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Growing Food in the City: Design Ideations for Urban Residential Gardeners

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1. ABSTRACT

Urban agriculture refers to the production of food in urban and peri-urban spaces. It can contribute positively to health and food security of a city, while also reducing ‘food miles.’ It takes on many forms, from the large and organised community garden, to the small and discrete backyard or balcony. This study focuses on small-scale food production in the form of residential gardening for home or personal use. We explore opportunities to support people’s engagement in urban agriculture via human-computer interaction design. This research presents the findings and HCI design insights from our study of residential gardeners in Brisbane, Australia. By exploring their understanding of gardening practice with a human-centred design approach, we present six key themes, highlighting opportunities and challenges relating to available time and space; the process of learning and experimentation; and the role of existing online platforms to support gardening practice. Finally we discuss the overarching theme of shared knowledge, and how HCI could improve community engagement and gardening practice.

Categories and Subject Descriptors

H.5.m. [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

Author Keywords

Urban agriculture; food; gardening; interaction design; urban informatics; sustainable HCI

2. INTRODUCTION

Gardening practice in urban and peri-urban environments can contribute to the aesthetics of the living environment, and supplement the range of available food for the gardener, their family, and the local community. In addition to the health implications of eating home-grown, local produce, the practice of gardening itself – literally being in touch with nature – provides

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gentle exercise as well as soothing sensory stimuli that are known to positively impact on physical and mental health [4, 6].

The number of people living in urban environments has been growing, and as of 2014 accounts for 89% of the Australian population [31]. Brisbane, the capital city of Queensland in Australia has observed significant population growth, doubling in the past 40 years [1] to 2.24 million as of June 2013. The inner city suburbs have the highest density, the greatest currently being New Farm with 6300 people per square kilometer, and spreading out to an average of 140 people per square kilometer for Greater Brisbane [2]. As a consequence, Brisbane residents are facing a new set of challenges for urban food production, including: rapidly decreasing spatial availability for farming, changing regulations, and effects of pollution. There is also an economic impact for households in cities such as Brisbane, where the cost of living is 21st on a Worldwide Cost of Living Index [20].

Interactive technologies provide a means by which designers could encourage uptake and participation in the practice of urban gardening. While this may extend the use of technology to augment the physical practice of gardening (e.g. sensor networks or automation), existing research suggests that this is not seen as useful for community based urban agriculture [16, 23]. This study instead takes the approach that focuses on opportunities for communications and knowledge based technology.

While there are a number of community gardening initiatives within Brisbane, this study focused instead on the smaller scale practice of food production in residential spaces for personal (and familial) consumption. The impact on residential households (such as economic benefit and increased self-reliance) is likely to benefit the members of that household, as the most common type of garden is a ‘cooks garden’ that Kortright and Wakefield [18] describes as: “...*practical gardens, built and maintained for the convenience of access to fresh and delicious produce.*”

Residential gardening is worthwhile examining further from an HCI design perspective, as there has been little focus on household urban food growing from HCI research. This study responds to a call to investigate small-scale producers of food, focusing on non-commercial production [17].

This study is the third in a series of cases where we have explored different types of urban agricultural practices in Brisbane since 2010, including a city farm [22] and a grassroots movement [21]. We depart from studying distinct communities and focus on residential gardeners, typically individuals or families, to understand the approaches to everyday gardening as an activity that is part of urban life. We use multiple stages of data collection from both gardeners themselves, as well as experts who teach gardening, and community garden leaders in Brisbane. The empirical data are thematically analysed to arrive at six design

considerations and a general understanding of shared knowledge and community among gardeners.

3. RELATED WORK

There has been a growing interest in HCI and food systems research [E.g. 8], often under the domain of Sustainable HCI. Other research has been conducted from a speculative and analytical perspective, understanding trends in Sustainability HCI research [12, 13], encouraging a focus on promoting community engagement. Recent studies aiming to understand how people engage in urban agriculture [3, 16, 22, 23] have done so with a focus of these studies is on established or emerging urban agriculture communities (such as city farms or community gardens), which represent the *meso* and *macro* forms of urban agriculture [25]. Research that has focused on the *micro* forms of urban agriculture – such as a backyard or balcony garden in a residential setting – has been lacking, with the food growing aspect considered auxiliary to studies such as [30], which explored gardening more generally as a relaxation exercise. Kortright and Wakefield [18] contribute to an understanding of residential food gardeners in Western industrialised countries by exploring the case of two neighbourhoods of Toronto, Canada, and highlight the limited number of studies that explore household food production.

