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Interactive Media Tools for Sustainable Food Production

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***Abstract*—Gardening is a transformative activity with various health benefits, contributing to immediate and long-term mental and physical health improvements. Home gardens contribute to biodiversity maintenance, identity and community preservation and food production. They also serve as an efficient platform for the transmission of collective memory related to gardening practices, although they are vulnerable to periods of turbulence or crisis. The disappearance of local and tacit knowledge related to agriculture within urban landscapes has led to an 'extinction of experience' in human-nature interaction. This collective 'forgetting' poses a significant threat, especially in times of major crises, contributing to potential urban food shortages. To address this issue, interactive media tools emerge as powerful educational platforms capable of fostering knowledge sharing and learning about sustainable food production, nutrition, and ecological systems. This work aims to study and prototype an interactive media tool to support the dissemination of sustainable farming techniques. It seeks to leverage engagement with such tools to facilitate the sharing of best practices and foster intergenerational learning, ultimately contributing to improved community cohesion and collective action in urban areas. By promoting awareness and understanding of horticultural processes, interactive media has the potential to inspire more individuals to participate in distributed food production, contributing to a more resilient and sustainable urban food system.**

***Index Terms*—home gardens, interactive media tools, intergenerational learning, resilience, sustainable urban food systems**

Introduction

The activity of gardening has multiple known health benefits. These include immediate and long term mental health improvements, and numerous positive outcomes for physical health [1]–[3].

Home gardens are an important source of food for a large number of urban residents [4]. These spaces can serve as a substrate for education interventions and policies that strengthen a sense of community and incorporate interactive methods [4], [5]. As third places in the urban landscape, both community and home gardens foster connections between people and to a location, increasing social connection and food justice, and supporting identity and culture preservation [4], [6], [7]. From an environmental perspective, home gardens also help maintain biodiversity [8].

Although this aspect can be overlooked, gardens themselves are a remarkably efficient way to retain and pass down collective memory on how to raise food and maintain the regulatory ecosystem services necessary to do so [9]. As an artifact of social-ecological memory, however, they are not immune to periods of turbulence or social/ecological crisis that can suppress that memory [9], [10].

Local and tacit knowledge related to agriculture is disappearing from metropolitan landscapes, creating an 'extinction of experience' of human–nature interaction and a collective 'forgetting' of how to grow food, significantly increasing the potential urban food shortages in times of major crises [5], [9]–[11].

Interactive media tools can serve as educational platforms, fostering knowledge sharing and learning about sustainable food production, nutrition, and ecological systems [12], [13]. These tools can provide access to educational resources, virtual tours of urban farms, and online courses on urban agriculture, among others [14]–[17].

By involving residents in distributed food production, individuals can actively participate in growing their own food, fostering a sense of ownership, empowerment, and connection to the local environment. With awareness and understanding of food production processes, interactive media tools can inspire more individuals to engage in distributed food production as they can serve as a means to organize community gardening events, workshops, and knowledge-sharing sessions, fostering social cohesion and collective action.

In this thesis we want to study and prototype how an interactive media tool can support the dissemination of sustainable farming practices. We will explore how we can leverage the engagement with such tools to enable relationship-building with the natural world. We also hope to contribute with a set of guidelines for the design of interactive media tools for gardening within a post-human context [18].

Background

Geographic context

Gardening is an activity that heavily relies on its geographical and physical context. Given this specificity, it is important to position the context we will be intervening in. Madeira Island is an oceanic island of volcanic origin situated in the Madeira Archipelago in the Atlantic Ocean. Climate-wise, it fits into maritime temperate, Mediterranean, and subtropical

climates, with its steep slopes allowing for smaller microclimates to occur. Administratively, it is an autonomous region of Portugal [19].

Madeira has a rich agricultural tradition, serving as a provisioning center for other Portuguese territories shortly after its colonization in the 1420s [20]. This continued with agriculture being the main economic activity of the island well into the seventeenth century. When sugar cane was adopted as a profitable cash crop in the middle of the fifteenth century, food production was relegated to higher altitudes and comparatively less ideal areas [21].

