

An insight into human-computer interaction research methodologies

COMP210 - Interfaces and Interaction

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1 Proposal

This journal discusses potential research techniques to be used in the assessment of the UI for the 3D modelling program *Genesis*. This research of the various usability testing methodologies will inform which one could be used to test the interface's efficiency in various domains, which include:

- The time it takes for a user to find an item or feature of interest
- How quickly a user may find an unfamiliar or advanced feature
- Whether any confusion is encountered whilst looking for a feature
- Whether it is intuitive based on a 3D modeller's expectations
- Whether there are any significant errors encountered
- Whether the user is aware of how to handle such errors

Some of these elements, such as those involving time or errors, may prove easy to measure quantitatively. Others may lend themselves to qualitative interviews or questionnaires. This journal assumes a small group of expert and non-expert subjects, with or without 3D modelling experience, from Falmouth University will be available for the evaluation process.

2 User testing methods - Ideal vs Achievable

2.1 Ideal: Eye tracking

Eye tracking involves recording a user's eye movement to determine their focus of attention [1] [2]. It traditionally uses a costly specialised camera, making the method fairly inaccessible outside of lab scenarios [3], thereby arguably limiting the demographic range of subjects. However, recent developments have achieved comparable effects with low-cost portable IR cameras, using Infra-red Pupil-Corneal Reflection Tracking [4] [5], for which open-source software [3] is freely available. This could potentially boost the accessibility of this technique in the near future.

Eye tracking takes advantage of the hypothesis that eye movement and fixation directly correlates to the user's interest (or the "task at the top of the stack" as noted in [6]). Specialised tools can record and visualise the user's area of focus in a heat map, which provides a broad visualisation immediately depicting the user's areas of interest. However, the heat map is unlikely to be useful alone, as it fails to illustrate the steps of the thinking process so much as it highlights the most attractive areas of the screen [7]. The latter may be useful when evaluating the *aesthetic* of a UI, but in a 3D modelling application where productivity is prioritised, a more detailed recording of the path of a user's eye focus and fixations could deliver a greater understanding of the user's thought processes [6] [2].

Unfortunately, since even the cheapest options require devices outside the infinitesimal

budget of the *Genesis* UX testing group, it is unlikely to be used for testing at this time. However, the development of technologies such as the Microsoft HoloLens could drive eye tracking technology by virtue of its applicability to the AR domain [8] [4], enough so that it would be worth monitoring as a potential research method in the future.

2.2 Achievable: Thinking Aloud

A concurrent Think Aloud Protocol (CTA [9]) could facilitate a deeper understanding of a user's experience. This protocol has users outwardly declare their intentions and experiences during application use [10] [9]. It is commonly used in UX testing groups [11], as it allows observers to gain a self-administered overview of a user's thoughts and feelings when using the system.

However, the Think Aloud Protocol is non-exhaustive, as the thought process is known to run faster than speech [12] and some unconscious processes could be overlooked [9].

In fact, the actions of the user may change when they are encouraged to speak of their process: A 1987 study [13] noted that deeper insight, in this case created during the process of thinking aloud, can negatively influence a person's perception of progress whilst increasing their own expectations of their performance. This could influence patience levels and frustration.

2.3 Achievable: Interviews, questionnaires and bias

For a designer to get specific answers to their questions about their design approaches - such as how effectively it works - they may be tempted to ask the users directly.

Interviews and **questionnaires** are two methods of data collection wherein the researcher can collect self-reported qualitative feedback of the user's experience.

2.3.1 Interviews

Interviews is a qualitative data collection method involving a direct (usually face-to-face) interaction between the end user and an interviewer. Its primary strength is in collecting detailed information about a user's experience, although this data is often hard to collate [14] [15].

One particular interviewing method, the self-confrontation interview method, is believed by some to be of particularly high effectiveness when teasing out details of the user's mental activity [16] [17]. The method involves requesting that the user perform a set of tasks whilst recording them on video, and then having them view the video in the presence of the interviewer [18]. The interviewer can, during this process, pause the video and ask the user about their own thoughts and feelings at the time [17].

