

# UNWIRED GAMING

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The Nokia Aeon  
Concept Phone  
(Image:  
Mobilewhack)

## The Move to Pervasive Entertainment Unwired Gaming

By Michael Mullin

### Interactive Entertainment is Big Business

Wireless and mobile technologies have advanced at an astounding rate over the past 10 years. In 1998 the Blackberry 850 allowed high ranking Wall-Street businessmen to exert their status by sending the legal department memos during power-lunches with clients. In 2008 teenage girls in North California send text messages and watch YouTube videos on their iPhones during recess.

The entertainment industry has also expanded over the past 10 years. Music, movies, and books are released at an ever

increasing pace and over new media outlets including digital downloads. A new marketplace in video gaming has blossomed into an \$7.4 billion industry(ESA), and is still growing. February of 2008 saw this video gaming market reach monthly profits of \$1.33 billion and sell 587,000 units of the Nintendo DS portable platform (New York Times Today).

The advances in both wireless communications and video game technology will soon collide to open a new market of mobile entertainment. Advancements in mobile consumer hardware will open new business venues

*"World of Warcraft has been the first American video game to achieve truly global success. Most players pay around \$15 a month for access to the game, which means it is on pace to take in more than \$1 billion in subscription revenue this year"*

**Seth Schiesel in the New York Times**

for multi-user interactive entertainment. Technological advancements are making this new form of mobile entertainment a near reality, so companies have a short time window to which they can carve themselves a branding image and project themselves as leaders in this new lucrative marketplace.

## Gaming and Cellular Trends

The video game industry is increasingly relying upon multiplayer games for its revenue growth. "Nine of the 10 top-selling games of 2007 include a significant multiplayer component" reports the New York Times (Schiesel, Top Selling). Multiplayer games themselves are changing from split screen games played on one system with one monitor in one room, to massive persistent online worlds played in millions of different homes all over the world.

The Massively Multiplayer Online Role-playing Game (MMORPG) "World of Warcraft," affectionally called WoW by many, is arguably the most profitable video

game ever. With 8 million subscribers paying \$15 each month, WoW's gross yearly revenues top \$1 billion dollars all by itself (Schiesel, Warcraft). Following in the footsteps of WoW are other innovative massively multiplayer games such as Second Life, which is an open sourced game of immense popularity and is changing views about how online business should be conducted.

As the video gaming industry grows and is increasingly dominated by persistent multiplayer games, the cellular communications industry continues to grow as well. On November 29th, 2007 Reuters UK reported "Worldwide mobile telephone subscriptions reached 3.3 billion, equivalent to half the global population" (Reuters).

The fastest adoption rates of mobile phones are in Asian and African countries where "mobile technology often represents the first modern infrastructure of any kind" (Ewing). To put things in perspective, David Kirkpatrick, the senior editor for Fortune Magazine reports that there are

### Games coming to Cellphones

**Left:** The popular Motorola Razr

(Image: Gizmodo)

**Right:** A group of Dwarves chat in World of Warcraft

(Image: Invidklr)



currently 755 million PC systems worldwide (Kirkpatrick); that equates to more than 4 and a quarter cellphones for every PC system.

## Expenditures by Wireless Companies

Modern living room based multiplayer gaming requires much more bandwidth than email or browsing, and bandwidth speed is of far more importance. While mobile games should be designed differently and use different bandwidth patterns from their stationary living room counterparts, the top ranked multi-player mobile games can be expected to demand much greater network usage than second generation (2G) wireless networks can provide.

Third Generation (3G) networks using technologies such as EV-DO, WCDMA, and HSPA, or other broadband wireless technologies eg. WiMax, will need to be installed in market areas to provide a satisfactory user experience. Games will also need to be designed around the quirks of the cell technologies used. 3G networks are already available in most of developed Asia (not China), Europe, and are now being integrated into North America. Rogers Canada for example, has spent more than \$500 million upgrading the “golden horseshoe” (Rogers 28) to provide HSDPA high speed coverage, and most of the large cities in the United States have WCDMA or EV-DO. The infrastructure for high-speed wireless data is being prepared in select areas of the developing world such as South Africa, Egypt, and Brazil.

Games which rely on 3G based technologies can be marketed to promote the purchase of new more expensive devices, and to spur quicker adoption of

higher cost data plans. Along with this increase to traditional revenue streams, mobile gaming has the potential to open a new market in ‘pay-to-play’ gaming services. Determining the usefulness of specific mobile services is a focus of many academic researchers.

