# A USER-CENTRED DESIGN METHODOLOGY FOR ENSURING USABILITY OF IR INTERFACES

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**Abstract**

*This paper presents a user-centred design methodology for ensuring the usability of IR interfaces. The methodology is consisted of sequentially performing: a competitive analysis, user task analysis, heuristic evaluation, formative evaluation, and finally a summative comparative evaluation. We first described each of tWe found that ourThe user-centred methodology could have a major impact on improving the usability of IR user interfaces. This proves the efficacy of our user-centred methodology. We hope this methodology wouldThis methodology provides a starting point for techniques that let IR researchers and practitioners to design better user interfaces that is are both easy to learn to use and remember.*

**Keywords :** User-centred design, Usability, HCI, IR, User interface

## 1. INTRODUCTION

Use of information retrieval (IR) systems has traditionally been the domain of librarians and information professionals. IR systems have been used almost exclusively by such search experts for several reasons, such as the number of search systems available, cost, and the complexity of use requiring command language searching. However, with the rapid growth of web-based access to IR systems during the last decade, there have been significant changes and improve-ments in IR environments. These include a wider and cheaper access to a variety of IR systems and improved user interfaces and functions. Despite all these changes and improvements, usability remains a key issue in accessing IR systems.

The user interface of an IR system is an important feature that impacts on the users' performance and satisfaction of that system. The IR interfaces must complement a variety of users' individual differences, their cognitive abilities, and task requirements. Although designers follow style guides and *de facto* standards in designing interfaces, there is, however, no guarantee that an IR interface will attain high quality by these means only. IR interface designs need to be user-centred in order to support users' interactive information searching. IR researchers are becoming aware of traditional human-computer interaction (HCI) usability efforts and beginning to apply and expand upon those methods for designing IR user interfaces. Prototyping, testing, and iterative design are key activities in a user-centred design. A few efforts have been reported to date (Mulherm and Nigay, 1996; Petrelli et al., 2004), however, user-centred design in IR as a practice still lags far behind what is needed.

illustrates the basic methodology. It is consisted of sequentially performing: (1) a competitive analysis, (2) user task analysis, (3) heuristic evaluation, (4) formative evaluation, and finally (5) a summative comparative evaluation.

## 2. OUR METHODOLOGY

IR researchers interested in applying proven usability design and evaluation methods would discover few documented, well-tested methods for IR usability engineering. The methodology, as illustrated in Figure 1, is based on sequentially performing:

1. A competitive analysis of an IR system to perform empirical usability testing
2. A user task analysis based on user activities during usability tests
3. An initial prototype design drawn from task analysis
4. A heuristic evaluation of the initial prototype design using heuristic guidelines
5. A interactive prototype design, incorporating input from heuristic evaluation
6. A formative evaluation of the interactive prototype using task scenarios
7. A revised prototype design based on formative evaluation
8. A summative evaluation of the final prototype design and compare a comparison of the results with competitive analysis for performing the same user tasks.

