Story Mashup: Design and Evaluation of Novel Interactive Storytelling Game for Mobile and Web Users

Jürgen Scheible
Media Lab
University of Art and Design, Helsinki
Hämeentie 135C, FIN-00560 Helsinki
+358 40 550 9268

jscheib@uiah.fi

Ville H. Tuulos
Helsinki Institute for Information
Technology (HIIT)
FIN-00014 University of Helsinki
+358 50 540 6608

ville.h.tuulos@nokia.com

Timo Ojala
MediaTeam Oulu
University of Oulu
FIN-90014 University of Oulu, Finland
+358 40 567 6646

timo.ojala@ee.oulu.fi

ABSTRACT

This paper studies the design rationale and evaluation of an urban storytelling game called Story Mashup. In the game ubiquitous computing infrastructure is utilized to facilitate real-time interaction between mobile and web users. Textual stories written in the web by certain people are illustrated by other people taking matching photos with camera phones. Complete stories are then displayed on a large public display and on the web. To carry out a thorough empirical evaluation of the game design in a real world setting, the game was played in New York in September 2006 with 180 players and by people in the internet around the world. The results show that the adopted iterative design process succeeded in achieving the goals set for usability, user experience and game stimulation.

Categories and Subject Descriptors

H.5.1 **[Information Interfaces and Presentation]:** Multimedia Information Systems – *evaluation and methodology, video*. H.5.2 **[Information Interfaces and Presentation]:** User Interfaces – *evaluation and methodology, input devices and strategies, interaction styles.* H.5.3 **[Information Interfaces and Presentation]:** Group and Organization Interfaces - collaborative *computing, computer-supported cooperative work, evaluation and methodology.*

General Terms

Design, Experimentation, Human Factors.

Keywords

Multimedia art, hybrid interfaces, experimental evaluation.

1. INTRODUCTION

The Story Mashup system introduces a new form of interactive storytelling by mobile and web users, realized as an urban game.

The system uses ubiquitous computing infrastructure to

dynamically combine the respective virtual and physical spaces of a web user and a mobile user into a multimedia game. The game is expected to trigger people's creativity into generating unpredictable and spontaneous visual stories in a collaborative manner.

We have previously reported the technical implementation and the overall game design of the Story Mashup [12]. The novel contribution of this paper lies in reporting the design rationale, the iterative design process employed in the development of the Story Mashup system and the major design decisions taken. In the following we provide an in-depth analysis of the various design stages and their design outcomes when building a series of prototypes. Further, we report new, previously unpublished findings on the empirical evaluation of the final system, and contrast them with the design rationale, providing valuable lessons learned for the community.

In Story Mashup, individual keywords of textual stories written by web users are presented, one word at a time, to mobile users for the purpose of taking a matching photo with their camera phone. Each resulting keyword-photo pair is validated by presenting the photo together with the original keyword and three other words to two other mobile users, who are asked to choose the most appropriate word given the photo. If either of the two chooses the original keyword, the photo is approved into the resulting visual story. All resulting stories are displayed on the web and selected best ones on a large public display. The players are awarded points for taking photos and for choosing the original keyword.

The Story Mashup system comprises of three physical building blocks: camera phones equipped with the game client, a website in form of a storytelling tool and a large public display. The fourth interesting functional component is the "human computing" carried out by mobile peers for the purpose of validating the photo offered for visualizing a particular keyword in a story.

When designing interactive systems and games it is useful to use guidelines and heuristics as part of the design process. Various people have studied this. Desurvire *et al.* [3] introduced Heuristic Evaluation for Playability (HEP), a comprehensive set of heuristics for playability. They say that in the realm of game playability, there is a need to go beyond basic interface game usability evaluation to assess additional properties of the game experience including game play, story, and mechanics.

Sweetser and Wyeth [11] have been looking into enjoyment in games and introduced GameFlow, a model for evaluating player's enjoyment in games. It consists of eight elements – concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction. Each element includes a set of criteria for achieving enjoyment in games. Malone [6] constructed a list of heuristics for instructional games.

Nielsen has introduced his usability heuristics [7]. Preece *et al.* [8] have explained that different combinations and types of heuristics are needed to evaluate different types of applications and interactive products.

The Story Mashup system deliberately promotes ambiguity in the gameplay, in order to leave room for the players' own creativity. Various benefits of ambiguity in design are discussed by Aoki and Woodruff [1]. We also discussed the dual role of the player in Story Mashup [12], the spectator versus the performer, in the light of the various aspects of the spectator experience explained by Reeves et al. [9].

In this paper we focus on the design and evaluation of the Story Mashup system. Our major goal from a design point of view was to build a system that a) provides engaging experiences to players, b) triggers creativity in writing stories and taking photos, and c) fosters collaboration and social interaction in form of team play. We believe the usability of the system plays a crucial role in achieving these goals. We were interested to see whether a novel system as Story Mashup could reach these goals by following well known design processes that include prototyping, iterative design, lab tests and empirical evaluations in the true environment of use.

This paper is organized as follows. Section 2 describes briefly the overall game design. Section 3 provides an in-depth analysis of the various design stages and design decisions regarding prototype design and evaluation. Section 4 presents the findings and lessons learned. Section 5 summarizes our thoughts.

2. GAME DESIGN

The game involves three different parties: a) the web players in the internet using the storytelling tool to contribute stories, b) the mobile players hunting for photos and c) the large public display showing the resulting illustrated stories (Fig. 1).

