Insectopia – Exploring Pervasive Games through Technology already Pervasively Available

Johan Peitz[1,2], Hannamari Saarenpää[3], Staffan Björk[1,2]

[1]Game Studio
Interactive Institite
SE-412 96 Göteborg, Sweden
{johan.peitz|staffan.bjork}@tii.se

[2]IDC | Interaction Design Collegium
Dpt. of Computer Science and Eng.
Chalmers University of Technology | Göteborg University
SE-412 96 Göteborg, Sweden

[3]Hypermedia Laboratory
Fi-33014 Tampereen yliopisto
hannamari.saarenpaa@uta.fi

ABSTRACT
We present the pervasive game Insectopia, which have been designed by the approach of utilizing commercially available mobile phones to provide context-dependent gameplay. The design and evaluation of the game is described together with a discussion on how this approach can speed up making pervasive games a viable game genre for the general public.

Categories and Subject Descriptors
H1.2 User/Machine Systems; H5. Information Interfaces and Presentation.

General Terms
Design, Experimentation.

Keywords
Pervasive Games, Context-Dependent Games, Bluetooth Harvesting.

1. INTRODUCTION
The rise of pervasive and ubiquitous computing [32] has sparked an interest in applying these new technologies in applications with entertainment purposes. In some cases these applications have explicitly been developed as means of exploring the technology itself (e.g. [29]) but increasingly an interest in the effects of pervasiveness on gameplay, rather than technology, has become visible. With this change in perspective came a change in design; instead of remaking existing games with pervasive computing technology (e.g. [20, 25, 30]), completely new games were developed which had pervasiveness as a core part of the gameplay experience (e.g. [5, 10, 4]).

The difference in gameplay experience has caused these new games to be classified as belonging to a new genre, pervasive games [15], where the adjective pervasive signifies that the gameplay is pervasive rather than the use of pervasive computing technology (see [18] for a historical survey of the use of the term pervasive within pervasive games). One important effect of viewing pervasive games as a genre is that this implies that it has its own sets of concepts, requirements, and archetypes. For the design possibilities of this genre to be understood, these sets need to be developed to the level that a coherent design language for the genre emerges.

An important distinction between pervasive games and pervasive computing applications is that pervasive games stress that the local context (e.g. other players, bystanders, game artifacts, and measurable environmental states) affect the gameplay through game rules. This is to distinguish, on a functional level, between games designed to be affected by their context and those simply designed to be more context-independent than traditional games. The alternative would be to call Snake or Tetris on a mobile phone a pervasive game simply because they can be played "anytime, anywhere", and that the first pervasive games were the Game & Watch machines (or Astragals, the precursors of dice, if the requirement of electronics is dropped). Thus, pervasive games can be said to be more grounded in ubiquitous computing or context-aware computing [26] than in pervasive computing, although the latter has for historical and research community reasons influenced the name of the category of games.

However, many of the developed pervasive games rely heavily on custom-built hardware. This naturally limits the possibility to reach a large user group and requires that a significant part of development costs go towards hardware development rather than gameplay or media content.

In this paper we report of an alternative route to exploring pervasive games using the game Insectopia as an example. Instead of using custom-built, or even commercially available, hardware that few people currently own or use in their daily lives, the approach is to work with the devices that already can be classified as being pervasive.

2. Background
The EU-funded research project IPerG (http://iperg.sics.se) was initiated to explore the design, commercial and cultural aspects of pervasive games. The project is structured into several game-producing showcases that run in parallel, each focusing upon creating pervasive games of a specific type, in order to achieve sufficient diversity regarding game types. Although many of the showcases focus upon developing new experiences through use of custom-built hardware [13] or a rich set of devices [19], the main focus is upon exploring the genre of pervasive games, which as mentioned above does not necessarily need novel hardware or even hardware at all [16].