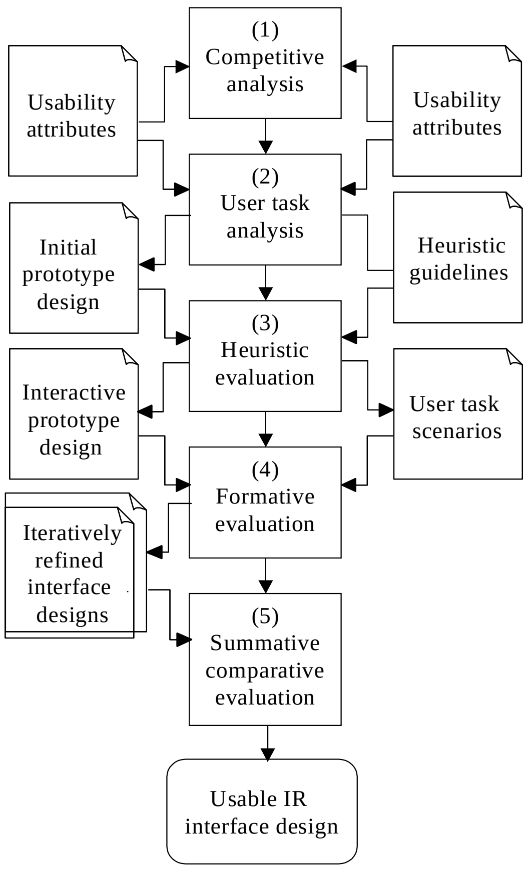


*Figure 1: Methodology for a user-centred design of IR interfaces*

These techniques are described in more details below. While similar methodologies have been applied to designing traditional GUI-based user interfaces, this particular methodology is novel because it is specifically designed for, and applied to IR user interfaces.

### 2.1 Performing competitive analysis

Performing a competitive analysis means analysing similar IR systems according to established usability guidelines. Usability testing with similar systems could help us to see how the functionality of the interface supports user tasks. The attributes that are frequently studied in usability testing include (Shneiderman, 1998):

1. Learnability: The interface functionalities should be easy to learn to use. This is very important for novice users.
2. Efficiency: The number of tasks per unit of time that the users could perform using the interface - the higher the system usability is, the faster the user can perform the task and complete the job.
3. Retention over time: The interface should be easy to remember, so that the casual user is able to return to the system after some period of not having used it, without having to learn everything all over again.
4. Error rate: The interface should have a low error rate, so that users make few errors during the use of the system. Good usability implies low error rates.
5. Satisfaction: This shows a user's subjective satisfaction of the interface.

Usability test always involves real users as participants in the tests. The number of participants in a test depends on how many sub-groups should be covered, how much time and money could be used and how important it is to get statistically significant results. Studies have showed that the first four or five users revealed most problems and additional participants are likely to reveal less and lessfew new major problems (Virzi, 1992; Nielsen, 1994). However, this smaller sample size is inadequate to identify significant differences amongst groups. Spyridakis (1992) argued for a minimum of 10 to 12 participants for an experiment.  in a true experimental design

Usability testing generally takes place in a specially equipped usability lab. Users are brought into the laboratory, where they perform a set of benchmark tasks. An effective technique during usability testing is to invite users to "think-aloud" about what they are doing. User remarks obtained in usability testing could provide ideas for the new system design. Videotaping is often used for capturing users performing tasks for later review and to identify the problems that users encounter. Another useful technique is transaction logging, which unobtrusively creates a record of how a user performed a benchmark task. Questionnaires can be used to assess users' satisfaction with the interface. The Questionnaire for User Interface Satisfaction (QUIS) has been applied in a number of usability tests and has proved useful (Chin et al., 1988).

The competitive analysis would help us to see how users interact with the system and interfaces and should lead to a more efficient and effective interaction design. A user task analysis is important as an early input to the new interaction design. It provides a complete description of tasks, sub-tasks, and the methods required to use a system in order to perform tasks. The task analysis could be carried out using following stages:

1. Identify and group the tasks to be performed
2. Break down the tasks from top to bottom showing detailed task descriptions, sequences and relationship amongst the tasks

3. Record details of interactions between the user and the current system and any problems related to them

4. Highlight areas where task processes are poorly understood, or are carried out differently by different users, or are inconsistent with the task structure

A user task analysis provides the basis for new design and evaluation in terms of what types of tasks and task sequences users will need to perform within IR environments. Without a clear understanding of user task requirements, designers must guess the desired functionality of the new IR system, which would inevitably leads to poor interaction design. The closer the match between user task analysis and actual end-user tasks, the better and more effective the final user interaction design.