A web player writes a story with the storytelling tool in the internet. After that the Story Mashup system extracts one noun of each sentence of the story, which are dispatched to mobile players. The mobile player A is provided with a list of up to 10 nouns. After accepting a noun (s)he has 90 seconds to take a photo matching the noun. After that the photo and the noun are sent together with three other nouns to mobile players B and C, who are asked to pick the noun matching the photo. If either B or C picks the original noun, the photo is sent back to the web player illustrating the story. The illustrated stories end up in a story pool, of which selected stories are displayed on the public display. A web player can also remix stories by choosing sentences from the story pool of already illustrated stories and adding her/his own new sentences into it, in order to get a new illustration in the same way as with a new story.

The **mobile client** has different viewing modes (Fig. 2). The keyword selection mode for choosing incoming nouns as the next target for shooting; The shooting mode that opens the viewfinder
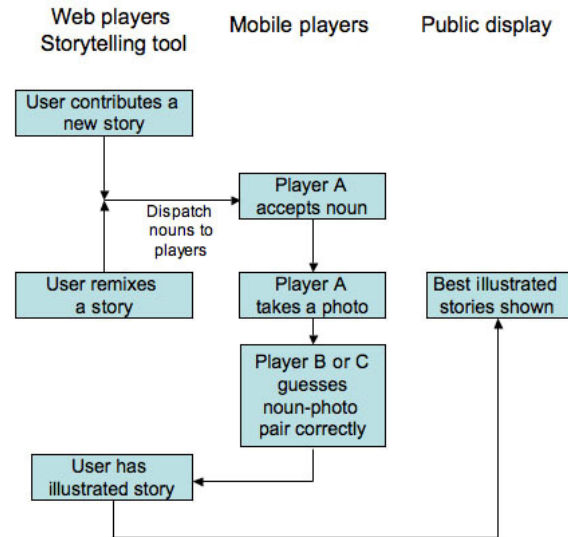

Figure 1. Game flow.

(a) (b)

(c) (d)

Figure 2. Screenshots of the mobile clients' viewing modes: (a) keyword selection; (b) shooting mode; (c) player statistics; (d) gallery.

and starts a 90 seconds timer; The guessing mode which presents a photo taken and four alternative nouns, one of which is the correct one; The player statistics mode for showing current player statistics; The gallery mode to see photos taken by other players.

The **storytelling tool** allows a web user to write stories from scratch or pick a previously contributed story as a basis for an own story. The tool allows leaving a creative handprint onto a large public display and interacting with real people in the streets.

The **public display** shows a selection of the illustrated stories, providing the storywriters and photo hunters an opportunity to display their collaborative work in form of street art.

3. DESIGN RATIONALE

Recalling our design goals of a) providing engaging experiences to players b) triggering creativity in writing stories and taking photos c) fostering collaboration and social interaction in form of team play, and the role of high usability and successful interaction design in achieving these goals, we first briefly describe the design guidelines, heuristics, and processes chosen for this work, of the many potential candidates. Then we provide a detailed description of their application in the design of the Story Mashup system.

3.1 Design Guidelines and Heuristics

Preece *et al.* [8] point out that the role of evaluation is to make sure that understanding of the users' needs happens during all stages of the development. They explain that different combinations and types of heuristics are needed to evaluate different types of applications and interactive products. To meet our challenge of designing both the mobile client and the storytelling tool with high usability, we decided to employ commonly known design practises, identify different types of heuristics and establish a set of questions that need to be answered when looking at our designs. We believed that by applying such design practises we could achieve the goal of high usability. Therefore, we formulated the chosen heuristics and the collection of questions in form of different criteria as follows.

Criteria 1:

a) The user experience goals as described by Preece et al. [8]. A system should be satisfying, enjoyable, fun, entertaining, helpful, motivating, aesthetically pleasing, supportive of creativity, rewarding, emotionally fulfilling etc.

b) The usability goals described by Preece et al. [8]. A system should be efficient to use, effective to use, safe to use, have good utility, easy to learn, and easy to remember.

Criteria 2:

The use qualities of digital designs articulated by Löwgren [5]: anticipation, surprise, playability, seductivity, social actability, transparency. We see these qualities as important design goals to achieve, so that the user can experience them when using the storytelling tool or the mobile client.

Criteria 3:

The usability heuristics defined by Nielsen [7] such as "Simple and natural dialogue" or "Speak the users' language" etc. These seem to be highly applicable when designing the mobile client and the storytelling tool in order to find out what is missing or what goes wrong.

Criteria 4:

The questions proposed by Instone (as quoted by Veen) [13]: a) Where am I?, b) What's here?, c) Where can I go? According to Preece et al. [8] there are few key design issues for websites that are different from other interaction designs and they can be captured by these questions. Instone explains that the answers to these questions must be clear to users.

Criteria 5:

a) Will users know what to do? b) Will users see how to do it? c) Will users understand from feedback whether the action was correct or not? These questions are used for a cognitive walkthrough of a design. They lean on the questions proposed by Preece et al. [8] who suggest a walkthrough as an alternative approach to heuristic evaluation for predicting the users' problems without doing user testing.

Criteria 6:

a) Why should I join this community? b) What are the rules? c) Can I do what I want to do easily? d) Can I express myself as I wish? These are heuristics from online community website design. According to Preece et al. [8], a key concern is how to evaluate not merely usability but how well social interaction is supported, in this case especially sociability. We chose these because the storytelling tool of Story Mashup exhibits significant character of an online community tool.

