside of this project without my written permission.
- ○ I understand that any work that is photographed remains my intellectual property, however any copyright material created by the photographic sessions is deemed to be owned by the researcher and that I do not own copyright of any of the photographs.
- ○ I agree to take part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

Participant's signature: .....

Participant's name: .....

Date:

I give approval for my comments to be attributed to me. (A copy of the relevant sections of the research will be made available for checking).

Participant's signature: .....

Participant's name: .....

Date:

Approved by the Auckland University of Technology Ethics Committee on type the date on which the final approval was granted AUTEC Reference number type the AUTEC reference number

Note: The Participant should retain a copy of this form.

Participant Information Sheet

Date Information Sheet Produced:

21 February 2018

Project Title

The creative potential of the Internet of Things for citizen-led urban design

An Invitation

My name is Heather McLay and I am doing research for a Masters in Creative Technologies. My research is on the Internet of Things and how it can contribute to citizen-led urban design. I would like to do an interview with you to get your point of view and experience of how individuals and groups are constructing their physical urban environment.

What is the purpose of this research?

The purpose of this research is to explore how the Internet of Things could be used by citizens to shape and influence their urban environment.

How do I agree to participate in this research?

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the research at any time. If you choose to withdraw, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used.

What will happen in this research?

You will be involved in a co-design session for 2½ hours getting to explore some new technology and then brainstorming ideas for how they could be used for particular urban activation scenarios. The interview will be recorded using notes, video and photos.

How will my privacy be protected?

You have a choice about whether you want to be identified or not in the research. You will have an opportunity at the end of the interview to give your consent for this. Also I will provide a copy of any statements attributed to you for you to check before publication. Please note though, even if you choose for your comments not to be attributed, it may still be possible for people in the community to identify your comments.

Will I receive feedback on the results of this research?

Yes, I will send you a summary of the research once it is completed.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, James Charleton, 021 676 187

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Heather McLay, ntx739@aut.ac.nz, phone 021 280 2707

Project Supervisor Contact Details:

James Charlton, James.Charlton@aut.ac.nz, 021 676 187.

Approved by the Auckland University of Technology Ethics Committee on 13/6 2017, AUTEC Reference number 17/156.

Participant Information Sheet

Date Information Sheet Produced:

6 June 2017

Project Title

The creative potential of the Internet of Things for citizen-led urban design

An Invitation

My name is Heather McLay and I am doing research for a Masters in Creative Technologies. My research is on the Internet of Things and how it can contribute to citizen-led urban design. I would like to do an interview with you to get your point of view and experience of how individuals and groups are constructing their physical urban environment.

What is the purpose of this research?

The purpose of this research is to inform a design that explores how the Internet of Things could be used by citizens to shape and influence their urban environment. There will also be a written component (an exegesis) that explains how the idea was developed and your contribution will be included here.

How do I agree to participate in this research?

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the research at any time. If you choose to withdraw, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used.

What will happen in this research?

You will be involved in a one on one interview for an hour talking about your projects, how you work, and the communities you work with. The interview will be audio-taped.

If relevant, I may want to take photos of your work or your space, I will ask your permission at the time.

How was I identified?

I invited people who are involved in DIY urbanism activities or community makerspace activities that have a public profile and publicly available contact details.

How will my privacy be protected?

You have a choice about whether you want to be identified or not in the research. You will have an opportunity at the end of the interview to give your consent for this. Also I will provide a copy of any statements attributed to you for you to check before publication. Please note though, even if you choose for your comments not to be attributed, it may still be possible for people in the community to identify your comments.

Given that this topic can involve projects done outside of official permission, which may have breached minor laws or regulations, we will just discuss work that you are comfortable being held responsible for, or speak in vague terms about anything else.

How is this research being funded?

This research is being funded by a scholarship from Spark NZ and AUT Colab.

Will I receive feedback on the results of this research?

Yes, I will send you a summary of the research once it is completed.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Ricardo Sosa, Ricardo.Sosa@aut.ac.nz, 09 921 9999 extn 7947.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

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Ricardo Sosa, Ricardo.Sosa@aut.ac.nz, 09 921 9999 extn 7947.