Even now, cash crop production, combined with relatively high import rates of food products, mean that 75% of agricultural production is exported [19]. With increased human activity and tourism pressure, agricultural surfaces and natural areas have tended to decrease [19], [22]. Madeira is also very susceptible to anthropogenic pressure, as climate change poses a significant threat to ecological systems in islands, including food production [19], [23], [24]. This places increased pressure on food systems and makes the island more vulnerable to climate hazards and supply chain issues [22], [24].

The role of home gardens in maintaining food security in Madeira is unclear in the literature, and their contribution to the local economy seems to remain unstudied. It is likely that their contribution is similar to that of home gardens elsewhere. However, with their abandonment and the aging and displacement of farming communities, knowledge loss has probably already taken place [10], [21].

Interactive media for home gardening

There is a vast corpus of work exploring motivation, conditions and interventions for gardening at several levels. Study areas that touch on the subject include Agriculture and Horticulture, Ecology, Botany, Environmental Science, Social Sciences, Nutrition and Health, Landscaping and Garden Design, Urban Planning, Policy Making, Economics, and Education and more.

Despite this, it seems that home gardens may be somewhat understudied from an interactive media perspective, as the literature on them corresponds mostly to their health benefits [1], [2], socioeconomic aspects [3]–[7] or ecology [8]. This may be because home gardens are relatively less accessible than urban or community gardens from a research perspective, as they tend to be located within people's homes. Home gardeners may also be less likely to adopt software based solutions, as their population seems to skew toward older generations. As such, a lot of existing interventions are geared towards commercial farmers or community gardeners.

In Quicktales, Lyle et al. [16] take an open, freeform, storytelling-based approach to sharing gardening experiences. This mobile platform allows users to create their own garden stories, based on the idea that storytelling can contribute to increased public visibility of agriculture and gardener interaction [16]. Participants also used the platform as a logging tool, or as a way to find solutions to issues. [16]

The Quicktales [16] approach seems to be unique, as other authors tend to tackle the subject in a more specific tech-oriented form. Both Heitlinger et al. [14] and Zonda et al. [25] use technology as the basis for learning and decision making, with physical and virtual components.

Also featuring a mobile app, Growkit [25] follows commercial solutions a bit more closely, with a network of sensors connected to a central hub. The sensor information, when compared with the recommended conditions for each plant, activates the hub that warns the user if plant needs are not being met [25]. The mobile application includes not only growing information, but also a social component, to foster community connection and learning [25].

With a similar IoT approach to [25], but using participatory design methods, Heitlinger et al. [14] created a data visualization platform and a Connected Seed Library. This library is a physical artifact, in the form of a cabinet, so as to not require specific technology ownership or skill to be used [14]. This interactive, playful artifact works as a shared knowledge base connecting users to their heritage [14]. Contrary to the previous example, one of the goals of this artifact is to challenge the idea of increasing productivity and efficiency through technology [14]. Instead, the authors propose that users engage with tech as a way to validate their own successive nurturing practices toward nature [14].

These examples of interactive media tools for food growing in a home garden context display the variance of approaches and methods within the realm of existing solutions. A cursory review of existing apps in the Google Play and Apple app stores shows similar patterns in content and target audiences, even if their form is limited to mobile apps.

For this review, a list of gardening apps from the Google Play Store and Apple App store was obtained using the following keywords: "garden", "farm", " farming", "agriculture", "plant". In the Google Play marketplace, a "-game" selector was added to each keyword, to reduce the amount of games that would appear. Apps specific to home gardening were manually selected from given descriptions. No general use apps (e.g. home design apps that have garden features) were included. The search was performed in english, and the results correspond to the european/eurasian region of the stores, with only apps available at the time of the search included. A feature analysis [26] was made from images and descriptions present in the app store, as some paid apps could not be accessed.