3.2 Design Process

To manage our design process, we tended to lean towards Nielsen's established usability engineering life cycle, focusing especially on prototyping and iterative design [7]. This includes in our case on one hand applying the set of identified design criteria, and on the other hand conducting tests in the lab and in the true environment of use, for the purpose of obtaining feedback for the iterative design.
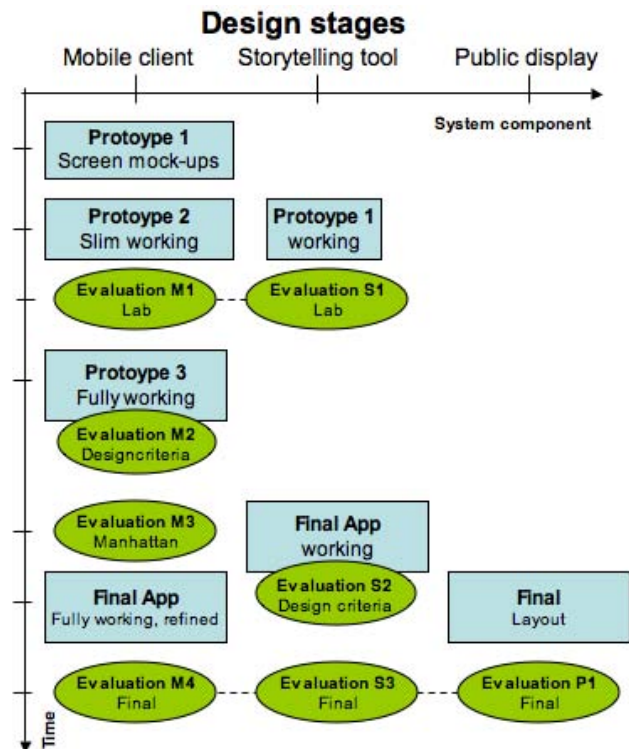

Figure 3. Design stages

We believe that by using prototyping and a fast iterative design cycle we can achieve our goals of high usability and successful interaction, since the instant feedback from evaluations can be incorporated in the design of the next prototype.

Fig. 3 gives an overview of the different design stages of each component, placing the different prototypes and evaluations on a timeline. While the prototypes have running numbering, the evaluations have unique identifiers, e.g. M1 or E2. Discussion on the final evaluation of the three components of the complete system (M4, S3, P1) is deferred till Section 4.

3.2.1 Designing the Mobile Client

Given the basic idea of the game, at the very beginning we knew only the general tasks of a mobile player such as shooting a photo and accepting keywords. We had no clear understanding what the mobile client should provide the player with in terms of features, UI modes, timings etc.

Identifying these requirements was part of the design process. Our challenge was to incorporate the complex underlying game mechanisms into the mobile client and make them transparent on the UI level. We wanted to provide the user with a simple UI, which would allow her to concentrate on the main tasks of the game, the creative tasks, instead of being occupied and interrupted by multiple UI navigation steps etc. To meet this challenge we built three prototypes of the mobile client en route to the final game version.

Prototype 1. Based on the ideas of the basic game mechanisms we designed a flow diagram including all possible UI view modes and task selection options, in the form of UI screen mock-ups (Fig. 4).

While creating the mock-ups, we were able to make cognitive walkthroughs applying criteria 5a) Will users know what to do? 5b) Will users see how to do it? 4 a) Where am I? 4b) What's here? and 4c) Where can I go? By asking ourselves these questions we came up with the most essential functionalities we believed would provide the user with an engaging experience when using the mobile client and would allow concentrating on the creative tasks of the game.

Prototype 2. Given the paper prototype 1, we implemented a vertical prototype of the mobile client. It was fully functional in terms of camera usage, data upload and the notification of incoming keywords as well as sending and receiving an image for guessing. However, high quality graphical design was omitted and feedback for the user's actions was only available as text on the screen.

Evaluation in the lab (M1). Prototype 2 was subjected to a usability test in a lab. Six test users played the game for 1.5 hours, dividing their attention between the mobile client and the storytelling tool (see evaluation S1). We collected data by conducting video interviews with each player and observed players by recording their actions.

The findings of the evaluation showed a clear need to provide a status indication in which part of the application the user was at

any given time. Further, we needed to come up with a clear navigation structure. Also, we needed to implement a scoring scheme that allows players to gain points and to be able to track them. Another important issue to solve was to provide proper feedback to confirm actions taken by the user and when uploads were done. Also, a status indicator showing that the application was online and ready for receiving keywords was deemed necessary. Most importantly, we had to provide a smooth and simple UI with just 2-3 clicks needed for all actions, which would allow the user to focus on the main task. After the lab evaluation we realized that we most likely could have avoided most of the design mistakes, if we would have made another walkthrough with our set of design criteria.
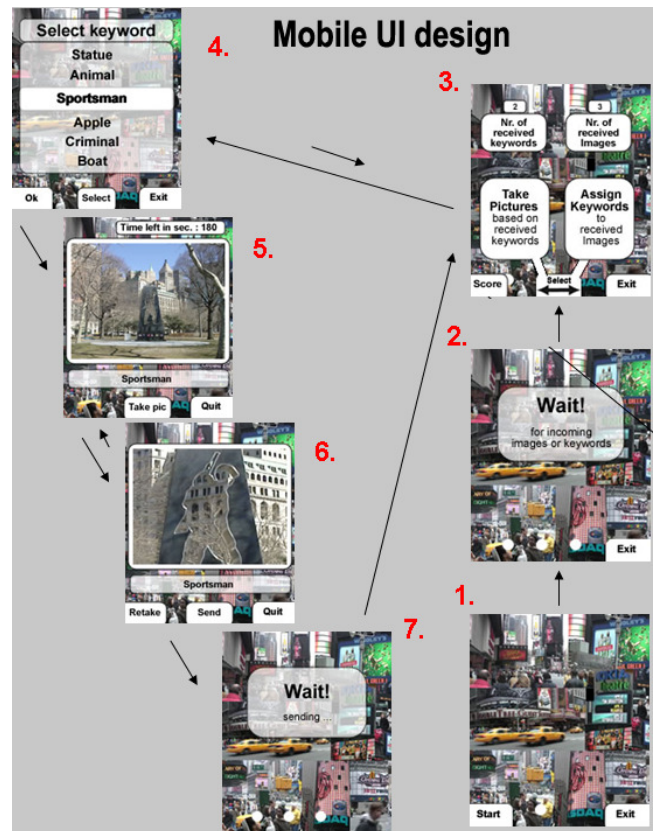