## Research Directions in Context-Aware Devices

Researchers have started examining the use of feature enhanced mobile devices to enable “context aware environments,” support mixed-media note taking, and devise pervasive interactive gaming environments. “Cyberguide: A mobile context-aware tour guide” published in Wireless Networks by Gregory D. Abowd et. al. describes how context-aware devices can be used by museums and other tourist areas to provide “personalized tours seeing any exhibits desired in any order, in contrast to today’s taped tours” (Abowd). The Cyberguide paper describes four important roles of any tour guide as:

- **Cartographer** - the tour guide must intimately know the geographic area. Guides must know pathways, and the locations of interesting sites.
- **Librarian** - the tour guide must have historical knowledge and be able to express interesting facts about the geography
- **Navigator** - the tour guide must not only know the geographic, but be able to quickly determine where a troop of tourists are quickly.
- **Messenger** - the tour guide must be able to help tourists communicate with people who are external to the tour. While a guide along an art tour must be able to communicate purchase requests from viewers to artists, safari guides must be

able to communicate with native inhabitants. (Abowd)

The ability and usefulness of a guide is determined by the amount of relevant knowledge they provide to tourists and by how quickly and accurately these four roles can be fulfilled.

The Cyberguide paper mostly describes output scenarios, that is, a mobile device giving information to its user and helping the user access a vast knowledge base. Research is also focused on smart devices that can be used to capture context-aware input from users in the form of pictures, dictations, and video, assisting users to store their own knowledge bases (Korhonen et. al). In the paper “Mobile Fair Diary: hybrid interface for taking, browsing and sharing context-aware notes” published by the journal Personal and Ubiquitous Computing, Jani Korhonen and others discuss their study of smart phone use as a context aware input device.

The hottest area of research I wish to introduce is being conducted on pervasive and reality augmented games. Pervasive games “regard the entire world, the architecture we live in, as a game board” (Magerkurth et. al), while reality augmented games go one step further and allow players to “see their view augmented with 3D objects registered such that they appear to exist in real space” (Magerkurth et. al.). Researchers are looking to improve classic games such as Pacman to heighten the gaming experience and add a new layer of entertainment for players.

## Evolution of Cellphone usage in Japan

In Japan, where mobile technologies are most quickly introduced and adopted, the cell phone has changed from a business tool into a culture shaping entertainment device.

During the 1990s Japan saw significant shifts to youth culture as cellphones proliferated throughout the nation. Michal Daliot-Bul comments on the spread of *keitai* (Japanese term for cell phone) throughout Japanese culture in her paper “Japan’s mobile technoculture: the production of a cellular playscape and its cultural implications” published in November of 2007 by Media, Culture & Society.

The social reception of *keitai* [cell phone] communication and the internet by Japan’s youth has oriented the shaping of the *keitai* [cell phone] eco-system, and thus its present and future, reflecting a larger cultural context in which youth have become the new **cultural avant-garde of urban lifestyles in Japan**. A process of social construction and negotiation of mobile technologies among carriers, handset manufacturers, content providers and young people has **transformed keitai [the cell phone] from a technological product into something playful**. (Daliot-Bul, emphasis mine)

It is important to pay close attention to Japan when it comes to mobile technologies. Japan is always on the mobile cutting edge “Japan led the change from 2G to 3G, was the first to add digital cameras to cell phones. ... Japan was one of the first mobile markets with e-mail and Internet access” (Breckenridge). One way in which mobile carriers have become so successful in Japan is their method of marketing devices and services at consumers. Japan’s wireless carriers have

successfully avoided being stigmatized as *naichatte internet* (close but not quite like PC-accessed

“from a technological product into something playful”

Michal Daliot-Bul



*“You can show off your mobile PDA with GPRS. When I was using it on the train, people would start asking ‘what is it that you have there and what do you use it for?’ It makes other people curious; it is a status symbol for others”*

**Comment from a participant in the “Always Connected” study conducted in the Netherlands.**

internet). Today, mobile carriers and mobile media content providers are looking for new ways to make multimedia consumption through the keitai [cell phones] unique and attractive.” (Daliot-Bul)

Japan’s mobile telecom industry is incredibly successful and is the envy of many wireless providers in other nations; as these providers follow in Japan’s mobile example, they should note the cultural and marketing factors involved in the success. The movement from “a technological product into something playful” (Daliot-Bul) where “79 percent of i-mode [the NTT DoCoMo brand of mobile internet,] content access was [is] for fun applications” (Daliot-Bul) shows how important unique entertainment is to the prosperity of the mobile telecom industry.

### **A study of Data-connected Mobile Device usage patterns**

Cellphone use is changing from a business device to an entertainment device all over the world. A Dutch study shows changes to a group of PDA users over a three month period similar to the changes seen in Japan.

Telematics and Informatics published a report in 2005 titled “Always connected: a longitudinal field study of mobile communication.” This study examined the gratifications a user experienced when using a modern data-enabled cellphone. This study sought to answer the questions:

- “What are users’ initial perceptions and expectations for using the new mobile communication technology?”
- “How do gratifications sought in using mobile communication technology change over time?”
- “How does the actual use of the new mobile communication technology differ

from the user’ initial perceptions and expectations for use? (Peters)

To answer these questions researchers gathered a small experimental group of novice users and closely tracked the use of the mobile during the dynamics of their daily life (Peters). Participants of the study were given a mobile PDA with unlimited data usage and asked to use it for three months. At the start of the study, all participants were given a survey to rank their expectations of usage, every two weeks afterwards the same questionnaire would be given to rank users actual device usage. The questions were rated with a “5-point Likert scale was used to rate the gratifications items, with ‘1’ meaning ‘strongly disagree’ and ‘5’ ‘strongly agree’ with the reasons mentioned for using the mobile PDA.” (Peters). Upon conclusion the questions were placed into seven categories and averaged.