Insectopia was developed within the Socially Adaptable Games showcase of IPerG, a showcase that looks at games not defined by the technology they use but by the fact that they can adapt either

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actively or passively to changing social environments. Based upon this perspective it takes an open approach to technology, looking at augmented board games [22, 23] for the first half of the showcase and at mobile phone games for the second half. Given that dedicated or hardcore gamers typically plan their game sessions to minimize disturbances including social encounters (with the exception of those within the game context), this target audience has consciously been avoided in Socially Adaptable Games. Instead, the showcase has created more or less casual games, i.e. games that are easy to learn, have simple rules, and do not require significant time investments from the players.

Custom-based technology was used in the first half of the showcase but a decision was taken to avoid this for the second half of the showcase. This was motivated by the intention to focus on pervasive games feasible for the general public within the near future. Having any form of additional hardware dedicated for gaming purposes was thought to significantly reduce the acceptability from casual gamers. Therefore the natural candidate platform for these games was mobile phones.

2.1 Project Goals

The design project that produced Insectopia was one of several game designs during the second half of the Socially Adaptable Games showcase (the other game designs were Coup, GeoQuiz, TrackIt, and Deluge). Based upon conclusions from the first half of the showcase, all the games in this phase had some common research goals; to explore how games can support several different layers of participation, to understand questions of intrusiveness in pervasive games, explore different ways to sense the presence of other players in pervasive games, and to pace pervasive games to fit the real life schedules of players.

Each game within the showcase explored the research goals by selecting design goals that aimed to inform the research questions while providing a good gameplay experience. Insectopia was the result of choosing the design goal to use novel context-aware technologies available in mobile phones for gameplay. This choice ensured that the game would be context-dependent in the pervasive gaming sense and would provide gameplay impossible without that technology. By choosing to use a technology able to detect some form of context, we had expectations that questions regarding both the research goals of intrusiveness and presences would arise.

Another design goal that steered the design was to have many short play sessions that together built up a game session, rather than having a game session consist of only one or few longer play sessions, or multiple short game session loosely linked through extra-game mechanics such as ranking lists for high scores (see [6] for a detailed discussion for these concepts). The motivation for short game sessions was that these would require least commitment from the players, making it easier to stop the game activity.

Although play sessions could be short, the research goal of supporting the pacing of a game to fit the real life schedules of players could also imply that players might also want to have short *breaks*. To make this as simple as possible an additional design goal to support intermittent playing was added, i.e. allowing players to have ongoing play sessions while letting the players themselves solely decide when to make actions within the game. A corollary of this was that players should not feel pressure when to play (and not play) depending on the system or other players.

2.2 Choice of Technology

The initial design requirement of using a mobile phone offered a limited amount of technologies to utilize. In addition to this, technologies had to have some amount of context-awareness to be interesting for the project. However, since the technological possibilities of mobile phones has not been fully explored in pervasive games this was still seen a fertile research area.

Five candidates were identified: infrared communication, digital photography, positioning through triangulation, positioning through cell station information, and Bluetooth connectivity. Network connectivity, which offers the pervasive requirements of "anywhere, anytime" was considered a supporting medium (but see [1] for use of connectivity as a gameplay mechanism). SMS can in this sense be described as a system piggybacking on the network connectivity and was treated in the same fashion as a possible supporting medium but not one that directly would support the pervasiveness of the game. It should be noted that most of the candidates can be said to only have weak context-awareness as the context they can detect are really other devices or infrastructure. That only digital photography can be said to be independently context-awareness was not considered a problem since the mobile phone platform was deemed ubiquitous, and this platform supported the other context sensitive technologies.

Several other technologies would have been interesting if they had been commonly integrated into mobile phones. The primary such technology is GPS, which would have offered a third positioning system. Near field sensors was also a known technology, but deemed not to have a large enough installed user base nor yet to be packaged sufficiently well regarding APIs for ease of use in design experiments.

Digital photography. Most mobile phones today are equipped with at cameras with at least VGA resolution. This makes it possible to use images as input to a game in many ways (see [31] for several examples). Digital photography can also be used as a positioning system if players need to take pictures of glyphs located at various locations as demonstrated by the ConQwest game [7]. However it is quite easy to trick the system since it is possible to take pictures of pictures. Image recognition and processing also requires quite a lot of computational power which is not always available. For these reasons, digital photography was removed as a viable candidate.