Figure 4. Initial mobile client UI screen mock-ups.

Prototype 3. Going back to the drawing board, we sketched a complete redesign on paper, including a flow diagram of the tasks the client should handle.

Evaluation (M2). By taking a walkthrough on the prototype 3 we applied criteria 3 (Nielsen's [7] heuristics), for example:

- Does our application have "Simple and natural dialogues?

- Do we "Speak the users' language"?

- Have we managed to minimize user memory load?

The walkthrough allowed us to see clearly what the missing parts in our design were.

Prototype 4. Given the prototype 3 on paper, we implemented it as a functional mobile client including a rich graphical design. For

each redesign we needed to make sure that any arising changes in the server side implementation were made, as well. Using Python for S60 [10] [4] as the programming language on the mobile client and Python on the server side supported efficient programming of the redesigned components.

Evaluation (M3) in Manhattan. The next step was to evaluate the new prototype in the target environment of use (Manhattan, New York), to find out about potential problems that we could encounter during the real game play and to be able to prepare for necessary backup solutions. The evaluation was done with 13 test players, five females and eight males. Each of them had a mobile phone connected to the mobile data network that we were going to use in the final game. One of the problems we had at this point was that the storytelling tool in the web was yet not ready. Therefore, we built a server component that simulated the storytelling tool by randomly drawing nouns from a database and sending them to players.

The game was played for two hours. We collected data by observing the players with a video camera during game play. We also video interviewed the players both during and after the game, getting instant feedback about the user experience. After the game ended, the players filled in a questionnaire with 26 statements, on which the users were asked to answer on a 5-point scale, and 23 open-ended questions. The questions focused on one hand on the user and game experience, on the other hand on usability issues.

From analysing the video interviews and the questionnaire we summarized a number of faults and key findings regarding the mobile client such as:

a) camera does not shoot immediately;

b) viewfinder sometimes does not show anything;

c) problems in sequence choose keyword - loading camera - guessing - keyword lost;

d) some popup notes are disturbing;

e) in certain locations the mobile data network worked very poorly or not at all.

Further, we got a range of valuable answers to the open-ended questions. Q: "What did you like most in the gameplay?" A:*"The challenge to find an object that best represented the word"; "The time aspect keeps the pacing. Like the guessing of the fact against other player"; "I liked getting / sending photos and guesses on my phone"; "Collaborating with people; playing in group was fun activity, completely transformed real world to game space."*

Q: "Suggestions for improvements?" A: *"I think you should get more points for guessing right. It feels I am just giving someone points"; "Make the score for a correct guess higher than just taking a photo + closer to getting a photo identified".*

Q: "Was there anything confusing for you?" A: *"The scoring was a little difficult to use / understand"; "I never found the time to look at the gallery"; "Some bugs in the game. Sometimes I miss choosing a keyword".*

One completely unexpected thing to see happening was that people acted out the nouns to take photos of, which was strongly visible in the observation videos. This strongly indicated that our interaction design was successful, as well as our design approach,

since one of our major design goals was to trigger creativity - it is certainly needed in acting out nouns.

Prototype 4 fared much better in its evaluation than prototype 2. At this point we realized that our design process and heuristics for evaluation had worked to a great extent. However, evaluation of prototype 4 indicated clearly that there were still some major issues to be solved, of such types that were not discovered at earlier stages of walkthroughs and applying our design criteria.

Final version. The findings from the evaluation of prototype 4 led to some minor changes in the design of the mobile client. Since many people complained about too many pop-up notes, we replaced them with sounds. Further, we enhanced the navigation pattern to find and use the gallery. We also changed the scoring mechanism to a more balanced level. At this point the mobile client was ready to be used in the final game. The final mobile client had three UI modes (Fig. 2): Keyword selection mode, shooting (camera) mode, guessing mode and player statistics mode. A simple gallery mode should provide the player a possibility to see the most recent photos taken by other players.

3.2.2 Designing the Storytelling Tool

In designing the storytelling tool, our first intermediate goal was to create a prototype with a basic set of functionalities. It was supposed to be exposed to user testing in a lab, in conjunction with the mobile client prototype 2. Testing would provide us feedback on the design, and would help in identifying further features and functionalities. Our ultimate goal was to design an intuitive interface that makes the concept of storytelling instantly clear and graspable, exhibiting good usability. As with the mobile client, we believed this could be achieved by applying the set design criteria.

Prototype 1. We started off with a first prototype that had simple graphical elements and text showing events such as the keyword that is currently sent to a mobile player and is in waiting state to be photographed and to return to the website. Also, all photos that had come back were visible in a side bar that needed to be clicked on. Another view was giving a starting point for a new story to be written. The user could choose existing pictures with the attached keyword and sentence from the side bar and add his own sentences of which a noun was extracted automatically and sent to a mobile player.

