Can eye tracking boost usability evaluation of computer games?

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ABSTRACT
Good computer games need to be challenging while at the same time being easy to use. Accordingly, besides struggling with well known challenges for usability work, such as persuasiveness, the computer game industry also faces system-specific challenges, such as identifying methods that can provide data on players’ attention during a game. This position paper discusses how eye tracking may address three core challenges faced by computer game producer IO Interactive in their on-going work to ensure games that are fun, usable, and challenging. These challenges are: (1) Persuading game designers about the relevance of usability results, (2) involving game designers in usability work, and (3) identifying methods that provide new data about user behaviour and experience.

Author Keywords  
Computer game, usability evaluation, eye tracking, testing.

INTRODUCTION
Broadly speaking, a great computer game is accessible and intuitive to use while being fun and challenging at the same time. In this respect it differs from office systems, which primary goals are fast, easy and efficient interaction. For both types of systems the element of usability is crucial. However, since the goals, the use, and the context of the two types of systems are different, usability evaluation methods used to test office systems often fail when applied to computer games. Thinking aloud while playing a first person shooter game for instance, proves practically impossible to many players [17]. Also, specific concepts such as game play and re-playability relate to games and not to office systems.

In this paper we discuss the use of eye tracking as a means to address some of the usability related challenges faced by the computer games producer IO Interactive. Since our work is in progress we cannot report any results as to the successes or failures of using eye tracking to support and facilitate the usability work in the development of computer games. We will, however, argue why we expect that the use of eye tracking will address crucial challenges for usability work in this particular company, and perhaps other companies alike.

We do not claim that all IO Interactive’s usability related challenges can be fixed by using eye tracking. Actually – and unfortunately – far from it. But we do expect eye tracking to tackle some of the challenges related to persuading game designers about the relevance of usability results as well as prove helpful when involving game designers in the usability work. Also, we expect eye tracking to improve the outcomes of retrospective think-aloud evaluations.

RELATED WORK
Much important work has been done on the development and use of usability evaluation methods that aim at evaluating office or web based systems. Such work include for example methodological studies and studies of how results can be described and reported, see for example [9,10,12,13,20,22]. In contrast, work on how usability in computer games is evaluated is limited. Helms Jørgensen explains the lack of descriptions of evaluation praxis with ‘Microsoft [being] the only example of major game developers having seriously taken up usability approaches’ [14]. Today, as the industry grows explosively and the competition increases, this is unlikely to be true. Several steps have been taken to facilitate the evaluation of usability in games during the years, see for example [3,5,16,24]. The indisputable value of this and related work aside, usability evaluation is still not necessarily a well-integrated part of the development of computer games, and usability practitioners are still in want for better methods and procedures to help them work specifically with the improvement of usability in games.

Next, we take a look at the specific challenges for the games producer IO Interactive, and discuss how the use of eye tracking might improve the impact that usability work has on computer games.

A COMPANY AND ITS CHALLENGES
IO Interactive (IOI) is a Danish producer of computer games, and has since 1998 produced games such as the Hitman series. IOI, which is owned by SCI/ Eidos group, develops, designs and produces interactive entertainment for the major platforms on the global market. Though IOI’s games are recognized for their game play, they are also
known as being difficult to access for novices [17]. And since the lack of usability is likely to have kept many users from getting value for their money or even purchasing the product in the first place, IOI has recently increased its attention on evaluating usability. Still, as has many before him, IOI’s QA manager Janus Rau experiences that one thing is deciding to conduct usability work, quite another thing is making sure that the work has real impact on the design process.

IOI’s usability challenges are described in a previous paper [17] which placed them in five categories; justifying the costs, work procedures, user involvement, collaboration and alliances, and responsibility. The challenges interesting for this paper concern how to persuade game designers about the relevance of results from usability evaluations, how to better involve game designers in the usability work, and how to improve on some of the limitations of retrospective think-aloud testing.

The persuasiveness of results
To elaborate on these three challenges Rau explains that lack of understanding and knowledge about how usability work is conducted (such as the prejudice that usability professionals simply ask players what they like) could be a reason why many game designers are hard to convince about the relevance of usability results. Based on his work experience with IOI’s game designers, Rau hypothesizes that presenting quantitative results using statistics, maps and graphs to supplement more qualitative observation-based results might prove more persuasive than the qualitative results alone.

The involvement of game designers
Involving game designers in the usability work is one way of securing that important designer knowledge is fed into the evaluation work. Moreover, when game designers have been involved in usability work, they have a stake in it, and are more likely to acknowledge the results, Rau explains. But getting the game designers involved in usability work proves difficult. This may be because they do not feel they profit by the time spent watching videos of players and discussing usability issues.

The evaluation methods used
Finally, since the use of games is fundamentally different from that of office systems, not all traditional usability evaluation methods apply equally successful to computer games. The combination of observation, interview and questionnaire used in IOI might support a valuable dialogue with the player about the overall experience and specific incidents. However, it may not cover all game-related topics such as level of challenge, immersion and attention.

In the following we describe the method of eye tracking and discuss how the use of eye tracking may result in more persuasive usability results, how it may involve game designers in usability work, and how it may produce valuable results that other methods overlook.