Infrared communication. Although Bluetooth is slowly gaining the upper hand for wireless communication, IR is still widely available on many handheld devices. What made IR impractical as a technology for the project was the severe restrictions of slow transfer speed, short range, and the requirement that transmitter and receiver have to face each other.

Positioning through triangulation. The use of cell station triangulation is by necessity a service provided by the mobile network providers. This posted two obstacles for using the technology. First, it would require agreements with one or more commercial providers. Second, players would then either be limited to playing only on phones connected through those providers and for support of multiple providers the game system would have to merge different positioning information.

Positioning through cell information. As mobile phones connect to a single cell station, the id of each station can be used to locate the player. However, as there is no information available about where each station is located, it is hard to use for anything but relative positioning. One way to add absolute position is to allow players to give each cell station a contextual meaning (as e.g. done in Hitchers [3]), but this is hindered by the fact that each operator has its own set of stations making it impossible for players using different providers to play in the same game world.

Bluetooth connectivity. Although Bluetooth connectivity could be regarded simply as a short-ranged version of network connectivity it has certain features that make it stand out. The discovery mechanisms built into the protocol offers ways to uniquely identify other Bluetooth units. This makes a form relative positioning possible as searching for specific nearby devices can determine if phone is near that particular device or not. The same way, searching for any kind of devices makes it possible to determine what devices are in vicinity of each other. We call this latter search method for *Bluetooth Harvesting*, and viewed it as a powerful way to both introduce semi-randomness and the possibility to localize elements into a game.

Due to being part of a larger research project, it was already decided that the game would be developed upon the java-based MUPE platform [17] which offers rapid prototyping of multiplayer games through an xml-based markup language. Although this platform was under development and had not support for all of the technologies discussed above before work on the game began, resources were available from the developers of the platform to either ask for or create such interfaces.

3. Design Process

The overall design process for Insectopia was in one sense guided more by design restrictions than by design goals. The showcase wished to explore many different games and to guarantee diversity restrictions were made on aspects including target platform, specific technologies, and gameplay styles. The basic idea of using Bluetooth devices to generate resources reported above was spawned during a workshop aimed at coming up with a large number of concepts for small pervasive games for mobile phones. A proof of concept prototype was created on the chosen platform directly after the workshop in order to make sure that the used technology would work. This showed that the concept was viable and that it was possible to realize on the platform.

After this initial test a rather long period followed, where the original design was more and more refined through several iterations, as per recommended by best practice descriptions [11]. One of the more interesting design issues arose around achieving different levels of participation while balancing the gameplay of single and multiplayer play modes. As both modes had to be available at all times depending on the player's social context, but also to be limited in order to encourage swapping between the play modes. For example, two of the basic actions in the game, searching and feeding insects, were at first split up as separate game modes, but early *self-testing* [11] (also called *designer testing* [27]) reveled that it would be severely limiting for a player to require to have a partner to catch the first insects with. On the other hand, moving too much of the multiplayer content to single player mode would render the multiplayer mode useless.

Once the core gameplay for the single and multiplayer modes had been established, the actions needed in both modes were weighed and ranked in order to find a feasible implementation road map. This list was also used to decide on what interfaces the game would need so that they could be designed as well.

For many reasons, the gameplay design of Insectopia became tightly coupled with its implementation. The MUPE platform was under constant development during the development of Insectopia and when necessary functionality was not implemented workarounds had to be devised. This led to effect on both gameplay and presentation in order to make the desired game dynamics work at all with the platform. For example, limitations in the available GUI widgets removed the possibility to present sorted lists of players' insects. Generally, the implementation was thoroughly tested as soon as new features were added. Constantly during the development, peers tested the game for quick informal feedback regarding functionality and gameplay.

In similar fashion as the gameplay design went through iterations, so did the software. Apart from the first proof of concept, two major iterations occurred. When all game functionality was implemented an alpha version was released for more structured internal testing using *confidants* [11]. The alpha version was tested during the summer and the confidants continuously reported their experiences. The defects they reported ranged from deviating interface standards to personal preferences and the comments, feedback, and bugs reported in this fashion were organized into a prioritized list. The list was used to ensure that the critical aspects of the game were finished in accordance with the project plan. This allowed for a fully functional game to be developed within the given time requirements while solving as many visual issues and other minor defects as possible.