From a theoretical standpoint, the design framework proposed by Choi and Blevis [7] provides three main approaches to design through engagement that are relevant to urban agriculture and residential gardening. Everyone depends on the availability of food, but not everyone is involved in the growing process. This study contributes to an understanding of the way in which individuals engage in gardening for food production.

This study is positioned to use qualitative approaches consistent with existing research, to understand urban agriculture in the form of gardening at home by urban residents, while maintaining an interest in what this means for HCI designers. By framing the outcome in terms of design without explicitly looking for solutions to problems, we consider a celebratory approach described by Grimes and Harper [15] useful, and extend these ideas to growing food. A celebratory approach in this study results in consideration of opportunities beyond trying to solve problems (i.e. a corrective approach).

4. RESEARCH APPROACH

Our study involved three stages of data collection, employing a number of qualitative research methods including i) a survey (with open ended questions) of residential gardeners; ii) a focus group and interviews with gardening experts and community gardening leaders, who have been involved in managing community gardens,

and/or training and providing education on gardening practice within the local community; and iii) semi-structured interviews with residential gardeners with a varying level of experience in food production. The data collection began mid 2012 and concluded mid 2013. In all stages of data collection, participants were given the option to remain anonymous, and in such circumstances a pseudonym has been used. By utilizing multiple stages of data collection, we are positioned to address bias validity threats inherent in qualitative research through triangulation of findings, and compare and contrast with existing research. Our study most strongly aligns with the ‘formative user study’ described by DiSalvo, et al. [12], taking an indirect approach whereby the intent is to understand people engaged in gardening, and derive possible design opportunities.

For the first stage of data collection, a survey was conducted with 36 participants (25 female, 11 male, mean age of 37), 33 of whom were currently involved in gardening for food production, and were the focus of the first phase of data collection; of these, 31 had been growing food for more than 1 year. The purpose of the survey was to gain an understanding of their experiences, difficulties and learning processes with regards to food growing. The questions asked were designed to address the following key aspects:

- The most challenging aspect of growing food.
- The most effective way to gain a sense of seasonality.
- Why and how the participant become involved in growing food.
- What the participant enjoys about growing food.
- What websites or mobile applications did participants use as information resources to help their gardening practice.

Participants for the survey were recruited via mailing lists of our partner organisations on the ARC Linkage grant (Cityfood Growers), other social groups involved in urban agriculture (e.g., PermaBlitz Brisbane and Northey Street City Farm), social media such as Facebook and Twitter, and word of mouth. The analysis of the survey outcomes helped to inform and guide the questions for the semi-structured interviews, as well as the interactions with community experts.

We then conducted two semi-structured interviews (1-2 hours), and a focus group (2 hours) with three expert gardeners within the local Brisbane community as the second stage of data collection. Experts in this case refer to people with over 10 years of gardening experience, and are either involved in the operation of

Table 1 Stage 3 Interview Participant Demographics

Participant	Age	Sex	Property Type	Location	Property Occupants
P1	24	F	House – Owned by Family	Outer Suburb	3 (parents and sibling)
P2	34	F	House – Owned	Suburb	1
P3	38	M	House – Owned	Suburb	2 (partner)
P4	31	F	House – Rented	Suburb	3 (friends)
P5	26	M	House – Owned by Family	Outer Suburb	6~12 (family)
P6	37	M	Townhouse – Owned	Suburb	1
P7	46	F	Apartment – Owned	Inner Suburb	2 (partner)

