Serious Fun
Pervasive game design as a CAAD teaching and research method

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Abstract. *Today and in the future, architectural students must be prepared for designing both physical and adaptive, computer-integrated spaces. The question is: How do we easily and effectively convey architecturally relevant theories and practices of pervasive computing in teaching? In this paper, we present a didactic model that has proved to be a possible answer. During a semester long design class, we supervised an interdisciplinary group of architecture and computer science students who teamworked on an early so called serious pervasive game prototype, entitled "ETHGame". The class culminated in a two week compact phase and a presentation before ETH representatives involved in e-learning projects.*
The resulting interactive prototype takes advantage of our campus's extensive wireless local area network infrastructure, allowing for user positioning and location based learning, servicing, and peer-to-peer communication. The game mutates the whole of the ETH Zurich campus into a knowledge space, issuing position dependent and position relevant questions to players. The ETHGame forces participants to engage with a given space in the form of a quiz and rewards them for collaborating both face-to-face and facelessly. The game helps them build a collective academic and space aware identity whilst being immersed in a sentient environment. Thus, in this paper we are introducing serious pervasive game design as a novel design research and teaching paradigm for CAAD, as well as a e-learning design strategy.

Keywords. *Pervasive computing; pervasive game design; serious games; location based learning; knowledge space.*

1. Introduction

Increasingly, information and knowledge technologies permeate through physical environments – they are being woven into the very fabric of everyday life. Objects, devices, services, and people that surround us become networked, as well as the space that we inhabit over time. Furthermore, our activities become mediated by the way of these technologies, often in a location based manner. This third wave of computing is commonly referred to as "pervasive computing", and it deeply impacts

how we design “sentient” spaces now and in the future.

1.1 Pervasive computing and CAAD: Games as Teaching Methods and Results

Architecture and CAAD in particular should reflect pervasive computing as a new field of interest by the way of innovative research and teaching. We believe this field to be as important as other CAAD education cornerstones such as history, design, structure, or finance. In order to address this reflection challenge, we have gathered a multidisciplinary team consisting of architects, game designers, social anthropologists, and computer scientists. During the winter semester 2004/05, this team has carried out an intensive studio course culminating in a two-week compact phase together with ten architecture and computer science students, eight men and two women. The class has concerned the detailed conceptualization and prototypical design of a location based “serious pervasive game” by the name of “ETHGame”, taking place on site the ETH Zurich campus.

Pervasive gaming integrates the technical approaches of computer gaming with emerging mobile interfaces, wireless and digital networks, and positioning technologies. By this, game experiences are introduced that combine both virtual and physical game elements in computer-integrated environments, see Figure 1.

In earlier CAAD teaching, games and their level editors have been used to let students explore virtual and often utopian realities taking place within the constraints of the computer display (Engeli 2002). Today, pervasive games allow students to explore their roles as architects who design not only passive space or displayed surface, but also physically based interactivity, dramaturgy, emotion, and novel experiences over time. Yet in order to use games as a teaching vehicle and result, students must first learn how to design them.

When being played, mutually all games become learning experiences. So by designing a game, students learn hands on how they can help players to learn, cf. Koster (2005). Fullerton/Swain/Hoffman (2004) has proven to be another helpful resource for the game design teaching component.

Figure 1. Gameplay situation from the prototype.

1.2 Specifics of Serious Pervasive Game Design for CAAD

In addition - and contrary to computer games and computer game design - pervasive game design takes into account the architectural genius loci of the physical „gameboard“. including its everyday uses which can be approximated with the help of social science techniques, for example ethnography, field observations, or interviews. Consequently, we have introduced students of our class to these techniques through lectures and exercises. Other pervasive games, for example, map the classic computer game PacMan onto a real-world setting (cf. http://155.69.54.110//research/HP/HP_webpage/research-HP-infor.htm: May 2005), focus on social and collaborative interaction (cf. http://craftsrv1.epfl.ch/research/catchbob/: May 2005), or represent artistic touring-style experiences (cf. http://www.blasttheory.co.uk/bt/work_cysmn.html: May 2005).

The social science design techniques mentioned in the above are even more important when the goal of a game is serious, as it is the case with the ETHGame project: We define “serious games”

as computer integrated games that are applied to "serious" purposes other than entertainment, e.g. learning, security, (building/environment) administration, and management. In this kind of game, players engage in an artificial conflict, resulting in a quantifiable outcome. Yet, a serious game should have effect beyond the gameplay session. These serious applications to gaming represent a growing financial outlet for game developers, where projects can produce both economic and social returns, see for example (www.seriousgames.org: May 2005) or (www.socialimpactgames.com: May 2005). Walz (2005) describes a pioneering serious pervasive multiplayer game from the year 2002, which is documented in full detail at (www.madcountdown.de: May 2005).