The developed version was released to the public after some additional packaging, and has been available for about 4 months as of this writing. Through the collection of log files this version has generated significant amounts of empirical data usable for further tweaking the gameplay and understanding gameplay habits. The description below is of the public version of the game.

4. Insectopia

Insectopia is a persistent mobile phone game that can be played both in pairs and alone. Players compete against each other to get, and then maintain, the most valuable insect collection of all. The game runs on mobile phones and makes use of the java-based MUPE application and GPRS connectivity. The game is supposed to be a casual game played over a rather long period, preferably months, but with each play session only lasting a few minutes, allowing players to play when they have a moment to spare.

In order to build a collection of insects, players must use their phones to search for them. The game uses the Bluetooth discovery mechanism to find Bluetooth devices which each represent unique spawn points for the insects. Since both mobile devices, such as players' and non-players' mobile phones, and stationary devices, such as photo kiosks and printers, can be found, the game world depends not only on where the players are but also other people's devices that are in close proximity. Each Bluetooth device always generates the same insect and has a certain score associated to it based on how rare it is and what quality it has. By catching insects, and trading them with other players, players can build their own collection bigger and better. When searching for

insects, the game shows a list of all insects at a player's location and the player can choose one to keep. The game features thirty-three different insects but a semi-random function on the server makes sure that some insects are more common than others and that some are quite rare. This gives rewards to players who keep playing as they are more likely to find rare insects in the long run.

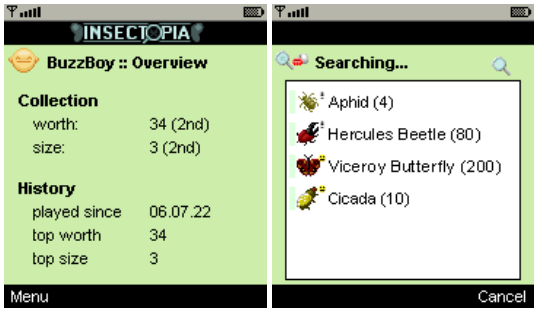

Figure 1 & 2 - Game views of the overview screen and a player searching.

Once players have built up a collection of insects they must keep playing to keep them alive. Insects die after eight days, but players can keep them alive by re-finding the spawning device where they originally spawned. This encourages players to figure out which Bluetooth device represents which insect but also allowing players to keep insects they only find once a week, for instance on a specific bus route. This mechanic also allows new players to join the continuously running game and within a week having mitigated most of the other players' advantage of starting earlier, resulting in the continued results depending on the players' skill.

When playing alone, it is only possible to catch a second insect after a cool-down period of three minutes from when the previous insect was caught. This was a conscious design choice to steer players towards short play sessions. However, Insectopia also allows players to cooperate as players in proximity of each other can team up two and two and catch all the insects they find. This feature was included to make the presence of other players be significant to enhanced gameplay. It also gives rise to another level of participation in the game with cooperating players that can be very active in collecting.

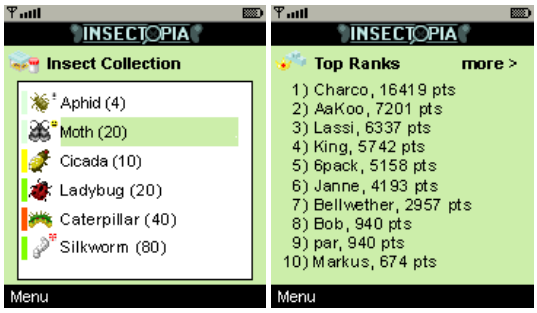

Figure 3 & 4 - Game views of an insect collection and the top rank list.

There is also a trading option available where the necessary coordination is not supported by the game. As there is no information about players' location in the game, players themselves must make contact through online communities or through other social networks. In order to further advocate social interaction there is no handshaking or other security methods for trading built into the game. Players can send any insects to any other player in the game at any time. Thus, players wanting to trade and not only risk giving away insects for free must first work out a mutual trust with their trade partners before doing the trade.