- Category I: Permanent access
- Category II: Entertainment
- Category III: Social Interaction
- Category IV: Attraction (*attraction of the device itself to the participant, not others*)
- Category V: Connection
- Category VI: Instrumentality
- Category VII: Fashion/Status (*perceived attraction of the device to other people*)

Test results showed that users initial perceptions believed they would use the device because of permanent access, social interaction, attraction, and instrumentality. As the study progressed and users became very familiar with the device, scores in permanent access, social interaction, and instrumentality dropped significantly, while Fashion/status and Entertainment rose.

During questionnaires, users were also asked three open ended questions which gave insight into how users felt about the

mobile phones during and after the test. “In the beginning I used the mobile PDA because it was a new device, I really appreciated it. But after a while it just became part of my usual ‘system’. The novelty had gone, it became a habit” (Peters) wrote one test subject. Another test subject wrote

You can show off with your mobile PDA with GPRS. When I was using it on the train, people would start asking “What is it that you have there and what do you use it for?” It makes other people curious; it is a status symbol for others” (Peters)

### Device and Network needs for Mobile Gaming

The collision between video gaming and wireless devices is imminent. Already less graphically non-multiplayer games such as breakout and solitaire ship on several cellphones, paralleling early video gaming technology of the 1980s. Once key abilities

are available on mobile devices, consumers will demand games of more depth and style; so long as games properly meet relevance to gamers.

Relevance is the key to attract gamers to a mobile platform. Similar to Daliot-Bul’s notion of *naichatte internet*, game players must understand that mobile gaming is not simply video gaming on the bus with a small screen, but it is truly a unique experience that cannot be replicated on a gaming console or computer system.

### Key Ability Requirement: Graphic Display Advances

Most current mobile phones lack the ability to render 3D graphics very well, if at all. Since 3D graphics are viewed as a key feature of quality video games, mobiles must introduce methods of rendering 3D if they wish to capture a significant portion of the video gaming market. Leading graphics chip providers have started product lines targeting the mobile marketplace. Nvidia offers the GoForce product line which

#### APX 2500 From NVIDIA

Images of Quake being played on the NVIDIA APX 2500 (Image: Cooper)



promises to carry the burden of 3D rasterizing and allow software developers the opportunity to use either the OpenGL ES API or the D3D Mobile DirectX library with hardware acceleration. Videos which Nvidia has posted to YouTube show impressive live demonstrations of their newest APX 2500 mobile 3D technology (Youtube). A special report in Business Week regarding the new Nvidia advances states

The company [Nvidia] on Feb. 10 [2008] began showing prospective buyers a prototype smartphone that uses a new cell-phone chip architecture it has designed called the APX 2500. The company says customers who use the applications processor and graphics chip package after it becomes available in late June will be able to promise wireless users up to **10 hours of high-definition video playback, 3D gaming and graphics**, or 100 hours of music playback—all on a single battery charge. (Edwards, emphasis mine)

In the realm of mobile communications 10 hours of rendering high quality video and graphics is extremely impressive. Having a cellphone rendered inactive or tethered to a wall socket because of a lack of battery power defeats the entire purpose of a mobile device.

The longevity of the APX 2500's power source shows a giant leap forward towards integrating these forms of entertainment with cellular communications. If Nvidia's claims are true, a revolution in mobile performance should occur roughly 18 months after Nvidia makes the APX 2500 available, since mobile manufacturers will need time to design devices around the new chipset architecture.

## Key Ability Requirement: High Speed 3G Data Networks

3G networks are a requirement for multiplayer gaming, 2G networks simple aren't sufficient to handle the bandwidth requirements of games requiring complex user-interaction.

HSPA and Wi-Max are the top two emerging high-speed wireless technologies to date. Both are able to provide mobile users with broadband like connection rates; both technologies can typically provide "real world" speeds of 1Mb/s (GSM World) (Wikipedia) with theoretical maximums being much higher. Following on the heels of HSPA and WiMax are 3G 1xEV-DO networks which averages nearly 600Kbps in real world tests (Lee). Speeds of this magnitude easily meet the requirements of multiplayer online games running on the Xbox-Live network, which recommends at least 256Kbps (Ramsay), and also rival wired based ADSL services connected to homes.

Data usage costs continue to drop world wide due to increased competition. In Canada, Rogers Wireless has started to offer unlimited internet browsing as an add-on package to other plans they sell for \$7CND/monthly, In the U.S. Sprint, AT&T, and Verizon all advertise unlimited data plans for under \$100US/monthly<sup>4</sup>. Japan's NTT DoCoMo advertises a maximum charge of 10,000 yen (roughly \$100US) for their highest speed service, while developing nations such as South Africa can receive 5GB of data on a 3G enabled phone for 1,049 RAND (\$128US) from the international carrier Vodafone. While \$100/monthly is still a lot of money for most people, these services can conceivably replace both home phone,

home broadband, and allow for unlimited in-country long distance calls.