### 2.2 Heuristic evaluation

Heuristic evaluation is a usability inspection method. It is beneficial to carry out a heuristic evaluation on early prototypes before actual users are brought into help with further testing. The results would generate good ideas for improving the interaction design. A number of studies showed that the design feedback provided by heuristic evaluation is valid and useful (Jeffries et al., 1991; Desurvire et al., 1992; Coumo and Bowen 1994; Doubleday et al., 1997; Cogdill, 1999; Peng et al., 2004).

Heuristic evaluation always uses a short list of heuristic principles and three to five evaluators. Each evaluator is given a short list of heuristic principles to go through the interface independently to identify problems. They are not allowed to communicate with each other until all evaluations are completed. The theory behind independent evaluations is that a single evaluator would miss out many problems but different evaluators will find different problems. Thus, much better results can be obtained by combining the results from several evaluators. Nielsen (1992) recommended using “double” usability experts who are specialists in both usability engineering and the user interface to be evaluated to ensure optimal results.

A Neilsen’s (1994) list of heuristic guidelines that has been frequently used in heuristic evaluationsis the one developed by Nielsen (1994). . This list contains the following ten heuristics: visibility of system status; match between system and the real world; user control and freedom; consistency and standards; error prevention; recognition rather than recall; flexibility and efficiency of use; aesthetic and minimalist design; help users recognise, diagnose, and recover from errors; and help and documentation.

### 2.3 Formative evaluation

Formative evaluation ensures usability of interaction design by including users early in the design process. It aims to iteratively improve a new interaction design. Because formative evaluation involves real users, it uncovers usability problems that an expert performing heuristic evaluation might be unaware of.

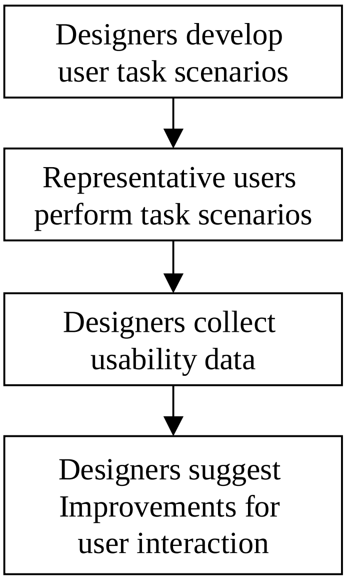


Figure 2: Stages in formative evaluations

Figure 2 shows the major stages involved in the formative evaluation. It begins with development of user task scenarios. Task scenarios derive from results of the user task analysis. Moreover, these scenarios should provide adequate coverage of all tasks as well as accurate flow of tasks identified during the user task analysis. Representative users perform these task scenarios and designers collect mostly qualitative data in the form of critical incidents. A critical incident is typically a problem encountered by a user such as an error, failure to complete a task scenario, or user confusion that affects the task flow or task performance. These data are analysed to identify user interaction components or features that both support and detract from user task performance. These observations are in turn used to suggest changes in the user interaction design.

### 2.4 Summative comparative evaluation

In contrast to formative evaluation, summative comparative evaluation is an empirical assessment of an interaction design in comparison with similar competitive systems for performing the same user tasks. Summative evaluation is typically performed with some more-or-less final version of the interface design to yield primarily quantitative data. The purpose of the summative comparative evaluation is to statistically compare different usability attributes with competitive systems. The same set of tasks that were used in analysing competitive systems could be compared in summative evaluation to see the design's' ability to support user task performance. Similarly, users' satisfaction rating could be compared to see whether satisfaction with the new interface improved.

### 2.5 Prototyping and iterative design

We suggest early prototyping and an iterative approach to designing IR interfaces. Early prototyping could save time and cost and can be tested with real users. Based on the usability problems and opportunities disclosed by the testing, a new version of the interface can be created and tested. Prototypes are grouped into broad two categories: low-fidelity and high-fidelity (Rudd et al. 1996). A low-fidelity prototype could be as simple as a paper-and-pencil mock-up that shows general flow throughout the screens. High-fidelity prototypes, on the other hand, are typically built with software tools and can be programmed to simulate the functionality in the final product. Some studies compared low- and high-fidelity prototypes in identifying usability problems in a user interface (Nielsen, 1990; Virzi et al. 1996). A general requirement for the prototype, however, is that it can be developed quickly and modified with a minimum of effort.