The status of the game is displayed on high score lists both on the players' phones and on the game's website (from www.insectopia.org) where the game is publicly available and can be played by anyone with a mobile phone compatible with the software.

5. Related Work

Looking at the technical aspect of Insectopia several other games can be found that push the boundaries of games using available mobile phones only.

Another game from the IPerG project is *Day of the Figurines* [8] where players role-play in a virtual city. The main interface between the players and the city is regular SMS which tell the players what is going on and allow them to tell the game what they want to do. It takes place over 24 days and is designed to allow the player to set their own pace to the game. Although this makes the game interesting in relation to social adaptability, the research goals of the game is not focused upon using context sensitive information.

Two commercial games are near Insectopia's approach to pervasive games. *Botfighters* [28] uses cell-ID information from base stations to determine players' location. The aim of the game is to build robots and that destroy the other players' robots in combat. Similar to Day of the Figurines, SMS is the only interface. The commercial game *Mogi* [14] also uses cell-ID and GPS for positioning to allow players to hunt for virtual objects placed in the real world. In contrast to Insectopia where the game resources are generated, the maintainers of Mogi have to place the objects themselves and continuously update the game world. In similarity, the game allows players to experience their surroundings in a new way. Both Mogi and Botfighters raise interesting questions about privacy issues but due to the commercial nature of the games neither the design intensions nor evaluations are available to other potential developers.

A game that does not use mobile phones but PDAs but still is worth mentioning is *Feeding Yoshi* [1]. It shares some gameplay similarities with Insectopia but instead of using Bluetooth connections it utilizes WiFi-spots. Feeding Yoshi can be seen as having a similar approach as Insectopia with the differences of the assumption that either PDAs will become as common as mobile phones or that mobile phones will start utilizing WiFi.

Other games that like Insectopia have pervasive core gameplay are *Pirates!* [5], *Can You See Me Now?* [2] and *Uncle Roy All Around You* [4]. Pirates! is location-sensitive in a fashion similar to Insectopia but was developed at a point where no context sensitive technologies were available in any devices commonly owned by the public (it should be noted that Pirates! can today be ported to mobile phones provide the same gameplay as the original game through the use of Bluetooth harvesting). Can You See Me Now? has a similar issue regarding GPS that may become mitigated in the near feature, while Uncle Roy All Around You uses self-reported positioning rather than a context-sensitive technology. For more examples concerning location-based games see [24].

6. Evaluation

An evaluation of Insectopia was conducted with two primary goals. First, we wanted feedback on the actual game instantiation in order to receive feedback for additional iterations of the game design. Second, we wished to verify that the assumptions behind the design goals were valid and how generally applicable these were. Since both goals required suggestions and opinions from players of the game it was deemed most effective to use a combination of questionnaires and semi-structured interviews. In addition, the evaluators first conducted a heuristic evaluation of the game itself.

Further, Insectopia was evaluated towards the major and minor themes identified in IPerG as a whole. Of these, only the results which are related to the topic of context-awareness are mentioned in the following (i.e. social aspects, providing social adaptability, and making the game interruptible).

6.1 Evaluation Process

To ensure a higher degree of objectivity, Insectopia was evaluated by a different organization within the IPerG project than the one who developed it. Furthermore, it was evaluated in another European country than the one in which it was created. For the evaluation eleven people (four women and seven men) filled in the questionnaire, and out of those eleven seven also took part in an interview (two women and five men). The participants were between ages 14 to 31. None of the participants had English as their mother tongue, although it is a mandatory language at school from the age of nine in the country.

Participants were recruited by simply asking colleagues and peers if they knew someone who might be interested taking part in the evaluation of a mobile phone game. There were several reasons why this selection strategy was chosen. First, the evaluation was run on a very tight schedule. The second reason was that mobile phones with the MUPE client pre-installed were loaned to participants in order to minimize technological problems. Also, having people who knew the participants easily accessible removed a lot of the legal issues otherwise required. Third, since it was important that the participants were easily available as we wanted to conduct interviews with the participants after the test. However, the method of recruitment was done with the knowledge that it may have caused several biases in the people recruited, e.g. concerning technological expertise and interests in games.