Of the 181 apps obtained, duplicates were removed. The resulting apps (n=169) were then assessed manually for the presence of certain features and characteristics. A majority of applications (n=112) were specifically directed at commercial growers and farmers. Only 35 apps were explicitly directed for home garden use, and 22 could apply to both contexts, but were not specific in their intended target audience.

According to the features described, the 35 apps for home gardeners can be grouped into seven categories: Comprehensive Garden Planner (n=11); Identification and care (n=10); Guide and/or Magazine (n=6); Spatial Planning (n=4); Care

Reminders (n=2); Plant Identification (n=1) and Social Sharing (n=1).

The largest category, Comprehensive Garden Planner, includes applications that provide comprehensive tools for planning and every day care of a home garden. These apps are not dissimilar to an agenda or project management app, but are geared towards gardening processes. They usually include care recommendations, companion planting suggestions, and some form of journaling or logging so gardeners can keep track of their plants and tasks. They may also include spatial planning sections, allowing users to position plants in a virtual view of their garden, or care reminders.

Second to Comprehensive Planners, we have Identification and Care apps. The focus on these apps is to allow users to identify their flora and provide detailed care guides for each plant. They tend to feature large libraries of plants, including their respective care and watering requirements. Identification and Care apps tend to mirror reminder/task list productivity apps, focusing less on planning a cohesive garden and more on the individual care requirements of each plant. A lot of the descriptions for this category seem to focus on the forgetfulness of potential users as a selling point.

In the Guide and/or Magazine categories we included apps that provide information to users, but do not include any planning or reminder features or other services. These apps sometimes allow users to correspond with experts through advice columns or direct messaging, but have limited social features.

Apps in the Spatial Planning category contain 2d and/or 3d tools that allow for simulations of the position and spacing of plants or garden items. Although apps in the Comprehensive Planner category can include some basic, 2d spatial planning features, the Spatial Planning apps tend to have more variety and detail on the visual planning aspect, and do not include other features.

The Care Reminders category includes two apps that exclusively feature reminders for plant care. Contrary to apps in the Identification and Care category, they do not allow users to identify the plants, and appear to be reminder apps that have been adapted for gardening.

The final two categories, Plant Identification and Social Sharing, are self explanatory. These apps have their category names as features. The Plant Identification app allows users to identify plants and provides some information, but not a care guide. The Social Sharing app is similar in structure to a visual social media app, but is geared towards gardeners.

It is important to note that, as we do not know which apps remained in use after users downloaded them, the number of apps or total downloads in a category may not be indicative of user needs or preferences. Regardless, some patterns emerge: with the exception of the guide/ Magazine category, all other apps follow the established paradigm of increasing efficiency through technology [14]. Several categories include applications that are based on reminder or task management archetypes, and were even included in the productivity section of the stores.

Designing for sustainability

For a broader view into paradigms in interactive media, we can look to sustainability as an issue in Human computer interaction (HCI). Two interaction design research communities, sustainable HCI and non-anthropocentric HCI, have emerged to tackle environmental challenges [18]. In sustainable interaction design, there is a focus on sustainable agriculture, addressing broader socioenvironmental issues related to food production, distribution, and consumption [18]. In non-anthropocentric HCI, scholars advocate for a multi-species worldview, fostering inter-species cohabitation, collaboration, and collaborative survival [18].

Sustainable HCI is often framed as an issue of awareness and persuasion, in part to control resource consumption and correct unsustainable behavior [27]. Given the mobile application examples in the previous section, this extends to a majority of interactive media apps for home gardening as well. However, this model of sustainability has been found to be limited in nature, "conceptually detached from the complex reality of everyday life" [27] and too much focus on individual behavior, "making sustainability an unrealistic pursuit" [27].