Evaluation in the lab (S1). Prototype 1 was subjected to a user evaluation in a lab, in conjunction with the testing of the prototype 2 of the mobile client (see evaluation M1). Six test users played the game for 1.5 hours, dividing the time between the storytelling tool and the mobile client. We conducted video interviews and recorded video observations of the players while they were using the tool. The suggestions for improvement made by the test users included:

a) provide topics or themes as categories to give some idea what the story should be about;

b) re-play / re-tell histories, fairy tales;

c) provide view for seeing the evolution of stories;

d) indicate a story's readiness;

e) provide more guidance, more links, more status information;

f) give instant feedback to the author of a sentence regarding the status of the sentence;

g) provide view of most popular sentences;

h) provide a collage view of images which have been sent in.

From observing the actions of the users of using the first prototype of the storytelling tool, it became painfully clear that navigation in the tool was too complicated. Further, the users had difficulties in fully understanding what was going on, e.g. what were the steps to take to write your own story or where to click to see other people's stories.

Final version. Given the outcome of the evaluation of the first version, we decided to completely redesign the structure and functionality of the storytelling tool. We were inspired to incorporate some of the ideas presented by test users into the final version of the storytelling application. In designing the final version, we focused especially on the design criteria 3-6, e.g. 4a) Where am I?, 4b) What's here?, 4c) Where can I go?, 5a) "Will user know what to do?" and 5b) "Will user see how to do it?"

In the final version we elected to have a grid structure of nine squares as the main view (Fig. 5). As described in [12] in detail, each square represented one sentence to be illustrated, hence a story consisted therefore of nine illustrated sentences. For each square or slot the user may either pick an already illustrated sentence, written by someone else, or she may write a new sentence by simply clicking on the square which opens a text input field. Once the user has chosen an appropriate content for each slot and the resulting story looks somewhat meaningful, she may publish the story.
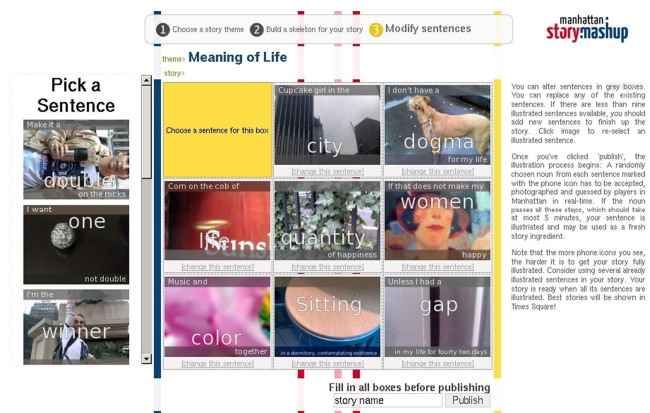

Figure 5. Storytelling tool.

In order to make access to the tool as convenient as possible, we decided to have no registration for the writers. They should be able to start playing with the tool immediately. This approach was inspired by the design criteria 6a "How do I join or leave the community" and also 6c "Can I do what I want to do easily?"

Given that people could include any kinds of sentences and words in their stories, the system performs simple filtering with a blacklist, together with some syntactical checks. The user is informed if something is wrong.

After a new story is published, the nouns are collected. From each new sentence a random noun is chosen and dispatched to randomly chosen mobile players. Then the story is moved to the pool of incomplete stories where it stays until all its sentences are illustrated.

The storytelling tool has another important feature of presenting the user on the left side of the grid a list of available illustrated sentences to choose from. By clicking on images they can be selected and placed inside the story grid. This design decision was inspired by criteria 6c) "Can I do what I want to do easily?" and "Can I navigate the site?"

Evaluation (S2). As we went along designing the features, functionalities and site layout, we made cognitive walkthroughs to make design decisions. This helped us to come up quickly and easily with a solution that we felt satisfied most of the criteria.

3.2.3 Designing the Public Display

The design process of the public display was different to that of the mobile client and the storytelling tool in the sense that instead of iterative design cycle it was a one-shot go in the final game environment.

The Reuters Sign in Times Square was used as the public display during the game. The sign was chosen due to its prominent location and enormous visibility. Times Square is an iconic location in global scale, thus the possibility to create personal content to be shown there was attractive for people around the world.

Figure 6. The Reuters Sign in Times Square.

Once all nine sentences of a story had successfully gone through the illustration process, the story became a candidate for presentation on the public display. A human moderator had to "bless" a story for presentation, which was then automatically sent to the display.

The graphical layout of the display was designed with Adobe's After effects, providing animation of the nine illustrated sentences of a story. The system running the display fetched a story from the game server and displayed the rendered graphical layout. For technical and aesthetic reasons we decided to overlay the sentence on top of the photo. The entire story was shown on the display whereas each photo was enlarged one by one for six seconds on the middle display (Fig. 6).

4. FINAL EVALUATION AND LESSONS LEARNED

We report here the evaluation of the system with previously unpublished findings, and contrast them with the design rationale, to provide valuable lessons learned for the community. Sometimes we also refer explicitly to the results reported by us in [12], in order to explore our arguments posed in this paper.

The game was played on September 23rd, 2006, between 12:00am-1:30pm in midtown Manhattan. 184 players played the game. Most of them were invited university students that had shown interest in this kind of game, but also people from companies and institutions participated.

Quantitative data collected on a server log revealed that during the game 3142 photos were taken, 4529 guesses made and 115 Stories created [12].