Table 2 Stage 2 Expert Participants Background and Participation

Expert	Sex	Background	Interview	Focus Group
E1	M	Operates a local business that provides information to subscribers to a website, in addition to facilitating training workshops teaching people gardening practice.	No	Yes
E2	F	Manages a local community garden in an inner-city suburb of Brisbane, in addition to maintaining a database of seasonal planting information.	Yes	Yes
E3	M	Co-founder of an inner-city City Farm, and has run Permaculture Design Certificate courses.	No	Yes
E4	M	Manages a Facebook page, and is a host of a nationwide gardening television program.	Yes	No

companies or community groups engaged in gardening for food production. All experts had also been involved in training or teaching less experienced and novice gardeners. Specific information about each expert and their participation is shown in Table 2. The focus group involved discussing the way the experts engaged with novice gardeners. In addition to observing and interacting with experts on a short field trip to a nearby community garden as shown in Figure 1, we conducted exercises to determine a consensus of main factors to consider when making planting decisions. Notes were taken during and after the focus group, and audio was recorded during the community farm field trip. The interviews with expert gardeners provided additional information and insights that were hard to gain from residential and novice gardeners, and allowed us to understand some findings from an experts perspective. These interactions with experts also served to inform the final stage of interviews.

Finally, the third stage of data collection involved seven semi-structured interviews (ranging from 20 to 50 minutes in length), conducted with residential gardeners. We drew on convergent interviewing technique [10], which means the recruitment used maximum variation sampling [24] to seek a diverse range of participant backgrounds and situations, and continued the interviewing process until no new themes were becoming apparent. The metrics consisted of basic demographic information (age and gender), in addition to information that would directly impact their ability and method of gardening practice – their housing situation (property type and occupancy). The breakdown of interview participant demographics is shown in Table 1. The ‘property occupants’ field refers to the current living situation, and although some participants spoke about the involvement of other members of the household with the gardening practice, that is not reflected as part of the metric. P1 lived in a rental property and was unable to practice gardening at her residence in Australia, and instead discussed her gardening experience in Germany. The interview questions focused on the following topics: understanding the way participants approached gardening; encountering and responding to challenges and difficulties; how they acquired knowledge and experience related to gardening (including the people and technology they interact with as part of this process); and then how they share knowledge about their experiences. The interview recordings were reviewed and annotated.

A process of thematic analysis was used to derive the themes [24], primarily from the third stage interview data, and supported by the first stage survey and second stage interactions with experts. The third stage interview annotations were coded and grouped, before similar codes were combined. The resulting groups of codes provided the basis for six key themes presented below. The other

sources of data, while informing the types of interview questions and providing a broader perspective of residential gardeners, also provides additional information that we have drawn on to strengthen and expand on the themes. This informs a discussion of these themes, and a broader theme of shared knowledge, understanding residential gardeners as a type of community rather than individuals.

5. FINDINGS

The following subsections describe the themes identified from the interviews with residential gardeners, supported by data collected from the survey and focus group with experts. There are six key themes, relating to the experience of gardening:

- Learning through Experimentation and Observation
- Commitment for a Low Priority Activity
- Social Motivation and Encouragement
- Limitations of Existing Technology
- The ‘Bush Tucker’ Factor
- Barriers to Engagement and Participation

5.1 Learning through Experimentation and Observation

Fuzzy Logic refers to reasoning that is approximate rather than fixed, and this provides a good analogy to the learning process, and outcomes of gardening practice. If two gardeners were to choose plants of the same type, grown at the same time, with the same conditions, the outcome of their process may differ. That is to say – the outcome of gardening is not deterministic when looking at individual plants (one may grow better, taller, or succumb to disease or be consumed by native wildlife).

As a general learning approach to gardening, trial-and-error through experimentation was the most commonly mentioned approach (13 of 33 responses) when the survey participants were asked about the most effective approach to gaining a sense of seasonality (deciding what and when to plant). This was followed by observation of local farmers markets, on the basis that if a local farmer is growing and selling particular produce, then it is likely that it is time to harvest (and grow) said produce.

All interview participants (P1-P7) described as part of their approach the role of experimentation, which impacts what they plant, how they care for the plant, and what they learn from the observed result. The experiments included planting different varieties and foods based on experiences living overseas (both P2 and P3 experimented with food plants based on experiences living in New Zealand and Italy respectively), to growing certain food



Figure 1 Interacting with expert gardeners during a focus group at a community garden near the university campus.

varieties based on what they wanted to eat. Some participants found failed experiments discouraging, such as P1 and P5, who both had situations where many crops were consumed by insects in a short space of time. P1 had found that the “snails eat everything,” and that had discouraged her from going beyond what she had previously found to work. This attitude, however, was not universal as the attitude of P6 demonstrated with a very relaxed attitude to failure: “Whatever grows, grows. And what doesn’t grow, it just dies.” (P6). This attitude was linked to P6’s time availability to engage in gardening practice, and relates to the next theme.