Collaborative survival describes how the subsistence abilities of humans and multiple other species are deeply enmeshed [28]. J. Liu et al. [28] suggest three strategies to guide designs towards inter-species cohabitation - "engagement, attunement and expansion". Engagement gets defined as "the shared physical experience of the environment", attunement as "the ability to sense the livelihoods of the nonhuman collaborator" and expansion as a "blurring of nature-culture divisions" [28].

Similarly to J. Liu et al. [28], S. Liu et al. [29] point to concepts originating from permaculture and wild agriculture, where humans work as collaborators with nature. They go further by framing the natural world or "the wild" as another type of lab environment instead of the opposite. This framing is supported in emerging notions in anthropology, and the historicity of nature as one of the first experimental grounds for humanity, a substrate for the scientific method [29]. This is relevant from a cognitive perspective, as this paradigm places focus on learning through experimentation.

S. Liu [18], as a practitioner in gardening and permaculture spaces, upholds posthuman theories as ways to broaden definitions of sustainability and include other stakeholders (like animals and plants) in interaction design. She points to the use of embodiment as a way to better understand the earth and cultivate intimacy with it "with and through technology" [18].

Within this post-human paradigm, the role of technology becomes one of fostering participation in slow, nature-led agricultural practices [14], [29]. Embracing this perspective challenges traditional design paradigms, encouraging us to consider the continuity of all living entities and ecosystems. By centering the design process around the needs of the entire environment rather than solely anthropocentric considerations, we can cultivate the relationship between technology, nature, and the users, ultimately fostering a sustainable and regener-

ative approach to home gardening.

Guidelines and recommendations

After establishing a theoretical paradigm, we can draw from some more pragmatic design guidelines and recommendations. These originate in projects that explore the human-technology-nature relationships and the processes of learning, motivation and reward they contain.

Lyle et al. [30] recorded opportunities and challenges in design for home gardeners. Although this work stems from a human-centered design approach, it is important to acknowledge the human component in a multi-species, post-human system. This is especially true when it is the component we will be directly intervening with. In this study several social and cognitive motifs emerge, interspersed with more practical concerns and finalizing with a list of design recommendations.

Vella et al. [31] investigated the implications of sensing technologies for human-nature relations. In this experiment, participants were provided commercial wildlife cameras they could use to record wildlife in their backyards at night. The researchers found sustained experimentation guided by curious observation and memorable image production created a positive feedback loop, which was only interrupted when labor was higher than reward [31].

Starting with the captured images, participants instinctively engaged in observation and "storying" [31]. This storytelling motif is also present in Lyle et al. [30]. It arises from the non-deterministic nature of gardening, which can be an opportunity for learning [30]. It's also a chance to build confidence through experimentation and observation [30], [31]. The authors propose a practical response in the form of a storytelling platform, drawing on the needs of users and considering existing experiences [30].

The storying participants engaged in in Vella et al.'s [31] study often involved their entire household in the process. This demonstrates the importance of designing for communities, even when hyperlocal. It also demonstrates the possibility to induce new thoughts and connections in human-nature relationships through free interpretation of evocative media [31]. In this case, the localized nature of the intervention added to the effect, generating a sense of care and kinship [31]. Lyle et al. [30] also show the importance of community - as motivators, memory keepers or mentors. They recommend designing for social, encouraging practitioners to "engage with gardeners in the context of their existing social connections." [30].

Vella et al. [31] highlight a common issue between slow, nature-based interventions and research - that of time. Natural cycles play out over seasons, spanning months and years. Short research studies are not necessarily compatible with that aspect of human-nature relationship exploration. The authors did find advantages in designing experiences for the times people are already spending in other regular activities.

These activities should provide experiences with storying potential, and "show a way in which care for the more-than-human can be nurtured through everyday maintenance of our physical and social worlds [32], which also has seasonal and annual variations" [31]. A similar idea appears in Lyle et al. [30]. Gardening as an activity can compete with other aspects of daily life, so designing for brevity involves careful consideration of the gardeners' time and priorities [30]. This includes using easily accessible platforms, assessing whether interventions should be done during the gardening activity or outside of it, and focusing on providing advice on production and plant care timing [30].