### **Key Ability Requirement: Accurate Location Awareness**

In order to provide context-awareness as defined in the Cyberguide, some functionality must be included to track device location. GPS is the most widely used tool to solve this problem.

Traditional GPS is accurate within 10 meters outdoors, and is usually unavailable indoors (Giaglis). GPS also has a great many problems if satellites are obscured because of unclear skies, or large monuments. GPS requires that receivers have “a clear view of the skies and signals from at least four satellites.” (Giaglis) However there are inexpensive methods to greatly increase the accuracy of GPS when receivers are unable to see the minimum four signals, and allow GPS usage indoors.

Assisted GPS (A-GPS) is a low cost method of increasing the accuracy of GPS when receivers cannot see four satellites at the same time. A-GPS also helps conserve mobile device battery power. Processing is moved from the GPS handset to a remote server on the mobile’s cellular network in order to improve mobile resources, and to allow complex calculations to be run on a more powerful processor (Djuknic).

Because the cellular network knows which cell and sector the mobile handset is located, heuristics “can predict the signals received by the handset for any given time”. (Djuknic). “A-GPS is accurate within 50 meters when users are indoors and 15 meters when they are outdoors.” (Djuknic)

If there is a demand for greater outdoor accuracy, GPS can be improved with a differential calculation (DGPS). By monitoring the integrity of the GPS satellites from multiple fixed ground sites

and correcting any discovered inaccuracies, accuracy can be improved below 4 meters (Australian Government). Further neural network technologies have shown to improve DGPS readings to 1.75 meters (Mosavi).

Even with A-GPS, location precision of 50m is unacceptable for museums and other indoor locations desiring location awareness. Pseudo-satellites (pseudolites) are devices which can produce GPS-like signals in areas that do not receive GPS satellite communications; in essence they ‘fake’ the appearance of a GPS satellite to handhelds. Pseudolites can be used to improve indoor accuracy to an astounding 5 cm. This indoor GPS solution requires installation of the pseudolite devices and applications must understand when they are in a pseudolite environment and receive GPS signals. A Stanford Pseudolite report claims “several projects at Stanford University have developed similar inexpensive pseudolite transmitter hardware,” (Stone).

The ability to be location and context aware is important to the concepts of pervasive gaming and is a key tool to providing relevance to users.

### **Relevance**

In the “needs for mobile gaming” section of this paper, I have explained that the speed, accuracy, and horsepower for mobile devices are close to commercialization stages (A-GPS is already common within cellphones). Early technology adopters should expect several high end iPhone-like devices on market within 2 years. What will separate the competing devices are software applications which can solve user problems, and give users entertainment gratification (Peters). Relevance is key to achieving a



competitive advantage in this location-aware device market

## A Usage Study of a Context-Aware Note Taking Device

The mobile phone diary is a case study where participants were asked to use a mobile phone equipped with a camera and internet capabilities, and a standard PC web browser in order to create a diary of a touring experience they were engaging in. The intent of using the mobile was to assist participants in taking notes of a housing fair they were attending; the web browser would assist in the retrieval of taken notes. Participants were given Nokia smart-phones loaded with special software that facilitated textual note taking, visual note taking, and dictation (auditory note) about the housing exhibits they attended.

To help organize exhibit location context, barcode like “visual codes” were placed around the fair, both on the outside and inside of exhibits. Outside codes allowed the devices to keep track of which exhibit the notes were being taken of, and indoor codes allowed tracking of particular objects in the exhibit. Indoor codes could also track the exhibit context if participants forgot to access outdoor codes. To access the codes, participants would take a digital photo before making notes.

A visual note was a digital picture taken with the onboard camera, a dictation was captured using the phone microphone, and text notes were taken using a 12-key keypad. The software on the mobile would upload notes to a networked server and organize the data on behalf of user participants. This had the intended functionality of collecting and organizing information for the users in one place and sharing information with others. “A big pile of brochures and miscellaneous photos

[and written notes] does not support efficient retrieval of relevant information at a later date,” (Korhonen) nor does it help share information with others.

Once participants were finished using the mobile device, they would go onto a website which contained all their accumulated and organized notes. Using the website participants could further organize their notes, and share the notes with friends and colleagues.