We also collected qualitative data with a questionnaire, which was filled in immediately after the game ended. The questionnaire for mobile players contained 26 statements on a 5-point scale between 1 (disagree completely) and 5 (agree completely). Additionally, 23 open-ended questions were presented. In total 99 questionnaires were returned, 56 from males and 43 from females. 24 players were of age 18-24, 64 of age 25-34, and 15 of age 35+. Upon returning the questionnaire, each player got an invitation to an evening party. We also observed the players during the game with a video camera. After the game was over, a few individual users and few groups of users were interviewed using video. The questionnaire for web players using the storytelling tool was available at the Story Mashup website. Seven people filled in the questionnaire.

In the following, we discuss the findings of our experiment to contrast them with our design goals.

4.1 Mobile Client

a) Engaging experiences

The replies to the open-ended question "What did you like most in the gameplay? Please define the most interesting aspects..." gives us some first insights. Of the 99 respondents 41 mentioned "shooting photos", 7 "guessing part of the game", 15 listed both and 26 users gave other answers. This means that 73 out of 99 players favoured just two game features: "shooting photos" and "guessing". Results reported by us in [12] supported these findings: people gave photo hunting and guessing keywords average rates of 4.63 and 4.39, respectively, on a 5-point scale. This shows that we succeeded in achieving our design goal of providing engaging experiences. In section 4.5 we look in detail at the aspects of players' enjoyment of Story Mashup, to explore this phenomena further.

Further, we were interested to get some answers to the question "Was there anything confusing or something you didn´t like? Please describe..." and received following answers: *"The server crashed a couple of times"; "Crashes / connection failures"; "Server problems, application quit unexpectedly"; "App crashed many times. Server crashed - very annoying"*. The game server had some problems for some period of time during the game play and the mobile client was not fully functional during that period. However, people were not overall frustrated since the total game experience was very strong. This became clear in video interviews of the players as well.

b) Creativity

A very strong observation was that people were acting out keywords when they could not find a suitable object to take a photo of. The use of imagination and original ideas in the production of the photos took place. This shows that we succeeded in designing the mobile client in such a way that it triggered creativity, which was one of the major design goals. Clearly, the use of the mobile device as an interaction device and as an image capturing device in the context of the Story Mashup system is strong. The question "Do you think the Story Mashup game is supportive for creativity" received following answers: *"Makes you figure out illustrations for words"; "Yes, especially when you must act out complex words"; "Yes, mime effect pushes creativity"; "Yes, because some words are not easy to find"; "Yes, teaches you to be abstract in conception"*. Some of the answers to the question: "What did you like most in the gameplay? Please define the most interesting aspects..." reflects this as well*: "Taking pictures related to images and having people enacting them was cool!"; "The creativity involved"; "The free association process"; "The narrative/contribution part"*.

c) Teamplay

One of our design goals was to foster collaboration and social interaction in form of team play. For us it was interesting to see if the mobile device could serve as a facilitator for such purposes. Indeed, it appeared that this was the case, since the completion of tasks where team play occurs is centered on the mobile.

The question "If you played in a team, what motivated you to join in the first place?" received following answers: *"Group energy"; "Helping each other with the words"; "Collaborating in hunting for pictures"; "To have fun with friends"; "Playing in a team helped in finding pictures, guessing"; "Collective excitement"; "Getting team members to act out keywords"; "Makes it more fun"*. Some similar answers were also given regarding the question: "What did you like most in the gameplay? Please define the most interesting aspects...": *"Playing in a group and doing silly things for pictures"; "Spread out yet collaborative spirit"; "Competition and kicking everyone´s asses"*. We can conclude that Story Mashup triggers collaboration and social interaction in form of team play.

d) Usability

Having applied the various design practises as discussed in section 2 and especially in section 3.2.1, we were interested to see what level of usability we had reached in our mobile client. Table 1 shows the average ratings of 99 mobile players on ten different statements assessing the usability. The first three rows of the table were reported by us in [12] and are used here to explore our argument.

The rating 3.19 for "The mobile application was easy to use" as well as 4.18 for "When I was holding the phone, I felt confident hunting for images and doing the guessing part" indicates strongly that we got many things right with our mobile client, especially regarding the application of our design criteria 1 on usability goals and criteria 2 on use qualities of digital designs. Also, regarding our design criteria 3 covering Nielsen's heuristics and criteria 4 "Where am I?", "What's here?", "Where can I go?", we can see that they helped us to bring fruitful results. The rating 3.65 for "The pop-up notes and instructions on the phone were clear" and the rating 3.51 for "At any given moment it was clear to me what I was supposed to do" as well as 3,72 for "It was clear to me which button to press to navigate" support this conclusion.

Table 1. Usability ratings by mobile players.

When I was holding the phone, I felt confident hunting for images and doing the guessing part	4,18
The mobile application was easy to use	3,19
At any given moment it was clear to me what I was supposed to do	3,51
It was clear to me which button to press to navigate	3,72
The pop-up notes and instructions on the phone were clear	3,65
I had enough time to accept a keyword, take a photo and to guess	3,5
I was able to compare my performance against other players	3,39
It was important to me to view my and other players photos in the gallery of the game client	2,15

We failed to discover that viewing photos in the gallery of the mobile client is less important to the mobile player than we anticipated. Rating 2.15 for "It was important to me to view my and other players' photos in the gallery of the game client" clearly shows that this feature was not really popular.