Iterative design is based on a cyclic process of prototyping, testing, and refining a user interaction design. A few studies showed that iterative design alone could improve the usability of a user interface. Nielsen (1993) provided four different case studies on iterative design. The interfaces went through 3 to 5 iterations with usability measured after each iteration. He found an average of 38% usability improvement between each iteration. In another study, Bailey (1993) showed iterative methodology alone could improve interface designs. The same study also revealed that while iteration on a poor design does improve it, iteration never gets it to be as good as an interface that was originally well designed.

## 3. APPLYING THE METHODOLOGY TO DESIGN A PROTOTYPE IR INTERFACE

We applied the user-centred methodology to iteratively design a prototype IR interface. We used the Web of Science system (available at: http://wos.mimas.ac.uk) to perform competitive analysis. The results of the competitive analysis were published recently (see Ahmed, et al., 2004 and Ahmed, et al., 2005 for details). This allows us to see how both novice and experienced users interacted with the Web of Science interface. Their performance of a benchmark tasks produced task analysis and initial design of a prototype IR interface. We performed extensive evaluations of our prototype design. After each round of evaluation, the prototype was modified as needed within an iterative design process. WeThe main activities of user-centred design and evaluation have been identified and provide a broad framework for introducing usability engineering in IR interfaces. We will now apply our methodology to iteratively design a prototype IR interface. went through three major iterations during the prototype design, each consisting of the progression of usability methods described in the user-centred methodology. Finally, we perform a comparative evaluation of our prototype design with the Web of Science results. The comparative analysis of the results show that the user-centred prototype interface enabled both novice and experienced users significantly to improve their performance compared with the usability tests with the Web of Science. The results of the prototype interface design will be published in a further article.

## 4. CONCLUSION

There is insufficient integration of HCI into IR interaction research. Although HCI has matured as a separate discipline in the past decade, an appropriate integration with IR research has not been accomplished. A user-centred design approach can ensure the usability of IR interfaces. In this article, the main activities of the user-centred design are identified that would provide a broad framework for introducing HCI techniques in designing interfaces for IR applications.

showed The user-centred methodology could have a major impact on designing IR interfaces. IR interface designs need to be user-centred in order to support users' needs and their information seeking behaviour. Until IR interface designers apply such techniques, most IR interface designs will be driven by the constructional domain, and possibly by computer scientists, rather than by the needs of the users for whom these systems are intended. This concludes our presentation of a user-centred methodology for the design and evaluation IR interfaces. This work provides a starting point for techniques that let IR researchers and practitioners to design better IR interfaces that areis both easy to learn to use and remember.

## 5 . REFERENCES


1. Ahmed, S. M. Z., McKnight, C., and Oppenheim, C. (2004). A study of users' performance and satisfaction with the Web of Science IR interface. Journal of Information Science, 30(5), 459-468

2. Ahmed, S. M. Z., McKnight, C., and Oppenheim, C. (2005). A study of learning and retention with a Web-based IR interface. Journal of Librarianship and Information Science. 37(1), 7-16

3. Bailey, G. (1993). Iterative methodology and designer training in human-computer interface design. In: INTERCHI '93: Conference Proceedings in Human Factors in Computing Systems, 24-29 April, Amsterdam, The Netherlands. New York: ACM, 198-204

4. Chin, J. P., Diehl, V. A., and Norman, K. L. (1988). Development of an instrument measuring user satisfaction of the human-computer interface. In: CHI '88: Proceedings of the Conference on Human Factors in Computing Systems, 15-19 May, Washington, DC. New York: ACM, 213-218