Keeping platforms and technology accessible could be considered a design limitation, but as Rosén et al. [33] demonstrate, it can also present opportunities. In their study, a smartphone camera is used as a means to enhance the experience of urban farming. They found participants used the environment photos as memory aids, examination tools, and for sharing, as they were quick and practical to obtain [33]. This echoes the thoughts on effort vs reward in Vella et al. [31]. Poikolainen Rosén et al. [33] found that smartphone camera photography could deepen "the experience of the natural environment, thus supporting both the creation of knowledge of the environment and feelings of closeness, connectedness or bonds towards the environment." [33].

In conclusion, the exploration of human-technology-nature relationships and the processes of learning, motivation, and reward in various projects has provided valuable insights for the formulation of this proposal. Free interpretation of evocative media is important in generating new thought patterns and connections in human-nature relationships. The source for this media can be as simple as a smartphone camera image, or a note.

We also highlight the importance of community engagement, not only with family members or other humans, but with the natural world itself. This fosters a sense of care and kinship, contributing to the success of interventions. It also corresponds to post-human and permaculture principles, where humans are a component of ecosystems. Bringing this to the local context of Madeira, and Funchal specifically, we will explore how these food production and ecosystem paradigms manifest here. We can also use the competition for individuals' time with daily activities and the temporal aspect of slow, nature-based interventions to our advantage. This means integrating our intervention with existing activities, focusing on brevity, and using short prompts instead of being more prescriptive. The idea is to not only enhance the urban farming experience but also deepen individuals' connection with the natural environment, teaching them to notice, reciprocate and engage with it.

Outline and Objectives

Objectives

The primary objectives of this research are as follows:

1) Uncover the current challenges for urban food production in the local context of Madeira Island, especially where they relate to a post-human paradigm and procedures;

2) Prototype an interactive experience that harnesses the power of observation and curiosity in the learner;

The idea is to design an interactive media intervention that helps familiarize newcomers with basic gardening concepts. These concepts would stem from the aforementioned post-human paradigm, so it will be important to evaluate how much or how little this exists within food production methods and processes in Madeira. This interactive media tool would allow for confidence building in newcomers, and ideally also foster intergenerational learning. As participants actively engage in noticing and observing, this would allow them to sift through the variety of possibilities in gardening based on their specific circumstances.

Research questions

The research questions are formulated in alignment with the stated objectives, and are outlined below:

1) What are the current challenges and motivations of aspiring home gardeners in Madeira Island?
2) Through a lens of collaborative survival, what design guidelines can be formulated for interactive media for home gardening?
3) How can an interactive media intervention, grounded in post-human and permaculture principles, aid aspiring home gardeners in Madeira?

Scope and limitations

Starting with the geographical scope, this research will primarily focus on the local context of Madeira Island, with a specific emphasis on Funchal. We will try to understand the unique challenges and opportunities for urban food production in this particular region.

This work will explore the application of a post-human paradigm in the context of urban food production. This will guide the design and evaluation of an interactive media intervention aimed at beginner gardeners. We aim to prototype an interactive experience based on observation and curiosity for learning. The intervention will be designed to familiarize newcomers with basic gardening concepts, promoting confidence building.

We will investigate how the proposed interactive media tool can contribute to knowledge exchange within the community. Finally, recognizing the competition for individuals' time with daily activities, we will design for integration with existing routines, with brief prompts.

Some limitations can also be foreseen. Our findings and recommendations will be specific to the socioeconomic and ecological characteristics of Madeira. From what we have seen in the background section, this is a necessity. However, the results may not be easily applicable to a broader context, considering variations in climate, culture, and agricultural practices. At an adoption level, some individuals may not be receptive to interactive media solutions, especially if the demographic skews toward older generations. Finally, this research will focus on the short-term impacts of the intervention. Long-term sustainability and the enduring effectiveness of the proposed tool will not be fully explored within the scope of this thesis.