The recruited participants started their tests by coming to the workplace of the evaluators. Here they were given a mobile phone each and a quick introduction of the game's web site. The game was specifically not demonstrated to the participants as *blind testing* [27] was performed, i.e. information was only given through the game (and web site) to measure how easy the game was to pick up and understand without outside influences. The participants were then told to play the game whenever they felt like during the time period of the evaluation.

The interviews were conducted after a short playing period which approximately lasted two days for each participant. The reason for the short playing period (for a game that is meant to be played over weeks or months) was mainly due to the logistics of loaning mobile phones to the participants in combination with the tight schedule. It should be noted that the short playing period could have affected the results; they might have been different if the players would have had more time to play the game, e.g. become more involved to the game and started to understand the long-term effects of different gameplay styles and strategies. Lending out mobile phones also affected the evaluation in that there were no interruptions coming from the mobile phone that they were using; they didn't use their own SIM-cards so no phone calls or messages came in the middle of the game.

The questionnaire was divided into different categories that covered the participants' backgrounds and various impressions of the game. In the interview participants were asked more specific questions about the game and their feelings about it. This also gave the possibility for the interviewer to ask more specific questions about things that seemed unexpected or otherwise interesting. Almost all the interviews were recorded after asking permission from the participant.

6.2 Additional Empirical Data

In addition to the evaluation, Insectopia has been publicly available for download and play since late August 2006 which has resulted in additional gameplay data. Until the end of 2006, 109 different accounts had been made but since some of these are tests accounts or accounts never used, the actual number of unique players is between 50 and 60, whereof between 20 and 30 have no known connection to the project or the different evaluations. More than 1500 successful logins were made, giving an average of approximately 20 logins per player.

Based upon the logging of game events some more facts about player statistics can be found in analyzing the evaluation. During the approximately four months the game has been available, players have conducted 1600 searches and tried to initiate 273 dual searches of which 48 were successful. 11914 insects were found by the players and of these 1110 were caught. The collected insects were found again 4819 times, indicating that players were successful in being able to find the same Bluetooth units several times.

The largest single collection consisted of 166 unique insects which gave the overall highest score of 16419 points. However, the second highest score of 7201 points was earned by a player with a collection of 99 insects which wasn't the second largest collection.

7. Game Design Feedback

Overall, the participants found the visual appearance of the game pleasing; 55 % of the participants thought that it was at least in some extent appealing. Only one participant said it wasn't appreciated at all. The interviews revealed that although the visual appearance was appreciated, the expectations of it varied significantly. This was due to the fact that Insectopia's web page is very visual and contains many graphical elements which led the participants to believe that the game would feature similar visuals. The insect theme was liked although one participant questioned why butterflies were not used instead; which also has several thousand different species and was deemed by that participant to be more appealing. Many of the participants thought that the functionality of the game worked just fine but the appearance wasn't as great as they had anticipated.

The questionnaire clearly showed that many of the participants wanted to be able to do more in the game; 82 % of the participants said that the game did not offer enough meaningful things to do. This is in fact in line with the next step of the

implementation plan, where several more features are to be introduced to facilitate more complex mechanics for hard core gamers as well as further encourage social interaction, primarily through trading. However, this result may also be due to a fact revealed during the interviews; some of the participants could not locate many Bluetooth units since they lived in rural areas or had lifestyles that meant that they spent much time in areas where there aren't that many people around. Another possible contributing factor may be that the base for participants can have been biased towards recruitment of hard core gamers (which may also have influenced the results of how appealing the game was). However, the logged events show that dedicated players have been able to collect several dozens of insects, find many insects several times, and found other players to do have dual searches with. Furthermore, the logs from the game show that the numbers for successful logins and number of searches are very similar. This suggests that players when they have a moment to spare, login, search, and then logout, much like how it was envisioned in the original design.

8. Analysis of Design Choices

The two primary design choices of Insectopia were to use Bluetooth harvesting and to have short play sessions. In the following we discuss how these design choices affected the overall game experience as well as how these effects can be related to pervasive games in general.