5. Cogdill, K. (1999). MEDLINEplus Interface Evaluation: Final Report. Unpublished Report, Human-Computer Interaction Lab (HCIL), University of Maryland. Available at: http://www.wam.umd.edu/~kcogdill/medlineplus.htm

6. Cuomo, D. L., and Bowen, C. D. (1994). Understanding usability issues addressed by three user-system interface evaluation techniques. Interacting with Computers, 6(1), 86-108

7. Desurvire, H., Kondziela, J., and Atwood, M. (1992). What is gained and lost when using evaluation methods other than empirical testing. In: Monk, A., Diaper, D., and Harrison, M. D., eds. Proceeding of the HCI '92: People and Computers VII, 15-18 September, York, UK. Cambridge: Cambridge University Press, 89-102

8. Doubleday, A., Ryan, M., Springett, M., and Sutcliffe, A. (1997). A comparison of usability techniques for evaluating design. In: DIS '97: Proceedings of the Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques, 18-20 August, Amsterdam, The Netherlands. New York: ACM, 101-110

9. Jeffries, R., Miller, J. R., Wharton, C., and Uyeda, K. M. (1991). User interface evaluation in the real world: a comparison of four techniques. In: CHI '91: Proceedings of the Conference on Human Factors in Computing Systems - Reaching through Technology, 27 April-2 May, New Orleans, LA. New York: ACM, 119-124

10. Nielsen, J. (1990). Paper versus computer implementations as mockup scenarios for heuristic evaluation. In: IFIP INTERACT '90: Proceedings of the 3rd International Conference on Human-Computer Interaction, 27-31 August, Cambridge, UK. Amsterdam: North Holland, 315-320

11. Nielsen, J. (1992). Finding usability problems through heuristic evaluation. In: CHI '92: Proceedings of the Conference on Human Factors in Computing Systems, 3-7 May, Monterey, CA. New York: ACM, 373-380

12. Nielsen, J. (1993). Iterative user interface design. IEEE Computer, 26(11), 32-41

13. Nielsen, J. (1994). Heuristic evaluation. In: Nielsen, J., and Mack, R. L., eds. Usability Inspection Methods. New York: John Wiley, 25-62

14. Nielsen, J., and Molich, R. (1990). Heuristic evaluation of user interfaces. In: CHI '90: Proceedings of the Conference on Empowering People: Human Factors in Computing Systems - Special Issue of the SIGCHI Bulletin, 1-5 April, Seattle, WA. New York: ACM, 249-256

15. Peng, L. K., Ramaiah, C. K., and Foo, S. (2004). Heuristic-based user interface evaluation at Nanyang Technological University in Singapore. Program: Electronic Library and Information Systems, 38(1), 42-59

16. Petrelli, D., Hansen, P., Beaulieu, M., Sanderson, M., Demetriou, G., and Herring, P. (2004). Observing users - designing clarity: a case study on the user-centred design of a cross-language retrieval system. Journal of the American Society for Information Science and Technology, 55(10), 923-934

17. Rudd, J., Stern, K., and Isensee, S. (1996). Low vs. high-fidelity prototyping debate. Interactions, 3(6), 76-85

18. Shneiderman, B. (1998). Designing User Interface: Strategies for Effective Human-Computer Interaction. Reading, MA: Addison-Wesley

19. Spyridakis, J. H. (1992). Conducting research in technical communication: the application of true experimental design. Technical Communication, 39(4), 607-624

20. Virzi, R. A. (1992). Refining the test phase of usability evaluation: how many subjects is enough? Human Factors, 34(4), 457-468

21. Virzi, R. A., Sokolov, J. L., and Karis, D. (1996). Usability problems identification using both low- and high-fidelity prototypes. In: CHI '96: Proceedings of the conference on Human Factors in Computing Systems, 13-18 April, Vancouver, Canada. New York: ACM, 236-243

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