E2 indicated that the most common reason new people get involved at her community garden stemmed from a position of being unaware of a specific activities relating to growing or garden setup, suggesting observation as an important means of gaining knowledge and experience. E2 lamented that the gardening was often seen as more difficult than it actually is: “...the whole gardening seems so complicated to so many people, when it really isn’t, it’s just common sense, and if you could somehow demystify so much of that, you know and ‘easy 5 steps to making compost’, ‘how do I plant beans’, ‘how do I plant lettuce?’, ‘what do I need?’” (E2).

5.2 Commitment for a Low Priority Activity

Living in urban environments, gardening is not a typical full-time job, and for those interviewed, it is an exercise performed with limited time. Participants varied in their ability to invest time tending to their garden, typically allowing for 1-2 hours, most weekends. As a result, issues can arise such as those experienced by P3, who found that when the garden was inspected during a weekend, particular produce was not ready for harvest, but by the next weekend (the next time he had available to work in the garden) it had over-ripened and was ruined: “We waste a lot of food because we don’t pick it up at the right time” (P3). This view conflicted with the experience of E2, who had found that gardeners value their food because of the effort invested in the growing process: “If you spent 6 months growing a cauliflower, you ain’t going to throw it away. You know, it’s just such a fundamental link that if you grew it, you really value it” (E2).

As an approach to deal with limited time, P6 introduced an automated irrigation system to help maintain the garden, by reducing the ongoing time commitment required. No other participant spoke of automated systems or processes to streamline their gardening activities, although in some cases such as P2, her garden was entirely pot-plants, and the mobility of the pots’ location was not conducive to a fixed system.

From the perspective of experts, the idea of efficiency was discussed in terms of the selecting the right plants for the job. E2 spoke about plants that the purpose of different plants. If they do not provide food for humans, then perhaps they provide food for local wildlife, or help encourage pollination of crops. E4 by contrast spoke about gardener’s expectation of growing food they buy in supermarkets, and how varieties of plant that may be suitable for large-scale agriculture are not necessarily the best options for home gardens (in terms of resilience of the plant, and effort required by the gardener).

5.3 Social Motivation and Encouragement

For many, family and friends serve as the context for people to get involved in gardening, as well as sources of trusted information about gardening processes, and understanding the results and failures. Family was mentioned by 6 of the 7 interview participants when talking about how they became involved in gardening, either directly as a motivation (E.g. shared desire to grow food) or just a historical context and initial knowledge (E.g. fond memories and childhood experiences of gardening with family). During the survey, in response to the question about how participants started growing their own food, the most common response included a mention of family or friends (13 of 30).

Most interview participants, and 16 of 33 survey participants indicated the actual practice of gardening is engaged in as a solo activity. Interactions with others about gardening experiences are therefore not something that is expected to occur at the same time or place as actually gardening activity.

5.4 Limitations of Existing Technology

The interview participants, especially those with limited gardening experience, viewed the usefulness of existing online resources and networks with some scepticism. For the novice, use of the Internet as a resource is not simple or straightforward. The difficulty relates to intimidation of the way in which people interact online: “I think it’s intimidating to see all these people growing food and being really, really good with it, but not really um, like, trying to become a part of that, wait a sec, I don’t really, these people are really passionate about growing food. While I’m passionate, it’s just starting it, it’s just a hobby, it’s not meant to be more than that.” (P5)

In the survey, we asked participants what online resources they used, and what made these resources useful to the participants. There was a mixture of online websites such as Gardening Australia (abc.net.au/gardening) mentioned, and the most commonly given reason for using any particular resource was the provision of locally relevant information: “Everyone’s got their own particular way of doing things, and I find that things like forums get very confusing for particularly new people trying to get into something like that.” (P4)

“The information is, like so many options that it could be that to actually decide which one it is, it’s too difficult.” (P7)

Experts also noted difficulty in making sense and discerning quality of gardening advice for inexperienced gardeners:

“Hundreds of sources, and when people go to research it, they don’t know what’s reliable” (E2)