Methodologies and Proposed Timeline

Methods

In order to explore our research questions, we will apply a research through design methodology [34]. To answer our first question, data will be collected through surveys and interviews. These surveys will be administered to adult aspiring home gardeners in Madeira. We will then analyze the data to identify patterns, trends, and correlations in the challenges and dynamics of home gardening. We also plan to hold a focus group with urban agriculture practitioners from the "Mãos na Terra" project [35]. "Mãos na Terra" is a socio-educational project that involves local residents, university students and teachers in the cultivation and management of a shared community garden, located at Quinta de São Roque near the University of Madeira [35]. This will allow us to understand the challenges of aspiring gardeners, and obtain guidelines from practitioners.

To address our third research question, building upon the foundation of our background literature analysis, a prototype for the interactive media tool will be made. This will be a mobile application, for reasons detailed in the "Guidelines and recommendations" subsection of the background. Another contributing factor is that smartphones are ubiquitous devices that participants are likely to own or have access to. The initial design will be informed by post-humanism and permaculture principles. This will mean approaching the prospective app as a relationship forming tool, and using observation as a starting point.

During usability testing sessions with participants, we will gather feedback on the tool's design, user-friendliness, and effectiveness. This feedback will involve usability testing, participant observation and pre- and post-intervention surveys. We will then iterate on the prototypes through feedback loops, incorporating the insights from each phase into the following revisions.

To address our second research question, we will combine the exploration of existing literature with the data obtained from participants. This will allow us to identify recurring patterns or themes and areas of alignment/deviation, providing a better understanding of the local context. Ideally, this analysis would also provide us with a set of guidelines that can be generalized to practitioners in other contexts.

Timeline

In Figure 1 a proposed timeline can be found. It includes information collection, development and testing of the intervention. Activities are color coded, with blue for preparatory phases, red for information and feedback collection and green for analysis and writing. The final writing phase is represented in purple.

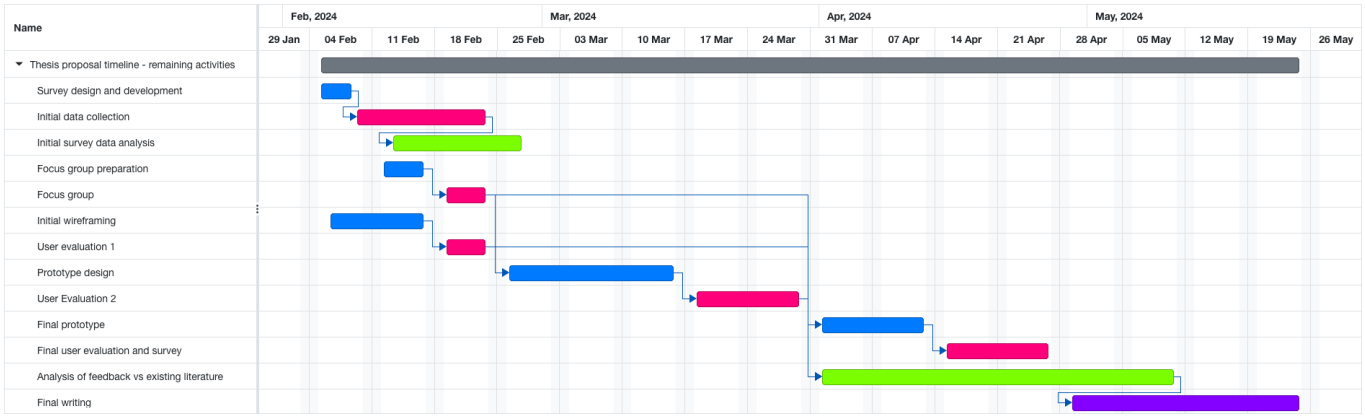

Fig. 1. Gantt chart of the proposal timeline

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