This is also reflected by question "How many times did you check photos in the gallery of the game client? Please describe…" Out of 99 persons, 11 used the photo gallery 2-3 times, 10 once, 36 never, 3 never/too busy taking photos, 3 at the end of the game, 1 every time when scoring, 6 when the game was down and 4 didn't know about the feature. 25 persons did not answer the question. This shows that this feature was hardly used within the main game flow. It seems that players were occupied by shooting photos and guessing nouns, in order to gain as many points as possible.

Design lessons learned:

1. **Fast iterative design cycle utilizing Python for S60**. By employing a fast iterative design cycle and the use of Python for S60 [10] [4] we were able to implement improvements quickly for each new prototype and test them out. For example, we were able to improve the scoring mechanism feature on the mobile client significantly from rating 3.18 in the first lab test (M1) to the 4.25 rating of the final game play.

2. **Replacing pop-up notes with suitable sounds**. The use of pop-up notes should be carefully planned since they can easily be bothering for people. For us it turned out to be a good thing is to replace them with suitable sounds instead.

3. **1-2 clicks to complete a task**. A mobile client used in activities such as in our system should provide the user with 1-2 clicks to complete a task. This reduces the cognitive load.

4. **Building an integrated custom mobile client is essential**. The fact that the mobile application does many things automatically e.g. open the camera, send and receive images and keywords in the background without the user's action, it allows her to concentrate on the more creative tasks in a seamless experience. We believe it would have been extremely difficult for people to use the native camera or SMS/MMS messaging applications as independent units for playing Story Mashup - due to their clumsiness and time consumption in handling them.

5. **The mobile phone is ideal for designing mobile interaction applications**. Having so many features such as camera, sound, graphics, keyboard keys, access to internet etc. available in a small device, allows designing of powerful integrated applications with many functionalities that are often needed for mobile interaction systems. We were able to add step-by-step new functionalities to the Story Mashup client, based on the needs identified by testers when going through the prototyping design phases. And luckily the mobile phone offered all of them.

4.2 Storytelling Tool

We give here some insights to our findings, even though our data is not as strong as on the mobile client since only 7 people filled in the online questionnaire.

a) Engaging experiences

The rating of 4.6 regarding the statement "It was fun and engaging to play this game" is very high. It is obvious that also the web users perceived the game as engaging experience. This means that our design goal was successfully met. The question "Do you want to play this game again?" received answers such *as "Yes, please !!!!! It could lead to addiction, cause it is so much fun to write stories to the topics you offered and to wait how they will develop."; "Now that I have the hang of it, I'm thinking of new ways to play it...".*

b) Creativity

To the question "Do you think the Story Mashup game is supportive of creativity?" we got answers such as *"You decide and value sentences and try to improve or adapt their meaning. You search for other possibilities while your decision what you want to express drives you there. You have to find new words and you try to remember which keywords you already had seen. So you put together what you already know and find a new expression - very creative!"; "Yes, Storymashup is supportive in creativity because it engaged you to use what was there to create new sentences and in turn creating new stories."* Thus, regarding the design goal of triggering creativity we succeeded on the web part of our system, as well.

c) Usability

The usability of the storytelling tool turned out to be worse in comparison to the mobile client and the web users provided mixed feedback. Though, it was interesting to observe that bloggers with lots of prior experience in contributing own things to the web had far less problems than inexperienced users. This difference is apparent in the answers to the question "Do you think it is easy to play this game?": "Yes, of course it is easy, because you can change small things and will have a result. The pictures and sentences which are already there bring you associations and ideas."; "I found it difficult to figure out how to add new sentences. I finished one story with no new sentences and got a message saying "Next time add new sentences", and I felt a little annoyed about that. Eventually I figured it out, though."

The rating of 2.5 to the statement "At any given moment it was clear to me what I can do next (build story, wait for images…)" and rating 3.5 for "It was clear to me which button to press to navigate inside the storytelling tool" indicate that we did not achieve our design goal of high usability on the storytelling tool.

Design lessons learned:

The storytelling tool lacked the finishing touch since we could not carry through all the planned development stages due to the lack of time. Nevertheless, we believe the storytelling tool can to be developed into a more advanced form including more functionalities and improved usability.

We think by designing tools as the storytelling tool as part of the Story Mashup system, new experiences can be delivered to web users due to the real-time aspect happening in the physical space – in our case the instant generating of images based on users web activity.

4.3 Public Display

The questionnaire data gives some idea of to what extent the public display enhanced the mobile players' game experience. For this exploration we refer to one finding that we reported in [12] in a different context: "For me it was an important part of this game to see the illustrated stories at the public display at Times Square" ranged from 1 (disagree completely) to 5 (agree completely) so that the average rating was 3.28. We dare to conclude that for the majority of the mobile players the public display was an integral part of the overall game experience. Though, there was also a significant amount of players to whom the public display was not as relevant. Therefore, the Story Mashup could possibly work as a game and as a real-time publishing environment without it.

4.4 Mobile, Web and Public Display as a Collaborative Real-time Authoring system

For us it was very interesting to see how the mobile client, the web and the public display could work together as a collaborative real-time multimedia authoring system. We were also looking for things that we could learn from a working system implementation.

To assess how people felt to be part of such a collaborative authoring system and what was their perception when being involved, we posed a number of statements to the mobile players and the web players.

Table 2 shows the average ratings of selected statements. These numbers show that the majority of the mobile players were aware of the overall game design and they had a sense of being the ones who are carrying out an externalised highly cognitive task originated from the web users.

It is interesting to see that the web users rated the statement "I felt I belonged to a joint, collaborative action contributing to a common goal" with 4.5, which is significantly higher than from the mobile players. However, we are aware that the data on web users is weak due to the small number of respondents (7).