When compared to traditionally structured interviews, wherein the set of questions is specifically decided by the interviewer [14], this method has an advantageous ability to aid user recall [17] through the video. On the other hand, this may come at the expense of biases [19] brought about by the knowledge of being recorded in the first place.

2.3.2 Questionnaires

Questionnaires are similar to structured interviews: defined as a document with questions to solicit information for analysis [20]. However, they involve no direct interaction with another person.

They can be conducted in writing or through a computer system. Beneficially to an IT-centred department, computerised surveys are believed to be preferable among users compared to paper surveys, and believed to have a higher completion rate [21]. They are quick to distribute and conduct online, require no paper resources, and do not require transcription to computer [22]. The latter could streamline the testing and UX questioning process by making the data instantly available.

Questionnaires suffer from many of the disadvantages of structured interviews, particularly

in addressing unexpected faults in a UX test. A 2011 study of university students [16] highlights with particular emphasis the importance of self-reported experiences by the users, and suggests questionnaires could be inadequate for collecting data on a user's challenges. This may perhaps be especially so when working with the complex interface of a 3D modeller.

2.4 Bias considerations

Both interviews and questionnaires are often impacted by bias, including: the demographic differences between respondents and non-respondents; motivational influence of the interviewer; language and cultural differences; social desirability bias (especially on sensitive topics [23]); and even the order of questions [24] [25].

3 Conclusions in applicability to Genesis testing

Eye tracking, while on the radar for future consideration, is expected not to be achievable due to the hardware (either specialised or webcam-based) required [1] [4] [5].

The Think Aloud Protocol, while useful in describing user experiences, suffers from the unintended influence of the user's actions and potential slowing of their thought process [12] [13]. Self-confrontation interviews could circumvent this issue: similar to questionnaires and structured interviews, they facilitate retroactive introspection of their thought process, with a video available to aid recall [18] [17]. These advantages make a compelling choice of methodology.

However, based on the above findings, questionnaires would be a cheaper and more time-constrained option, especially a computer questionnaire as they do not need transcribing [21]. The provision of quantitative data could also allow for easier collation of data.

An ideal approach could, with inspiration from the advice in Bach's study [16], combine two methods so that one could tease out the biases of the other. A modified version of the self-confrontation interview could subjectively measure confusion and intuitiveness,

with respect to particular parts of the interface; whilst the benchmarking of time taken between tasks could provide useful data on the time efficiency of the interface.

References

- [1] A. Poole and L. Ball, “Eye tracking in human-computer interaction and usability research: Current status and future prospects,” in *Encyclopedia of Human Computer Interaction*, pp. 211–219, Jan. 2006.
- [2] M.-J. Tsai, H.-T. Hou, M.-L. Lai, W.-Y. Liu, and F.-Y. Yang, “Visual attention for solving multiple-choice science problem: An eye-tracking analysis,” *Computers & Education*, vol. 58, pp. 375–385, Jan. 2012.
- [3] H. Ho, “Low cost and better accuracy eye tracker,” in *2014 International Symposium on Next-Generation Electronics (ISNE)*, pp. 1–2, May 2014.
- [4] P. Majaranta and A. Bulling, “Chapter 3 Eye Tracking and Eye-Based Human Computer Interaction,” 2014.
- [5] J. R. Khonglah and A. Khosla, “A low cost webcam based eye tracker for communicating through the eyes of young children with ASD,” in *2015 1st International Conference on Next Generation Computing Technologies (NGCT)*, pp. 925–928, Sept. 2015.
- [6] M. A. Just and P. A. Carpenter, “Eye fixations and cognitive processes,” *Cognitive Psychology*, vol. 8, pp. 441–480, Oct. 1976.
- [7] S. T. Dumais, G. Buscher, and E. Cutrell, “Individual Differences in Gaze Patterns for Web Search,” in *Proceedings of the Third Symposium on Information Interaction in Context, IIX ’10*, (New York, NY, USA), pp. 185–194, ACM, 2010.