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

Appendix C - Prototype project ideas

	Accessible	Empowering	Connective	Playful	Total
Signs that see you coming, give personal messages as you walk along	4	5	5	4	18
Little object that you can voice record a story and leave for others to find	4	5	5	4	18
Plants in pots that can be moved to wherever is ugly. Send out request for plants	5	4	4	4	17
One piece is added at a time. People find out where it is and bring things to contribute (which is tagged so they can get it back)	4	4	4	4	16
Object art that is left in a space for others to enjoy and is tagged with the makers info	5	4	4	3	16
A tree to ponder under - provides questions (crowd sources) when sit under it. Triggered by button, motion or pressure.	3	4	4	5	16
Tag locations with personal stories/ way finding	4	4	4	4	16
People can send message to the wall like 'Bobby -come home for dinner and it knows you are there	4	4	4	3	15
Push on wall and see different art	4	4	4	3	15
A clue to where a stash of flower bombs are hidden ready to deploy	4	4	3	4	15
Get given a plant and you can decide where to put it - tracked and see if it survives	4	5	3	3	15
Park bench talks to people who sit on it	2	4	4	5	15
Little hidden messages pop up randomly on a wall	2	4	4	5	15
Paint your own momentary art work with gestures	2	4	3	5	14
Lighting or projected art changes so always something new to see	3	4	3	4	14
Can click on street art around town	4	3	4	3	14

Footprints show up where you are walking - either following or for you to chase	2	3	3	5	13
Throw 'paint balls' at wall and watch it splatter	2	3	3	5	13
Path lights up as people walk through a space - can trip ones ahead	4	4	2	3	13
Light sensors pick up presences and shines light on left art	4	4	2	3	13
Digital projection on wall of pictures sent in by citizens	2	4	4	3	13
Streaming messages from citizens on a simple text scroller	3	4	3	3	13
Senses virtual money/ local currency/ exchange at market	2	3	4	4	13
Voting button of passer-by's appreciating/hating event	4	3	3	2	12
Plant moisture sensor lets group of gardeners know if it needs watering	3	4	4	1	12
Knows when it is raining and shows hidden umbrellas	3	3	2	4	12
Senses pressure on a park bench and lights up a happy quote opposite	2	4	3	3	12
Shares space that could do with some plants or are available for planting	3	3	4	2	12
Street art is a reflection of viewer or their digital data	2	3	3	4	12
Different activities happening at the pop up park – eg. follow at home chess games	3	2	4	3	12
Bags' a chair that lights up when you arrive at the park	3	2	3	4	12
Hidden sensors that welcome you to the park with whatever you would like them to say	3	4	2	3	12
Put sensors in newly planted areas that yell if stepped on	1	4	2	5	12
Map guerrilla gardens in a city	3	3	2	3	11
Records and tallies the number of times people give and take from a garden	2	3	4	2	11

Shares info about where food sources are/when ripe and ready	2	4	3	2	11
Wall is a game that you play with your body	1	3	3	4	11
Fake plants that show and track the water quality that the real plants are getting	3	2	2	4	11
Make your own route - tracked along paths - which ones are most popular	3	2	4	2	11
Area lights up as it senses presence creating a welcoming feeling	3	2	2	3	10
Use your phone to find a pop-up park nearby. Also tracks where people are when they search for one	5	1	3	1	10
Senses sound and whistles in response (like bird echo)	3	2	2	3	10
Take a talisman that can guide a path with little lights that light up as you are coming	3	2	2	3	10
Can plant and check plants to see where the best place to plant is	3	3	2	2	10
Hammocks in public parks with timers on so that you have to share	3	2	2	2	9
Measures heart-beat of people attending or in different parts of city	1	2	3	3	9
invited to press sensor which is sent through a measure/response to art	4	2	1	2	9
Senses increased amount of noise from activities	4	2	1	2	9
Furniture moves around the space. Reacts to movement and lights up when people come near.	1	2	2	4	9
Tracks traffic and adjusts to help people get where they are going	1	3	4	1	9
Bookable public spaces that show name of person who has booked it	3	1	2	2	8
Tracks number of people attending pop up event	3	1	2	1	7
Senses how people use the space, changes and senses again until it has an optimal usage	2	2	2	1	7

Measures length of time spent at event	2	1	2	1	6