The Mobile Fair Diary study used demographic ranges similar to the total demographics of the fair. 44% of the participants were female and the largest age group of 35-49 constituted 41% of the study group. “Nearly half of the users did not have prior experience in using smart phones.” (Korhonen)

The mobile diary proved to be very successful. 349 diaries were created with an average of 78 notes taken per diary. Of the total 27258 notes 7% were images taken of visual codes. Of the remaining 25389 notes, 95% were pictures, 3% were audio recordings, and 2% were text based notes. Researchers believed that the noisy atmosphere of the fair and the difficulty using a 12-key keypad were the main causes of the overwhelming number of notes being visual. 92% of all users signed on to their resulting website at least once, and 60% logged on multiple times; the average logon time was 8.4 minutes, but occasionally logons would last more than 1 hour. (Korhonen)

Researchers conducted exit interviews on 10 randomly picked test users. “Overall interviewees showed great enthusiasm for the service,” favorable quotes include statements, “We have visited the housing fair regularly for 10 years in a row and this fair proved us with the best the data that

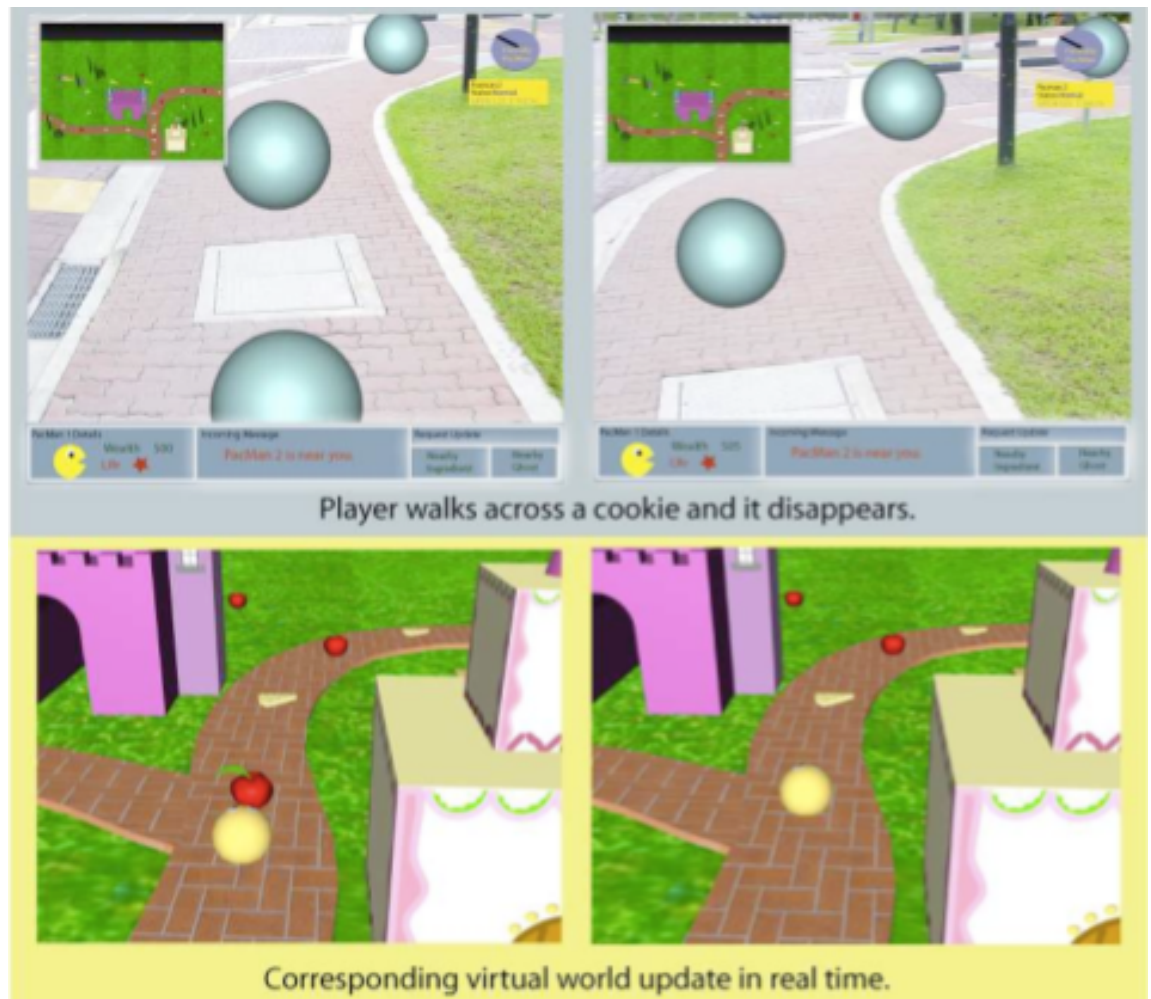
one really wanted to store” (Korhonen) and “it would have been impossible to remember afterwards the places of all photos I shot.” (Korhonen)

### A Study and Comparison between a Popular Video Game and it's Pervasive Mobile Counterpart.

Personal and Ubiquitous Computing published the results from a study conducted by the Mixed Reality Lab at the National University of Singapore in 2003. This study examined the popular video game Pacman and the impacts of using Pacman game concepts in an augmented reality mobile game. Unlike the other

studies examined, “Human Pacman” does not use PDA technology; rather Human Pacman uses a wearable computer system with a backpack and virtual reality headset. Review of this study is important on a relevance level because it examines the entertainment value of pervasive gaming and highlights players enjoyable experience when engaged in pervasive mobile play.

In the Human Pacman study, players moved through an indoor playground, called Pac-World. One player filled the role of “Pacman” and collected virtual cookies while avoiding the other “Ghost” players. Cookies could only be seen through the headset screen which augmented the cookie



images over the real landscape being viewed.