5.5 The ‘Bush Tucker’ Factor

‘Bush Tucker’ is Australian slang that refers to native food plants in Australia, and this theme refers to local and cultural context of gardening knowledge and information. P4, who had previously studied horticulture, explains the local context issue: *“One of the stumbling blocks of the Internet is a lot of it is written for northern hemisphere, and doesn’t necessarily apply the same way to us in the southern hemisphere.” (P4).*

This issue is relevant to the previous theme of limits on existing technology, and also applies to the utility of existing online resources as relevant to the Australian, or even Brisbane local context. This impacts the type of plants that can be grown, with changes to the seasons, weather, soil composition, and availability of different seeds or tools. There are a number of resources that are specifically Australian, and even specific to the context of Brisbane (such as brisbanelocalfood.ning.com), so the issue becomes one of visibility. This echoes an outcome identified by Odom [23], that calls for greater visibility of local urban agriculture practice – in this case specifically to provide residential gardeners with easier access to locally relevant knowledge. When survey participants were asked why they prefer particular gardening websites, the most common responses were that it is specific to their local context (8 of 22) and contains high quality information (5 of 22), suggesting that increased visibility of good local resources will benefit the community.

5.6 Barriers to Engagement and Participation

There were three common areas where participants encountered difficulties and barriers to their gardening practice. These relate to two dimensions of the physical environment – space and maintenance – as well as the broader issue of accessing knowledge.

5.6.1 Space

The first of these issues applies to the amount and configuration of physical space available to participants to create a garden. Those that had previously rented (and P4 that was renting at the time of the interview) expressed some frustration with regards to gardening. Participants who rented felt little connection or ownership over the space in which they could possibly garden, and in some cases the landlord (or body corporate) held conflicting views on how space could or should be used: *“It is very challenging for people in rental situations to setup their own resources for long term. Um, you need size, space, stability to be able to set yourself up to be, you know there are things you can do in any sized space obviously, but in terms of being able to produce a decent range of vegies, or you know, a sustainable range of foods, it can be really difficult in the rental market when you never know when you’re going to be moving again.” (P4)*

For P2, who felt unable to have a garden at her rental property, had plans to create a garden when she became a property owner: *“One of the things that really annoyed me about renting was that I couldn’t have a garden” (P2)*

The configuration of gardens for residents of urban spaces varies, given it is not practical for all residents of an urban environment to have an area of dedicated backyard. For participants who were not renting, the availability of space varied: from indoor planting in a repurposed fish-tank (P4) as a method of both avoiding possums, and avoiding potential conflict with their landlord because of different ideas of how the yard should be presented; to a balcony

garden (P7) made entirely of pot plants; to a large front yard space (P5) where relatively flat land was located on a hill. The availability of space at a residential property is a fixed variable (unless the participant moves), and this presents an opportunity to try and determine what approach to the actual garden design would be most suitable.

5.6.2 Maintenance

Once participants have set up and begun to grow their own food, there are ongoing maintenance tasks to perform to increase the likelihood of successful crops. This presents a different set of challenges of knowing what and how to effectively manage a garden. These include issues such as the state of the soil, and preventing and/or treating the issue of pests and plant diseases. Wildlife in a city such as Brisbane can be a problem for some participants, such as P4 who had ongoing issues with possums regularly eating or destroying plants, drastically increasing the measures needed to maintain a garden: *“Growing food crops is difficult when you have to, almost use an Avery to garden in.” (P4)*

Maintenance as a barrier to engage in gardening practice was the most common response in the survey when participants were asked what they found most challenging about food production, with 21 of 30 survey participants described the management of pests and diseases (with 5 explicitly mentioning a preference for organic or non-synthetic pesticides). The second most common aspect of maintenance mentioned was that of the weather. This includes unpredictable weather on a day-to-day basis, as well as managing natural disasters, especially given Brisbane’s susceptibility to flooding [5]. In addition to this, artificial flooding that P2 regularly experiences, where parts of their property floods every few months due to a council pipe.

5.6.3 Knowledge

Knowledge of what, when, and how to plant, or lack thereof was the other commonly cited issue for multiple interview participants, referring to failed experiments. This impacts how effective the gardening is at producing food, and relates to the limited time commitment theme above. For example, P5 found that all of the type of crop he was growing (broccoli) became ready for harvest all at the same time, and his family was not able to effectively utilise the produce before it expired.