1.3 Pervasive Game Design as a CAAD Teaching and Research Paradigm?

When we understand pervasive games as systems of excitement and education in hybrid space-time, then learning to design these kinds of games becomes the act of understanding how to design for both learning and interacting with synchronous physical and virtual architectures. This is why we believe that serious pervasive game design can serve as a novel design research and teaching paradigm for CAAD with regard to e-learning. Other experiments at our chair have included, for example, a biofeedback game that allows to direct computer integrated building functionalities such as light control by the way of playfully manipulating one's own heart rate variability as well as skin conductance (www.building-ip.ethz.ch/education/Biofeedback). The paper at hand describes the planning and implementation of our CAAD course on serious pervasive game design, its results, its documentation, and a number of future research issues.

2. Design Studio Didactics and Structure

In the following section, we outline how we have, didactically and structurally, organized the ETHGame design class from the planning phase until the final presentation.

2.1 Goal of the Design Class

Because in the year 2005 the ETH Zurich celebrates its 150th anniversary, we had originally considered a historical pervasive game prototype, assuming we would have been able to implement the result as an jubilee event. We have dropped the plan early on, though, trying for a more sustainable, reusable result.

We have defined that the students' final, campuswide game concept should focus on faceless and face-to-face interaction and links between physical locations and players, as well as interaction in-between players by the way of physical locations. We consider this approach a model for creating sentient environments equipped with digitally stored knowledge. Given locations are overlaid with a „character" that is only recognizable with the help of digital media and networked hardware. Such enhanced locations become a user's play partner rather than a functional container. This way, students have become aware that pervasive games help architecture to be experiential, interactive, emotive, space-time based, and entertaining. Also, we have taught students that mapping knowledge onto computer controlled buildings is necessary today. Yet, architecture turns into a dynamic learning space, and serves to connect people with a site's past, present, and future.

2.2 Class Curriculum and Structure

Topics we have taught during the weekly three hour class included, for example, (pervasive) game design fundamentals, ethnographic methods, digital building interaction, media architecture, and wireless / mobile application design. We have met

these demands with the help of our chair's multi-disciplinary team, and individual expertise.

By means of known spatial categories, we have exemplified pervasive game design techniques, increasing scale week by week. In succession, students have home worked miniature pervasive games, addressing body, (play) object, room, level, building, and campus as a game platform. Concerning the documentation of this work, refer to section 2.3.

This learning-by-doing approach (Dewey, 1916) has helped to successfully convey the rather technical issue of pervasive computing. We have also included lectures on formal and dramaturgical game design vocabulary and elements, applying specifically Fullerton/Swain/Hoffman (2004). Besides this input, the course has featured site specific history and pervasive technology lectures, as well as exercises in ethnographic observation of people's behaviors all across the campus, next to spatial analyses of playgrounds, and gameplay flowcharting. By analyzing campus locations, students have identified the locations' specific "stories". Thus, players and specific locations can communicate through the players' own mobile computer. We have amended these matters with programming sessions wherein students learned how to work with our custom built building intelligence middleware (cf. Bahr/Ochsendorf/Strehlke, 2004; Ochsendorf and Strehlke, 2004; www.building-ip.ethz.ch: May 2005). Additionally, during the beginning of the semester, we have invited two game design researchers – Jussi Holpainen (Nokia Research Center, Tampere, Finland) and Dr. Staffan Björk (Chalmers University Gothenburg, Sweden) – to hold a one week voluntary workshop about "Game Design Patterns", see also Björk and Holopainen (2005).

We had jointly settled on a basic game design concept by the end of the semester after student groups had pitched concept ideas against each other. We then have invited game designer Jochen Hamma - chair of the Frankfurt/Main chapter of the International Game Developers Association (IGDA) - for an one day intermediate game design workshop. This workshop has helped students and us to receive valuable feedback concerning the results thus far, as well as tips for how to carry on. The same time it strengthened the students' group feeling.

During the academic vacation period, we have finalized a core concept as well as an early, stable game prototype during a two-week compact phase that took place at the chair. For this purpose, we divided the group into subgroups, each responsible for a certain game development aspect, e.g. game design, prototyping, marketing etc. Each group had to fullfill its own work packages in time. Ongoing, but besides class lectures, tutorials, and the workshop, we have also organized a lecture series entitled "The architecture of games", giving insight into possible interfaces between CAAD and game design. Students have been introduced to serious pervasive game design within CAAD quite intensely throughout the design studio process.