Twenty three subjects participated in the study and were first asked play the traditional arcade version of Pacman on a PC for 5 minutes followed by a 15 minute game of Human Pacman. After playing both games, participants were given a questionnaire to rank the games against each other. One question (iv) asked,

“Please rate, from 1 (lowest) to 7 (highest), the level of excitement of playing as a Pacman in a Pac-World (first person experience), in comparison with the arcade Pacman that you can play using joystick/keyboard (third person experience).” (Cheok)

Average scores show very high excitement by participants, ranking the first person experience as a 6. Other questions also showed high regards for the Human Pacman game. All of the participants believed that Human Pacman was superior to other tradition video games when asked “How do you compare this game with other computer games?”; 52% answered “it is a breakthrough in the computer game.” while 48% answered “it is a refreshing change.” (Cheok)

Despite the success of the study, researchers concluded that Human Pacman was still unsuitable for commercialization because of four main reasons:

- The cost of each wearable computer is very high
- The wearable computer is very bulky
- The game needed a more accurate positioning system
- The robustness of the system needed to be improved.

With advances mentioned in the market drivers section of this paper, the Human

Pacman game can solve their first two problems by using a high graphic mobile device conceptualized by the APX 2500. The third problem can be combated by the advancements in GPS technologies such as A-GPS, pseudolites, and Neural Network assisted DGPS systems. The issue of robustness is combated by extensive Q&A testing prior to commercialization.

## The First Steps of Pervasive Mobile Gaming

Designing relevant pervasive entertainment will be a very difficult task. Part of the allure of World of Warcraft is it's ability to take players on a grand adventure *without* ever leaving the comfort of their home; game companies cannot expect to put WoW on an iPhone and generate the same revenues as seen with the PC version. Players will simply see the iPhones WoW “port” and rightly believe it to be an inferior experience compared to the current method of gameplay. Game companies can also not expect gamers to purchase context-aware games which *force* players to certain locations. As a suburbanite, I would not want to be traveling downtown in order to participate in a game of Human Pacman. However, I would like to be able to join or set-up a local game for myself and friends at the location I desire. I would also desire to be delivered enhanced entertainment content when I *do* happen to visit a site of interest.

In this paper I have shown that companies will shortly have the technological ability to create context-aware cellphone systems; I have shown that people specifically desire their cellphones to provide them with entertainment and make a fashion statement once they become comfortable with its functionality; I have shown that there is an interest in pervasive

entertainment; and I have shown that when the correct relevance is applied, context-aware devices can be very beneficial and enjoyable to users.

Further projects and studies in the area of pervasive entertainment should focus on delivering the right services to the right users and examine methods of incorporating the Cyberguide recommendations into mobile devices. One such project that I find fascinating is the REXplorer project.

REXplorer is a tourism enhancing game service which combines many of the elements contained within this paper. REXplorer is located in the UNESCO world heritage city of Regensburg Germany, a picturesque and romantic city in its own right. Players rent a portable device called a “magic wand” which allows them to

interact with the location-based and site-specific spirits by performing a gesture, ... thus “casing a spell”. Situated gestures allow players to evoke and communicate with spirits to receive and resolve quests. With their detector, players can also take pictures, which appear on each player’s individually generated souvenir, a weblog. The weblog also maps a player’s route, describes spirits a player has encountered, and lists books and deepening URLs for each character and site (Walz).

While the authors of the study admit that “we need to conduct greater scale empirical studies once the game launches in the summer of 2007” (Walz) I predict that this game will be at least a moderate success, and act as a template for future context-

aware games. The REXplorer game fulfills the requirements of a Cyberguide as it acts as a Cartographer (the map is a major component of the game), Librarian (its goal is to provide information tourists desire), Navigator (it keeps track of player movement, and shows players how to get to the next location), and Messenger (players can share their experience using a blog similar to the Mobile Fair Diary and are suggested books and URLs).

REXplorer does, however, force people to travel to the city of Regensburg to play the game. This will surely limit its popularity. Furthermore, REXplore lacks any multiplayer components. If REXplorer was an underlying system where players (or third party developers) could create their own gaming experience in any location, and to play together, its popularity and marketability would be much bigger.

REXplorer is an early example showing that advances in both wireless communications and video game technology will collide to open a new market of mobile entertainment. I look forward to engaging in some truly remarkable future games.