To understand this issue better, during an interview with E4, it became apparent that while most people are aware that different varieties of crops exist, what they fail to know is that trying to grow the same varieties that would be found in supermarkets is not necessarily the best approach for home gardening. Varieties of produce from supermarkets (described as ‘modern crops’) are chosen because they provide large farming operations an effective output at a predictable time. These differ from ‘open pollinated crop’ varieties, which are less suited to mass production by large-scale agriculture operations because of the variability in when they become ready for harvest; however, this would often make them better suited to residential gardeners because they are more durable. Both E2 and E4 discussed how the labels on plants, and seed packets provide basic information about the planting process, and tend to be the default location where gardeners seek information.

E2 indicated during both the focus group excursion and separate interview that a common line of questions she receives in her work at a community farm is about what to foods can be grown to meet a particular dietary requirement (E.g. ‘what plants do I need to eat to give me foliate?’), or other specific vitamins or minerals.

6. DISCUSSION

The findings presented so far have explored themes without explicitly linking to the design impact for HCI practitioners. This discussion looks to highlight the way in which interaction designers can act upon the opportunities and challenges found. Our design considerations favour a celebratory rather than corrective approach, given a number of parallels to Grimes and Harper [15], which discusses similar connections between HCI and food, but from a consumption perspective. The discussion suggests six areas of consideration for interaction design working with urban residential gardeners:

- Design for Reflection
- Design for Brevity
- Design for Social
- Design for Transparency
- Design for Local
- Design for Commons

6.1 Design for Reflection

Gardening is an activity that is not strictly deterministic. This is not necessarily a problem to be fixed. While the outcome of one season of planting could differ from another for a variety of reasons, this experimentation and observation as an approach to learning and building confidence through increased experience could be the focus of HCI interventions. We suggest that capturing the experimentation process and creating opportunities for reflection on gardening experiences will improve the utility of observation, given the use of reflection in problem solving and learning [27]. This process of reflection on gardening practice forms part of the broader call for critical reflection on the food practices by Choi et al. [9]. We envision a practical response to this could take the form of a storytelling platform, drawing on the needs of gardeners and existing storytelling platform experiences within the HCI literature [26]. This could involve the use or repurpose of existing platforms such as Twitter (for brevity) or WordPress (for rich functionality), or involve a purpose-built system, in order to better accommodate the other design considerations presented.

The experimental approach to gardening by our participants was guided by the desire for specific foods: to replace food that is currently purchased; or to grow food that holds cultural significance to the gardener, but that is not typically be grown locally. Failure for any given experiment will have a varied impact on the gardener, as we found during the interviews – some participants were discouraged, others began to try growing different crops.

6.2 Design for Brevity

The priority of gardening for urban residents must compete with other aspects of their daily lives. Understandably this priority can be low, and HCI practitioners should respect and consider this as part of understanding the context for design. In practical terms this has a number of implications, including what target platforms would be most easily accessible, and whether an intervention could be used in-situ or separate from gardening practice. This would also guide how information is presented, focusing on giving meaningful advice on the effort required to grow different food crops, as well as how to stagger planting or harvesting to decrease the likelihood of lost produce, according to a gardener's schedule. Taylor et al. [30] discuss the time spent gardening by participants in a UK study as 'pottering,' activities that are performed during

leisure time. This description is given to the more general gardening act, rather than the food-growing purpose of this study. However, the idea that gardening falls into a category with other competing activities reflects the nature of our participants' time investments.

The prospect of considering automation as part of design is interesting, where in the case of P6, an automated household gardening irrigation system served to reduce the maintenance time commitment. This demonstrates opportunity for interventions that may focus on mechanical or electronic automation. This provides a contrast from the findings of Heitlinger, et al. [16], in which the context of community farming, suggests that automation is seen more as a potential burden. Similarly at another gardening community in Brisbane, Odom [23] found participants skeptical of the value of sensors and automation. In both of these studies the skepticism relates to the increased effort required to maintain a system compared to the promise of reduced effort required, and that the use of automation or sensing creates a disconnect between the gardener and their garden. The potential of garden automation should not necessarily be discarded, but rather we should be careful when considering the relationship between what automation might offer, versus its imposition on the values of the gardener and both the setup and ongoing resource costs. It seems that measures that can work effectively for residential gardeners, do not scale to community gardening environments. This lack of scalability seems related to different priorities and values of individuals compared to communities, in addition to time constraints, which Lyle, et al. [22] identified as a consideration for design at a Brisbane city farm community.