8.1 Gameplay effects of Bluetooth Harvesting

The use of Bluetooth harvesting as a gameplay mechanism was confirmed to significantly affect the gameplay experience. This verified that the design choice of using Bluetooth harvesting provided valuable information for the research goals of the project, specifically regarding questions of surveillance and technology penetration. The following sections present the observations and the data from the evaluation and design process that contributed to the conclusions.

Raise awareness of technology penetration. Since the chance of finding valuable insects in Insectopia increases with how many insects one finds, the game encourages players to do searches in several different places at several different times. This automatically provides them with samples of how many Bluetooth devices are present in a given context and by being repeatedly exposed to this information they can learn differences in penetration of Bluetooth technology, similarly to how *Feeding Yoshi* shows WiFi hotspots. As one Insectopia player expressed it: "*I got to investigate all the places where you can find Bluetooth connections.*" (male, 25)

Anecdotally some of the confidants pointed out that Insectopia was a bit unfair since they knew that some other players worked at a mobile phone producer and that these players could harvest large amount of insects by simply playing the game in the lunch cafeteria. The questionnaire and interviews revealed similar results but based upon living in rural or urban areas as well as general mobility in their lifestyle. Although this can be seen as an imbalance in the game, it also shows the awareness of players on the differences of penetration of Bluetooth technology among different parts of the population.

Understanding the hidden context. The necessity to harvest the same Bluetooth ID at least every eight days to keep the resource it represents makes players interested in matching people and machines to specific Bluetooth devices to be able to plan their gameplay. When players find an insect for the second or third time they know that something in their environment is the same as during a previous search. This poses an implicit question to the player; *what devices or people nearby do you remember from another search?* If they can find a potential match this forms a hypothesis which can be verified or refuted during later searches. Since it is easier to check these hypotheses if as little in the context is changed as possible, the game also encourages players to do systematic searches. In Insectopia this was confirmed by a confidant tester who told how he had located a very valuable insect in his office and used this knowledge to repeatedly catch it.

Having successfully matched a Bluetooth ID to a machine help players build static reference points in the game although accessibility to machines in non-public places may require players to plan for their future gameplay. Matching Bluetooth IDs to people is a more delicate issue since this can require social interaction or be in other ways daunting for certain players. However, players can over time draw conclusions without any direct social contact in a vein similar to identifying familiar strangers (see [21] for a related discussion). This gameplay effect was quickly picked up as can be seen from this player comment:

"Then there was this nice feature that I found very interesting that when you already had collected some insects and then for example in a supermarket did a new search and noticed that you already have one of those found insects. So there is a same person nearby who has been in the same place with you earlier." (male, 24)

Raise awareness of personal habits. The process of identifying Bluetooth IDs through systematic searches makes it beneficial to consider the characteristics of the context of the search. This can make players aware of their own habits since these are some of the key factors for when searches are done. For example, eating at the same place or taking the same bus to work everyday determines much of the context for a search. Realizing that this affects the game can not only suggest changing lunch places or busses, but make players notice their routines.

Pervasive content for pervasive computing applications. Not only can the game be played anywhere, making it pervasive for the player, but the game facilitators of Insectopia do not need to localize the setup of game content. As long as a player finds herself in a fairly populated area, there will be content automatically generated. Although which insect each Bluetooth unit represents is randomly determined (using the unique ID as a seed for a random number generator) their movement, and visibility, is not determined by the designers but by the routines of the users of those Bluetooth devices. Indications that Insectopia was perceived as being pervasive in the pervasive computing sense can be seen from the player comments on the next page regarding incorporating game activity into other activities.

Give new perspectives of familiar locations. A design hypothesis based upon the use of Bluetooth harvesting was that players would change their views of locations simply from noticing the technology penetration. The basis for this hypothesis was the findings of the Sonic City project [12], where a context-dependent music interface changed people's perspectives of familiar locations. For Insectopia, one player (female, 23) said that she specifically went to a *familiar* library to play this game just because she knew that there were many laptops in there. The

confidants that pointed out that other confidants were privileged in the game due to their high-tech working environment also give indication of changed perspectives of familiar locations, in this case of both working environments.