## Works Cited

- Abowd, Gregory. et. al. "Cyberguide: A mobile context-aware tour guide." *Wireless Networks*, Vol. 3, No 5, October 1997. 6 Apr. 2008 <<http://www1.cs.columbia.edu/graphics/courses/mobwear/resources/p421-abowd-97.pdf>>
- Australian Government. "Differential Global Positioning System (DGPS)." Australian Maritime Safety Authority. July 2007. 6 Apr. 2008 <[http://www.amsa.gov.au/shipping\\_safety/Navigation\\_Safety/Differential\\_Global\\_Positioning\\_System/DGPS\\_Fact\\_Sheet.asp](http://www.amsa.gov.au/shipping_safety/Navigation_Safety/Differential_Global_Positioning_System/DGPS_Fact_Sheet.asp)>
- Breckenridge, Joel. "Handset Publishing: Just a Japanese Phenomenon?" *Seybold Report: Analyzing Publishing Technologies*. Vol. 7. Issue 24, December 13, 2007. Academic Search Premier. 6 Apr. 2008 <<http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=28060792&site=ehost-live&scope=site>>
- Cheok, Adrian. et. al. "Human Pacman: a mobile, wide-area entertainment system based on physical, social, and ubiquitous computing." *Personal and Ubiquitous Computing*. Vol. 8, Issue 2, May 2004. Academic Search Premier. 6 Apr. 2008 <<http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=13677864&site=ehost-live&scope=site>>
- Daliot-Bul, Michal. "Japan's mobile technoculture: the production of a cellular playscape and its cultural implications." *Media, Culture & Society*. Vol. 29(6), 2007.
- Djuknic, Goran. Richton, Robert. "Geolocation and Assisted GPS." *Computer*, vol. 34, no. 2, February, 2001. 6 Apr. 2008 <[http://www.cs.huji.ac.il/course/2003/postPC/docs/Geolocation\\_assistedGPS.pdf](http://www.cs.huji.ac.il/course/2003/postPC/docs/Geolocation_assistedGPS.pdf)>
- Edwards, Cliff. "Special Report: New Chips Could Boost iPhone Rivals." *BusinessWeek*. February 11, 2008. 6 Apr. 2008 <[http://www.businessweek.com/globalbiz/content/feb2008/gb20080211\\_561071\\_page\\_2.htm](http://www.businessweek.com/globalbiz/content/feb2008/gb20080211_561071_page_2.htm)>
- Entertainment Software Association. "2007 Sales, Demographic and Usage Data: Essential Facts about the Computer and Video Game Industry." ESA, June 2007. 6 Apr. 2008. <[http://www.google.ca/url?sa=t&ct=res&cd=2&url=http%3A%2F%2Fwww.theesa.com%2Farchives%2Ffiles%2FESA-EF%25202007.pdf&ei=GGf4R-2JBjXcigGUoJHhDg&usq=AFQjCNHtYylErtjlKgOHht9pXdw5W7eVHg&sig=ChZUAwPcc5\\_2B733jyLGSA](http://www.google.ca/url?sa=t&ct=res&cd=2&url=http%3A%2F%2Fwww.theesa.com%2Farchives%2Ffiles%2FESA-EF%25202007.pdf&ei=GGf4R-2JBjXcigGUoJHhDg&usq=AFQjCNHtYylErtjlKgOHht9pXdw5W7eVHg&sig=ChZUAwPcc5_2B733jyLGSA)>
- Ewing, Jack. "Upwardly Mobile in Africa." *Business Week Online*. August 14, 2007. Academic Search Premier. 6 Apr. 2008 <<http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=26628776&site=ehost-live&scope=site>>
- Giaglis, George. et. al. "On the Potential Use of Mobile Positioning Technologies in Indoor Environments." *Proceedings from the 15th Bled Electronic Commerce Conference eReality: Constructing the eEconomy*. Bled, Slovenia. June 17-19, 2002. 6 Apr. 2008 <[http://www.bledconference.org/proceedings.nsf/Proceedings/470EE786EC116F7DC1256E9F0034EBF0/\\$File/giaglis.pdf](http://www.bledconference.org/proceedings.nsf/Proceedings/470EE786EC116F7DC1256E9F0034EBF0/$File/giaglis.pdf)>
- GSM World. "3GSM Platform." GSM World. 6 Apr. 2008 <<http://www.gsmworld.com/technology/3g/evolution.shtml>>