2.3 Class Twiki: Realtime Web Collaboration Tool for successful Group Organization

A Twiki is special instance of an open source collaborative "wikiwiki" website which multiple users can edit in real time. Wikis offer a great and remaining framework for easy, fast, and seamless documentation, teaching, monitoring and communication. At the ETH Zurich chair for CAAD, we have been using this handy tool widely for a couple of years, asking newbie students to learn how to work with it, too. Our large ETHGame (German only) Twiki website can be explored here: wiki.arch.ethz.ch/twiki/bin/view/Game0405 (June 2005)

Especially during the compact phase, the class Twiki proved to be an efficient platform for idea exchange, and for (self-)organizing and updating the student group as well as sub groups. It enabled a permanent supervision of each student's working process.

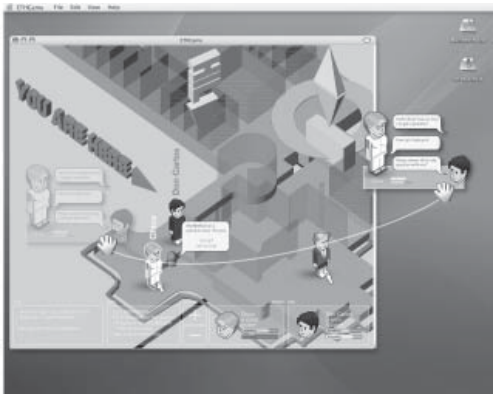

Figure 2. ETHGame main application interface example including dragable chat client

3. Final ETHGame Feasibility Study, Concept, and Early Prototype

In the following section, we present the final core concept of the ETHGame, as well as an early prototype we finalized during our two-week compact phase: At (wiki.arch.ethz.ch/twiki/bin/view/Game0405/ETHGameSessionFinal), you can down-load the full feasibility study. On this website, you will also find an interface demo, movies exemplifying the ETHGame, and Java files you may try to run.

3.1 ETHGame summary

The ETHGame prototype game is a question and answer quiz-like experience. It takes place on the whole of the city wide ETH Zurich campus, involving a virtually unlimited number of student

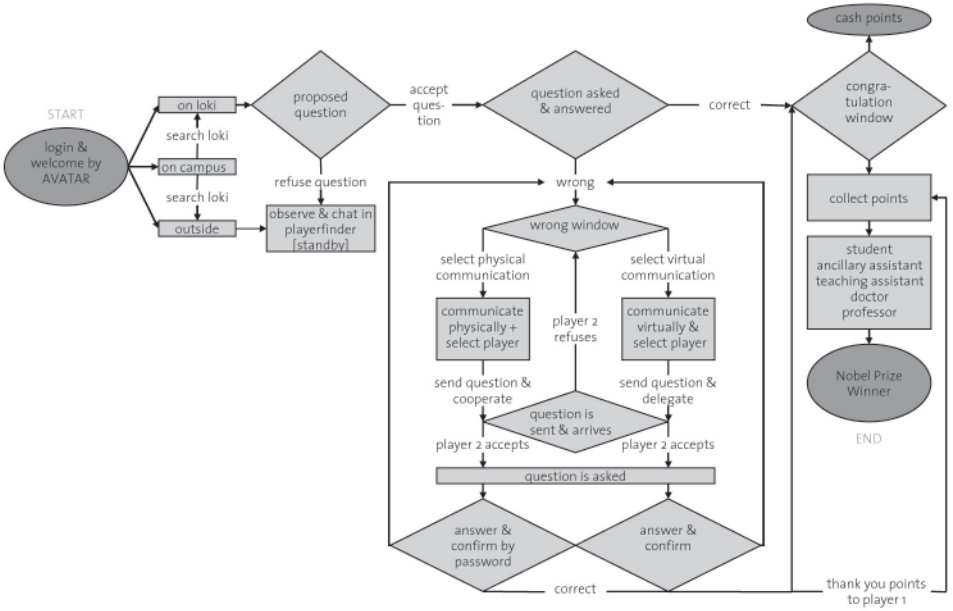

Figure 3. Functional flowchart specifications of the ETHGame concept.

and faculty players and an estimated number of around 250 wireless LAN (WLAN) access points, representing interactive locations and their stories. The concept foresees the game as a vehicle for transporting and querying knowledge about the individual locations' stories. Thus, each physical location serves as a game interface, whereas the combined locations serve as an almost seamless cross campus playground. The pervasive environment of the building sites involved connects players and the game system. The final game will be playable on campus with any given mobile or stationary computer and a valid ETH account: Upon physically entering a pre defined knowledge space with their mobile device, this so called "locus" will ask players location dependent questions concerning general and technical ETH topics, see Figure 2 which illustrates an exemplary application interface for the locus "Baumensa". The locus has certain characteristics such as being moody, etc.. This allows to instantly change the gameplay by software without changing whole physical locations. It is possible to indirectly influence players, objects, and the use of space.