8.2 Short Play Sessions

The primary motivation for designing Insectopia to have short play sessions was to promote social adaptability. The previously mentioned correlation between searches and logins show that players did play relatively short play sessions. The logs also show that the average play session lasted for slightly less than five minutes. Although this showed that the design goal was met, the interviews show that the effects of meeting the design goal informed the research goal of pacing the game activity.

Incorporating game activity into other activities. The design of Insectopia aimed at letting players easily start and stop playing, as a way to let players pace the gameplay to co-exist with any other activities they were doing. The feedback from the players indicates that the cool-down period between catches, possibility to take breaks whenever, and incitements to develop long-term gameplay habits were successful in this regard:

"*I think this game could be played anywhere.*" (male, 27)

"*Hmm… this could be played at school. And of course at work. I cannot think of any place where you couldn't play; maybe at the dentist."* (male, 25)

Analyzing the generated logs also revealed that some players did still have long play sessions, going on for more than an hour, but did then typically have one or several period of inactivity ranging for more than 10 minutes. This sporadic gameplay without logging out specifically indicates that they could fit breaks into their play sessions to do other activities.

Social adaptability The players gave comments about the social implications of changing from a game activity to other activities. As shown below, the view of what is socially acceptable is a highly subjective matter and this implies that gameplay design of pervasive games needs to critically consider the norms for social interaction of the intended target audience:

"*Maybe some ceremony when it would be impolite to play some game and not concentrate on the issue at hand… but I don't know. People use their time at lectures and anywhere to do anything. After all, people think different things that are related to something else than what they are actually doing in their heads as well. So why couldn't you freely play some game just as well?*" (male, 24)

"*Well at least I couldn't play this game when I'm taking care off official matters. Possibly it would fit almost any place if you could leave the game for a while so that you wouldn't pay attention to it at all.*" (female, 24)

8.3 Intrusiveness in pervasive games

Pervasive games that utilize non-players or items belonging to non-players raise a number of ethical issues. In the case of Insectopia, a non-player could be carrying a very valuable insect that all the other players would like to catch.

Raise awareness of potential surveillance issues. An initial issue with the design of Insectopia was that it would raise privacy issues. However, the interest in people and devices in one's proximity did not have negative connotations. This finding is in line with the view that technology can encourage players to be *flâneurs*, spectators that wish to draw no attention to themselves and who are "looking around with no other ambition than to soothe his curiosity of what goes on" [33]. A player expressed the combining of playing and being a spectator as: "*I did go to some places where there were a lot of people just to sit around and watch people walking by and at the same time collect new insects.*" (male, 24)

9. Conclusions

The design and evaluation of Insectopia provided many insights of how the game provided a casual pervasive game experience as well as how the game could be refined to better meet the design goals. Further, many of the design choices led to observations regarding research questions of pervasive games in general. These observations will feed back into the IPerG project to support the development of a design language for pervasive games and games in general (see [15] and [6] respectively for example of such work).

As the current game system logs events it allows for analyzing the data to find social networks, similar to [9]. However, this would raise ethical issues about the prototype, especially since it is released to the public, and would shift the focus of the research from understanding gameplay to understanding users.

For pervasive games to become pervasive as a phenomenon they need to be developed commercially. Insectopia is a proof-of-concept that pervasive games can be created using commercial available mobile phones to provide novel gameplay impossible without context-aware technology. This shows that it is easier to start projects focusing on gameplay aspects of pervasive games since the investments on hardware development can be significantly reduced without compromising research goals. Piggybacking on existing mobile phones, as Insectopia does, to create a context-dependent game (without requiring services from network providers) removes economical and logistical hurdles. This since players no longer have to invest in additional hardware to be able to play games with novel gameplay due to context-dependency. However, Insectopia is just one example of novel gameplay and it is most probable that a critical mass of examples is needed before the feasibility of the design space of pervasive games is convincing. However, the low overhead of the approach used for Insectopia ([3] and [8] can here been seen as additional examples) means that a multitude of further examples can most likely be developed within the near future if projects choose to focus upon the possible gameplay aspects on already existing platforms rather than develop new hardware.

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