- "Innovating for Life: Rogers Communications Inc. 2006 Annual Report." Rogers Communications Inc. 2007. 6 Apr. 2008 <[http://downloads.rogers.com/Annual\\_Report\\_SECURE.pdf](http://downloads.rogers.com/Annual_Report_SECURE.pdf)>
- Kirkpatrick, David. "Tech's biggest trend: everywhere." Fortune Magazine, June 15, 2007. 6 Apr. 2008 <[http://money.cnn.com/2007/06/15/technology/personaltech/fastforward\\_pcgrowth.fortune/index.htm](http://money.cnn.com/2007/06/15/technology/personaltech/fastforward_pcgrowth.fortune/index.htm)>
- Korhonen, Jani. et. al. "Mobile Fair Diary: hybrid interface for taking, browsing and sharing context-aware notes." Personal and Ubiquitous Computing. Vol. 11, No. 7, October 2007. 6 Apr. 2008 <<http://www.springerlink.com/content/9g3136521tk2m677/fulltext.pdf>>
- Lee, Youngseok. "Measured TCP Performance in CDMA 1x EV-DO Network." Proceedings of the Passive and Active Measurement Conference 2006. 6 Apr. 2008 <<http://www.pamconf.org/2006/papers/sl-lee.pdf>>
- Magerkurth, Carsten. et. al. "Pervasive Games: Bringing Computer Entertainment Back to the Real World." Computers in Entertainment (CIE). Vol 3, Issue 3, July 2005. 6 Apr. 2008 <<http://ipsi.fraunhofer.de/ambiente/paper/2005/p4a-magerkurth.pdf>>
- Mosavi, M.R. "A practical approach for accurate positioning with L1 GPS receivers using neural networks." Journal of Intelligent & Fuzzy Systems. Vol 17. Issue 2. 2006. Academic Search Premier. 6 Apr. 2008 <<http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=20237082&site=ehost-live&scope=site>>
- Peters, Oscar. ben Allouch, Somaya. "Always connected: a longitudinal field study of mobile communication" Telematics and Informatics Volume 22, Issue 3, , August 2005. 6 Apr. 2008 <<http://www.sciencedirect.com/science/article/B6V1H-4F60JX8-1/2/77f509961c938cf97b5a49f47274501c>>
- Ramsay, Randolph. "Live it up: 10 steps to get your Xbox online." CNET. May 10, 2005. 6 Apr. 2008 <<http://www.cnet.com.au/games/xbox/0,239029621,240054700,00.htm>>
- Reuters. "Global cellphone penetration reaches 50 pct." Reuters UK, November 29, 2007. 6 Apr. 2008 <<http://investing.reuters.co.uk/news/articleinvesting.aspx?type=media&storyID=nL29172095>>
- Schiesel, Seth. "In the List of Top-Selling Games, Clear Evidence of a Sea Change.(Movies, Performing Arts/Weekend Desk)(VIDEO GAMES). ." The New York Times. 157.54207 (Feb 1, 2008): E1(L). Academic OneFile. Gale. Seneca College. 19 Mar. 2008 <<http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T004&prodId=AONE&docId=A174091877&source=gale&srcprod=AONE&userGroupName=king56371&version=1.0>>
- Schiesel, Seth. "World of Warcraft Expands." The New York Times (Jan 17, 2007): E2(L). Academic OneFile. Gale. Seneca College. 6 Apr. 2008 <<http://lcweb.senecac.on.ca:2097/itx/start.do?prodId=AONE>>.
- Stone, Jonathan. et. al. "GPS Pseudolite Transceivers and their Applications." Proceedings of the ION National Technical Meeting 'Vision 2010: Present and Future', San Diego. 1999. 6 Apr. 2008 <[http://waas.stanford.edu/~wwu/papers/gps/PDF/gps\\_pl\\_apps\\_jms\\_1999.pdf](http://waas.stanford.edu/~wwu/papers/gps/PDF/gps_pl_apps_jms_1999.pdf)>

- "Today in business." The New York Times. 157.54250 (March 15, 2008): C2(L). Academic OneFile. Gale. Seneca College. 19 Mar. 2008 <<http://lcweb.senecac.on.ca:2097/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T004&prodId=AONE&docId=A176725684&source=gale&srcprod=AONE&userGroupName=king56371&version=1.0>>.
- Walz, Steffen. Ballagas, Rafael. "Pervasive Persuasive: A Rhetorical Design Approach to a Location-Based Spell-Casting Game for Tourists." Proceedings of DiGRA, 2007. 6 Apr. 2008 <<http://www.digra.org/dl/db/07311.17007.pdf>>
- Wikipedia. "WiMAX." 6 Apr. 2008 <<http://en.wikipedia.org/wiki/WiMAX>>
- Youtube. "NVIDIA APX 2500." Youtube. 6 Apr. 2008 <<http://www.youtube.com/watch?v=M2L4P1WR5Mw>>

## Images Cited

- Cheok, Adrian. et. al. "Human Pacman: A Mobile Entertainment System with Ubiquitous Computing and Tangible Interaction over a wide outdoor area." Lecture Notes in Computer Science. Springer, 2003. 6 Apr. 2008 <<http://cs.ubc.ca/~krasic/cpsc538a-2005/papers/human-pacman.pdf>>
- Cooper, Sean. "Hands-on with NVIDIA's APX 2500, and yeah, it plays Quake." Engadget. February 13, 2008. 6 Apr. 2008 <<http://www.engadgetmobile.com/2008/02/13/hands-on-with-nvidias-apx-2500-and-yeah-it-plays-quake/>>
- Invidkllr. "To WoW or not to Wow." Invidkllr. 6 Apr. 2008 <<http://www.invidkllr.com/2006/03/23/to-wow-or-not-to-wow/>>
- "Photo Messaging On the Up." Gizmodo. August 9, 2006. 6 Apr. 2008 <[http://uk.gizmodo.com/2006/08/09/photo\\_messaging\\_on\\_the\\_up.html](http://uk.gizmodo.com/2006/08/09/photo_messaging_on_the_up.html)>
- "Top Ten List of iPhone Competitors." MobileWhack. 6 Apr. 2008 <<http://www.mobilewhack.com/top-ten-list-of-iphone-competitors/>>