EYE TRACKING
Visual perception is an essential part of users’ interaction with games interfaces, and modern eye tracking equipment makes it possible to record and analyze parts of this process such as: Which elements are actually seen? And did modifications of the graphic design lead to the intended change in user gaze patterns?

Eye tracking has been criticized for being costly and tedious [1,21]. Difficulties calibrating the equipment to users with glasses, contact lenses, or even dark/brown eyes were common. Precision was low, and tiny head movements could jeopardize the validity of the recorded eye tracking data. State-of-the-art eye tracking equipment has solved most of these problems, and accurate recordings of eye movements can be made without obtrusive head-mounted cameras, or unnatural fixations of the head in a stand. This is part of the reason, why the application of eye tracking technology in usability studies is clearly blossoming [11,18].

Further, eye tracking has proved to be a valid method for discovering usability problems [2,6,7], and is thought to provide an indication of the amount of cognitive processing required to interact with an interface [19]. Surprisingly, eye tracking as an evaluation method has not yet taken off into the area of computer games, as only few studies have been published, see for example [4,15].

Getting new data from use of computer games
One particular qualitative method that has received much attention in relation to eye tracking research is the retrospective think-aloud method. Using the retrospective think-aloud method with eye tracking, usability researchers can let users interact with an interface without disturbing the interaction. This will make users focus more on the task at hand, and provide a more valid test situation. When a task is completed a video sequence can be shown to the user with an overlay of their eye movements. Recordings of eye movements have proven helpful to support the user in verbalizing his or her experiences and thoughts retrospectively [8].

The experience of evaluation using retrospective think-aloud method is perceived as being subjectively more pleasant by the users [2]. Also, an increase in speed and focus on the task at hand has been observed, resulting in significantly higher task-completion rates than when using the conventional think-aloud method. This means that users are not distracted by the cognitive load they experience during traditional think-aloud tests. Traditional think-aloud testing makes it more difficult for them to concentrate on finishing their task. This is the reason why traditional think aloud testing often gets avatars killed [17].
Apart from supporting retrospective interviews of user experience, eye tracking may also provide new data about user behaviour and experience that could add to the data gathered through current methods used by IOI.

During the development of a recent new game IOI experienced how players had difficulties getting by a team of snipers on a bridge. The questions concerned appearance of snipers: were the snipers spotted, but too big a challenge, or did the players not notice the snipers until too late? This question, and other questions related to attention, could be answered by measuring players’ eye movements. Figure 1 shows a heat map for visual attention of players, where it is clear that the players don’t notice the sniper in the middle top of the bridge. Colored areas indicate where players directed their attention (red is high attention, yellow is medium, and green is low attention). This problem could be solved by adding more light to the scene, like illustrated in Figure 2. The figure show how players in a more well-lit version of the sniper attack were more likely to notice the sniper quickly.

**Involving game developers with live eye gaze videos**
During a test, the test moderator and observers are able to follow the player’s eye movements on a screen. This possibility provides game designers and others with the possibility to get a better understanding of how players play and what is going on in the mind of a player during the game. We hypothesize that the access to such new information (and the engaging nature of a video with eye gaze patterns) might make game designers keener to get involved in usability work.

**Gaze plots and heat maps increase persuasiveness**
In addition to the qualitative data gathered by the retrospective think-aloud method, game evaluators can apply several quantitative measures to the test setup, since each session is completed without disturbances in the cognitive processes. This makes it possible to collect eye tracking data, and report on a wide variety of eye tracking metrics, e.g.

- fixation duration that can tell if the user have difficulty in extracting information or finds an object especially engaging [11].
- time-to-first-fixation that can reveal if an object or area has good attention-getting properties [18].
- fixation spatial density that can reveal inefficient search [18].

Such measures document, how the game interface is performing. The evaluator can generate illustrative visual output from the eye tracking data, such as heat maps (like Figure 1 and 2), and gaze plots that shows in which order players are directing their attention on screen. Such output are based on objective and quantitative measures and make it easier for evaluators to illustrate problems, document specific findings, or to convince the project team that results from usability testing are valid. Also, such outputs are generally considered persuasive for stakeholders such as developers, designers, and managers [23].

We suggest that eye tracking could be favorable to use for game evaluation, when focus and attention is vital for the game play, and when cognitive distractions can be devastating for ‘player survival’ in the game. Further, videos with overlay of eye movements support verbalization of experiences and thoughts in retrospective interviews. Eye tracking seem also promising as a means to involve game designers better in usability work since it offers completely new data about the use of a game. Finally, the quantifiable quality of the results of eye tracking suggest that game designers would consider results more persuasive that results derived using more qualitative methods.

**CONCLUSION**
In this paper we argue that the use of eye tracking to collect data during evaluations thanks to its quantitative nature might produce results that game designers at IOI consider more persuasive than for example results from traditional retrospective think-aloud tests. Also, videos showing eye gaze patterns or heat maps, that reveal what players see (and miss) on the screen, might involve game developers with live eye gaze videos.
designers in usability work since they get the chance to get valuable information about for example the players’ attention. Likewise, the use of eye tracking may improve the quality of retrospective evaluation since videos with eye gaze patterns may diminish a player’s tendency to subsequently rationalize the gaming experience and the attention on the screen. Eye tracking may also provide new data about user behaviour and experience that current methods used by IOI miss, such as quantitative data about attention and orientation when playing a computer game.

REFERENCES