6.3 Design for Social

Social interaction with friends and family is important to residential gardeners, and as such HCI practitioners should consider the existing social networks and methods of communication gardeners already use for discussion. These interactions are relevant to both initial and ongoing participation in gardening practice, so allowing for social interaction through design is useful. This aspect of designing for social gardening provides an interesting alternative (or complementary) reason for gardening compared to improved food security or ecological sustainability. Pearson, et al. [25] suggest residential gardening is often driven by relaxation, which is consistent with Taylor, et al. [30] study of gardening as 'pottering'. For HCI design, there is the opportunity to consider ecological sustainability as an implicit goal or outcome, while explicitly encouraging social interaction.

Our experience when enquiring about gardener interactions revealed the interaction with family and friends primarily occurred separate to the actual activity of gardening. The design consideration we suggest is to engage with gardeners in the context of their existing social connections. In a practical sense this would result in consulting with target users before integrating existing online social network platforms, or creating new systems with social network integration. When considering why people are motivated to engage in gardening in research such as this study, the assumption tends to involve environmental sustainability as a goal, where perhaps the value of community should be the focus. If designing for the activities of gardening that occur outside of the physical acts of gardening, this provides a wider scope for the types of interventions. This, however, is still constrained by the limited time and effort gardeners are willing to invest.

6.4 Design for Transparency

The way in which information is presented through interactive technology should consider the novice case, where the ability to discern information quality is lacking. When allowing for social interaction and sharing of information, there is a risk of gardeners encountering conflicting opinions. A response could be to consider limiting the scope of interactions to trusted family and friends, or providing a reputation system to filter relevant content. This issue of different opinions is made complicated as the lived experiences of the different opinion holders may hold true, due to both the differing location contexts, as well as the non-deterministic nature of gardening. A gardener's trust in the information presented via interactive media, and expectations of data relevance should be the focus of consideration. For HCI practitioners it is difficult to ensure information quality and relevance where users are responsible for creating content. As such, where data is crowd-sourced or users share experiences with each other, a reputation system may be a matter of practicality [32].

6.5 Design for Local Contexts

The importance of understanding location and 'place' as a key to understanding a gardener's context cannot be overstated. This applies on a *macro*, *meso* and *micro* scale, with hemisphere, country, city, and even street address providing essential pointers for relevant information and useful approaches to successful gardening. Gardeners must be able to distinguish between information that applies at different scales of locality, and be able to translate general information about specific plants or growing techniques to the local context. Location context relates to the previously described consideration of transparency, as it impacts the quality and relevance of information.

Two practical responses as examples to this consideration would be to champion and enable connections between existing local communities; or to tailor gardening information based on a user's location. Mobile devices that are location aware create an opportunity to plot gardener information and experiences on a map responds in-part also to increasing visibility of local urban agriculture, an opportunity identified by Lyle, et al. [22] and Odom [23].

6.6 Design for Commons

The development of technology should be able to respond to at least one of the three common problem areas people experience – space, maintenance, and knowledge. This aspect stands apart from the other considerations, as it focuses on corrective aspects of design, rather than celebratory aspects. Relevant to all three areas identified is the aim of improving gardener education. The approach of improving gardener education was also suggested by Heitlinger, et al. [16], in the context of disseminating information across an existing community garden, which differs to the needs of residential gardeners, who have a varied range of gardening spaces and location contexts. It is important to note that a lack of knowledge also poses potential risks in gardening practice that can negatively impact health, such as pollution in the form of soil toxicity, common in older cities [4].