- [8] M. Cognolato, M. Atzori, and H. Mller, “Head-mounted eye gaze tracking devices: An overview of modern devices and recent advances,” *Journal of Rehabilitation and Assistive Technologies Engineering*, vol. 5, p. 2055668318773991, Jan. 2018.
- [9] L. Cooke, “Assessing Concurrent Think-Aloud Protocol as a Usability Test Method: A Technical Communication Approach,” *Professional Communication, IEEE Transactions on*, vol. 53, pp. 202–215, Oct. 2010.
- [10] M. J. v. d. Haak and M. D. T. d. Jong, “Exploring two methods of usability testing: concurrent versus retrospective think-aloud protocols,” in *IEEE International Professional Communication Conference, 2003. IPCC 2003. Proceedings.*, pp. 3 pp.–, Sept. 2003.
- [11] S. McDonald, H. Edwards, and T. Zhao, “Exploring Think-Alouds in Usability Testing: An International Survey,” *IEEE Trans. Prof. Communication*, vol. 55, pp. 2–19, Mar. 2012.
- [12] M. E. Fonteyn, B. Kuipers, and S. Grobe, “A Description of Think Aloud Method and Protocol Analysis,” *Qualitative Health Research - QUAL HEALTH RES*, vol. 3, pp. 430–441, Nov. 1993.
- [13] J. Metcalfe and D. Wiebe, “Intuition in insight and noninsight problem solving,” *Memory & Cognition*, vol. 15, pp. 238–246, May 1987.
- [14] C. Wilson, *Interview Techniques for UX Practitioners: A User-Centered Design Method*. Newnes, Nov. 2013. Google-Books-ID: 2h3SDP7xSLIC.
- [15] J. Dumay and S. Q. Qu, “The qualitative research interview,” *Qualitative Research in Accounting & Management*, vol. 8, pp. 238–264, Aug. 2011.
- [16] C. Bach, N. Gauduchau, and P. Salembier, “Combining Interviews and Scales in the Multidimensional Evaluation of User Experience: A Case Study in 3d Games,”

- in *Proceedings of the 29th Annual European Conference on Cognitive Ergonomics*, ECCE '11, (New York, NY, USA), pp. 157–160, ACM, 2011.
- [17] S. S. Lim, “The Self-Confrontation Interview: Towards an Enhanced Understanding of Human Factors in Web-based Interaction for Improved Website Usability,” *J. Electron. Commerce Res.*, vol. 3, pp. 162–173, Jan. 2002.
 - [18] M. v. Cranach, *The Analysis of Action: Recent Theoretical and Empirical Advances*. CUP Archive, Sept. 1982. Google-Books-ID: nxs4AAAAIAAJ.
 - [19] S. G. Henry and M. D. Fetters, “Video Elicitation Interviews: A Qualitative Research Method for Investigating Physician-Patient Interactions,” *Annals of Family Medicine*, vol. 10, pp. 118–125, Mar. 2012.
 - [20] B. Acharya, “Questionnaire design,” in *A paper prepared for a training Workshop in Research Methodology organised by Centre for Post Graduate Studies Nepal Engineering College in collaboration with University Grant Commission Nepal, Pulchok, June*, pp. 2–11, 2010.
 - [21] J. M. Ryan, J. R. Corry, R. Attewell, and M. J. Smithson, “A comparison of an electronic version of the SF-36 General Health Questionnaire to the standard paper version,” *Quality of Life Research*, vol. 11, pp. 19–26, Feb. 2002.
 - [22] K. B. Wright, “Researching Internet-Based Populations: Advantages and Disadvantages of Online Survey Research, Online Questionnaire Authoring Software Packages, and Web Survey Services,” *Journal of Computer-Mediated Communication*, vol. 10, Apr. 2005.
 - [23] R. Tourangeau and T. W. Smith, “Asking Sensitive Questions: The Impact of Data Collection Mode, Question Format, and Question Context,” *The Public Opinion Quarterly*, vol. 60, no. 2, pp. 275–304, 1996.

- [24] A. Bowling, “Mode of questionnaire administration can have serious effects on data quality,” *Journal of Public Health*, vol. 27, pp. 281–291, Sept. 2005.
- [25] B. C. Choi and A. W. Pak, “A Catalog of Biases in Questionnaires,” *Preventing Chronic Disease*, vol. 2, Dec. 2004.