Once a player reaches the level of a "professor", she keeps collecting points to ensure her victory. Only one, and only the best player wins the ETHGame Nobel Prize with the last locus question. If a question has not been answered to a locus's satisfaction, a player has to consult with another player in proximity and solve the riddle cooperatively. Game highscores are displayed on a public highscore board. Players may also swap points for coffee discounts in the school's cafeteria.

The game's story underlines the social and collaborative, yet competitive learning nature of the experience: The entirety of the ETH's professors conducts an experiment where physical rooms of knowledge take over the lecturer's teaching role. Meanwhile, the professors can consecrate themselves to their research. By ascending levels through cooperation, ken, and credit points, a player can win the game.

3.3. Functional specifications of the ETHGame

After having downloaded the game application onto a notebook computer equipped with a WLAN card, players choose a nickname, registers with the game, and logs into it. Player receive their ETH department dependent avatar, which changes over time and player success. Figure 3 displays how the game as a whole works conceptually from the player's perspective.

Our game's credit point system adjusts to the player and depends on the locus' IT and WLAN infrastructure and overall availability. Players from smaller departments and only a few access points should not be at a disadvantage. On the other hand, a courageous and enthusiastic player who explores other buildings and departments should be rewarded. Finally, the game rewards those players who cooperate with another player when answering a question. This way, the game supports social interaction and community building, whilst still being balanced.

3.4 Technical specifications of the ETHGame

To our knowledge, the wireless infrastructure at the ETH Zurich is Europe's largest wireless local area network, with, for example, over 25 access points up and running at the faculty of architecture.. Usually, the ETH Zurich community uses these access points as Internet connection gates for mobile computers. The ETHGame prototype uses this infrastructure to locate single clients - the players - in a building by simply measuring the signal strength of the receivable access points.

We have found that an an exact positioning with a triangulation all building access points is impossible. As a solution for locating a client at a game locus, we have defined the condition to receive the signal of two or more specified access points. In effect, a peer-to-peer messaging tool will make up the core function of the ETHGame.

In this paper, we will not go into details regarding other prototype components we programmed or planned, such as using Java for implementing

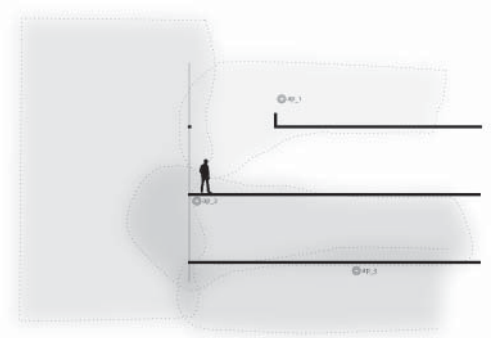

Figure 4. WLAN clouds from different access points (AP) blur spatial areas.

tions concerning location based interactive site maps; user positioning tools; site identity authoring tools; visitor information applications; a digital annotation framework; or departmental messaging services.

For purposes of wrapping up the class, we have required each participating student to deliver a written documentation of their specific role within the prototyping team after the prototype had been presented finally.

4. Summary: Results and Findings

By using pervasive game design as a teaching and prototyping method for students in architecture, we have learned to create an architectural framework for empowering user experience within a large-scale computer-integrated scenario very effectively. Hands on, students have learned how architecture turns into an interacting organism and adaptive surrounding. And: designing fun experiences is a serious fun experience in itself.

On the one hand, the methods and techniques we have been applying in our course allow a perception of space and time from the point of pervasive networked computing. Students have assessed the possibilities and limitations of designing an adaptive building scenario. In addition, students have addressed issues of digitally connected location based services. Another result of this course shows that students have started to include pervasive computing into their skill set as an additional, yet fundamental design element within architecture. However, we were amazed that students had problems realizing that Wireless LAN access points describe blurred spatial areas, see Figure 4 – although this had been an immediate output of the our WLAN prototype as soon as it had been was tested within the faculty's building.

As pervasively computed buildings are steadily becoming reality, our applied teaching method introduces both a pragmatic design tool and a scantly developed formal design field. In future courses, we aim at developing pervasive computing authoring tools and templates for easy prototyping / authoring, as well as exciting and playful forms of location based services in sentient environments. Further on, the field of physical spaces for e-learning will be researched both theoretically and practically at our CAAD chair, also in combination with projects such as ETH World 'Building IP - lecture hall of the future' (www.building-ip.ethz.ch: May 2005) and the Blue-C immersive video technology endeavour, see (blue-c-ii.ethz.ch: May 2005).

On the other hand, with the ETHGame design studio, we have successfully introduced a novel design paradigm into CAAD - game design, and more specifically, serious pervasive game design. How deeply pervasive game design can be established as a continuing CAAD method needs to be shown in future research and teaching projects. We believe that pervasive game based learning as well as learning based pervasive games should be of interest to the e-learning research community, the building industry, as well as the IT industry.

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