Also, we have succeeded in designing a system that provides engaging experiences, which has been identified by Brignull [2] as an important part of interaction with large screens.

Table 2. Ratings regarding the mobile and the web as a joint system.

	Mobile	Web
I felt I belonged to a joint, collaborative action contributing to a common goal (reported in [12] already)	3.59	4.5
It was easy for me to find objects to shoot photos based on the keyword	3.34	N/A
While playing I felt I was part of a joint activity between players on the web and mobile players in Manhattan	3.22	N/A
I was aware that I contributed images to other people's stories	3.19	N/A
It was clear to me that the keywords were coming from stories of players on the web	2.28	N/A

4.5 Player's Enjoyment

Finally, we use the GameFlow model by Sweetser and Wyeth [11], to understand why Story Mashup produces the strong enjoyment stated by the players.

Challenge: Games should be sufficiently challenging and match the player's skill level. In Story Mashup, players had two challenges: to shoot images and the guessing part. Also, the race-against-clock-factor was present as well as the competitive style of play.

Control: Players should feel a sense of control over their actions in the game. In Story Mashup, players were able to choose keywords from a list at their convenience and own speed in order to start the action of shooting a photo. Also, they had the freedom to do the guessing part or not.

Clear Goals: Games should provide the player with clear goals at appropriate times. In Story Mashup, players had to score points by shooting good images that can be guessed by others, but also by guessing other players' photo correctly.

Feedback: Players must receive appropriate feedback at appropriate times. In Story Mashup, players were constantly able to check their rank. A sound informed them when their score increased.

Immersion: Players should experience deep but effortless involvement in the game. In Story Mashup, players expressed in video interviews e.g. *"Usually you are aware of strangers and people passing by. But this, you kind of ignore them and do crazy stuff"; "It actually feels like I´m really immersed, and then that helped me to do these strange things which I would feel otherwise uncomfortable in doing it publicly."*

Social Interaction: Games should support and create opportunities for social interaction. In Story Mashup, players were often playing in groups to act out keywords.

5. CONCLUSIONS

The Story Mashup system introduces a new form of interactive storytelling by mobile and web users. We studied the design process of combining a mobile client, a storytelling tool in the web and a large public display into a collaborative street art authoring system deploying ubiquitous multimedia. By exploring the findings from the empirical evaluation in the true environment of use we showed that by applying the chosen design process and a set of design criteria we were able to make good design decisions and achieved the design goals of providing engaging experiences, triggering creativity and fostering collaboration and social interaction in form of team play.

Reporting the experience and knowledge on how to design such a system has relevance in informing the design of future mobile services that aim to combine the virtual and physical space, offering mobile and web users a seamless collaborative experience in real-time.

While current design methods still work, we can also clearly see there is need to develop new methods in order to live up to the forthcoming design needs for designing real-time mobile interaction systems that combine the web and the mobile space that go beyond Story Mashup. In this regard it felt to have just stepped into an area that needs more exploration and future research.

The Story Mashup system could well suit for educational purposes, even across city and country boarders. The use of video or other multimedia pieces would increase the presentation power over still images and would open many new opportunities on how the Story Mashup system could be utilized.

6. ACKNOWLEDGMENTS

7. REFERENCES

[1] Aoki P.M, Woodruff A. 2005. Making Space for Stories: Ambiguity in the design of personal communication systems. In: Proc. of the SIGCHI conf. on Human factor in computing systems, ACM Press.

[2] Brignull, H., Rogers, Y. 2003. Enticing people to interact with large public displays in public spaces. In Proceedings of INTERACT-03, 17–24.

[3] Desurvire H., Caplan M., Toth J.A. 2004. Using Heuristics to Evaluate the Playability of Games. In Proceedings of Computer-Human Interaction 2004, 1509-1512.

[4] Laurila, J., Tuulos, V., MacLaverty, R. 2006. Scripting environment for pervasive application exploration on mobile phones. In Adjunct Proceedings of Pervasive 2006.

[5] Löwgren, J. 2006. Articulating the use qualities of digital designs. In Fishwick, P. (ed.) Aesthetic computing. MIT Press, 383-403.

[6] Malone, T.W. 1982. Heuristics for designing enjoyable user interfaces: Lessons from computer games. In John C. Thomas and M. L. Schneider (Editors), Human Factors in Computing Systems, Norwood, NJ: Ablex Publishing Corporation.

[7] Nielsen J. 1993. Usability Engineering, Morgan Kaufmann.

[8] Preece, J., Rogers, Y. & Sharp, H. 2002. Interaction Design: Beyond Human-Computer Interaction. New York, NY: John Wiley & Sons.

[9] Reeves, S., Benford, S., O'Malley, C., Fraser, M. 2005. Designing the spectator experience. In: Proc. of the SIGCHI conf. on Human factors in computing systems, ACM Press.

[10] Scheible J., Tuulos V. 2007. Mobile Python - Rapid prototyping on the mobile platform, John Wiley & Sons.

[11] Sweetser P. and Wyeth P. 2005. GameFlow: A Model for Evaluating Player's Enjoyment in Games, ACM Computers in Entertainment, Vol. 3, No. 3, July 2005.

[12] Tuulos V., Scheible J. and Nyholm H. 2007. Combining Web, Mobile Phones and Public Displays in Large-Scale: Manhattan Story Mashup. In proceedings of the Fifth International Conference on Pervasive Computing, Toronto, Canada, May 2007, 37-54.

[13] Veen J. 2001. The Art and Science of Web Design. Indianapolis: New Riders Publishing.