Our findings regarding barriers to entry offer three foci for HCI practitioners. In the case of interactive technology development, it is possible to address more than one of these issues as they interrelate. For example: a mobile application could provide knowledge or insight as to how to effectively use space, and what plants are best suited to the gardener's local environment. Alternatively HCI practitioners could focus entirely on providing reminders for performing maintenance tasks on the garden,

identify and suggest treatment for pests and diseases; or let a user know when particular produce will be ready. An intervention could provide information about the choice of plants, what is more likely to grow given the gardeners local context, compared with their eating preferences. It is important however to understand that interventions such as the examples above may be used as guides, and the information disregarded as part of the experimentation process to focus on a cultural or dietary consideration.

7. GROWING CONNECTIONS – SHARED KNOWLEDGE

A common thread across these themes and implications for design, is the way in which people engage with each other and share knowledge: allowing for shared reflection on gardening practice; flexible design for different types of commitment to gardening; recognising the importance of friends and family as a form of motivation; tailoring for meaningful exchanges of information that are locally relevant; and, the commons, across the identified problem domains of space, maintenance and knowledge. It is from this that we see an opportunity to understand residential gardeners as a local community for whom knowledge sharing is key. By considering how local networks of gardeners can interact with each other, and how the design of technology can better enable or facilitate meaningful interactions (and urban agriculture can be understood as beneficial to society and environmental sustainability), we can treat residential gardeners as a community (rather than individuals) that exhibits civic intelligence [28]. Civic intelligence, as opposed to collective intelligence, is applicable in this case because of the connection between the act of gardening, and its contribution to sustainability (among other society benefits). The corresponding design pattern articulated by Schuler [29]: '#1 Civic Intelligence' describes a need for, among other things, '*tools of civic intelligence that can help integrate thought and action more effectively*'. We propose that the HCI design can contribute to provide tools, by drawing on the findings of this study (in particular the social, reflection, and commons) could result in a platform that promotes social interaction and knowledge sharing among community members.

Networks of gardeners can be understood in terms of social and familial connections as we have found, but also amongst local backyard gardeners, whom Larder, et al. [19] found described themselves as a 'food-based community'. These networks are used for sharing knowledge, gardening tips, and produce amongst the local neighbourhood. Expanding the notion of community amongst gardeners would provide an opportunity to explore the way residential gardeners form groups such as the Brisbane Organic Growers Inc, (an example mentioned by several of the experts), or communities with a shared purpose and/or location, such as our work with Northey Street City Farm (NSCF), or PermaBlitz Brisbane.

8. CONCLUSION

In this study we have discussed the role of urban agriculture in Brisbane, and the existing research that explores the HCI perspective of food production. We have presented a series of data collection methods that resulted in six key themes and a discussion of design considerations: the learning approach of observation and experimentation and the non-deterministic nature of gardening; the practical limits of commitment to gardening as part of urban living; the need to engage with friends and family to encourage ongoing gardening practice; the downfalls of existing online gardening information for novice gardeners; the role of context to garden in Australia; and, the common barriers to gardening in

urban environments. Given the societal, economic, environmental and health benefits of promoting urban agriculture, the design considerations derived from these themes present a number of opportunities for celebratory HCI approaches to future interventions. In particular the potential to build on the theme of shared knowledge, to reframe residential gardeners from individuals to a community with potential to engage in civic intelligence.

8.1 Limitations and Future Work

This study was focused on the city of Brisbane, and as such the generalisability of the findings will be limited. It would be beneficial to conduct similar studies in other cities of Australia as well as other countries with different population demographics, where cost of living and access to food might yield different priorities and attitudes to residential gardening in urban spaces.

The sample sizes of each phase of data collection were small, however, utilising a mixture of data collection methods, and the variation in sampling of interview participants should reduce or mitigate this limitation. The discussion draws on existing literature to strengthen the findings and ground the contribution to research.

The future direction of this study is to design and develop a platform that responds to the opportunities presented, drawing on the idea of residential gardeners as a community, and how they can exchange ideas and share their stories. Such a response would focus on creating opportunities for reflection as part of gardening experimentation. A design that uses storytelling on a mobile platform would allow for quick, serendipitous usage, capturing moments in the garden, and encourage sharing of knowledge, and ongoing engagement with the local community of residential gardeners. The design of this platform will enable flexible capturing the story of the gardening process, utilizing multiple media types given the power of modern smartphone hardware, and pervasiveness of ownership in Australia of 65% [14]. Storytelling platforms may also offer an approach to engage with established gardening communities [E.g. 22, 23] given existing community uses [11].

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