A Methodology to Establish Usability Heuristics

Cristian Rusu[1], Silvana Roncagliolo[1], Virginica Rusu[2], Cesar Collazos[3]

[1]Pontificia Universidad Catolica de Valparaiso, Valparaiso, Chile
e-mail: cristian.rusu@ucv.cl, silvana@ucv.cl

[2]Universidad de Playa Ancha, Valparaiso, Chile
e-mail: virginica.rusu@upla.cl

[3] IDIS Research Group, Universidad del Cauca, Popayan, Colombia
e-mail: ccollazo@unicauca.edu.co

***Abstract* — Usability evaluation for applications based on emerging information technology brings new challenges. Is it the classical concept of usability still valid? Which are the dimensions of the (new) usability? How can it be measured? How should we develop for (better) usability? A methodology to develop usability heuristics for emerging applications is proposed. The methodology was fully checked in the case of Grid Computing applications, and partially applied in the case of Interactive Digital Television and Virtual Worlds.**

Keywords - usability; usability evaluations; usability heuristics; grid computing; interactive digital television; virtual worlds.

I. INTRODUCTION

Usability evaluation for applications based on emerging information technology brings new challenges. Is it the classical concept of usability still valid? Which are the dimensions of the (new) usability, into the context of new interaction paradigms? How can it be measured? How should we develop for (better) usability? The traditional usability engineering concepts and evaluation methods should be re-examined. There is a need for new evaluation methods or at least for the use of traditional evaluations in novel ways [1]. Frameworks of usability evaluation, including appropriate methods or combination of methods should be established, in order to get more effective and efficient evaluations on new interaction paradigms.

The paper proposes a methodology to establish new usability heuristics. Section 2 highlights the necessity of new heuristics for applications based on emerging information technology, and describes the proposed methodology. Section 3 shows preliminary results of applying the methodology: usability heuristics for Grid Computing, Interactive Television, and Virtual Worlds. Section 4 presents preliminary conclusions and future works.

II. DEFINING NEW USABILITY HEURISTICS

The ISO/IEC 9241 standard defines the usability as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [2]. Usability evaluation methods are commonly divided into inspection and testing methods. Inspection methods find usability problems based on the expertise of usability professionals. Testing methods find usability problems through the observation of the users while they use (and comment on) a system interface [3].

Heuristic evaluation is a widely used inspection method. A group of evaluators inspect the interface design based on a set of usability heuristics [4] [5]. Heuristic evaluation is easy to perform, cheap and able to find many usability problems (both major and minor problems). However, it may miss domain specific problems. That is why the use of appropriate heuristics is highly significant.

Usability inspections, including heuristic evaluation, are well documented and many publications describe the usage of the methods. Literature usually focuses on describing the advantages and disadvantages of usability evaluation methods but not on how to develop new methods and/or usability heuristics.

Over the last couple of years there is an increasing interest on usability of applications based on emerging information technology [6]. Measuring the usability of such applications was a challenging task. Traditional usability evaluation methods, especially usability heuristics became short.

A methodology to establish new usability heuristics, for specific applications, was gradually defined. The methodology includes 6 stages:

- STEP 1: An *exploratory* stage, to collect bibliography related with the main topics of the research: specific applications, their characteristics, general and/or related (if there are some) usability heuristics.
- STEP 2: A *descriptive* stage, to highlight the most important characteristics of the previously collected information, in order to formalize the main concepts associated with the research.
- STEP 3: A *correlational* stage, to identify the characteristics that the usability heuristics for specific applications should have, based on traditional heuristics and case studies analysis.

 ISBN: 978-1-61208-117-5

- STEP 4: An *explicative* stage, to formally specify the set of the proposed heuristics, using a standard template.
- STEP 5: A *validation* (experimental) stage, to check new heuristics against traditional heuristics by experiments, through heuristic evaluations performed on selected case studies, complemented by user tests.
- STEP 6: A *refinement* stage, based on the feedback from the validation stage.

STEP 1 explores the specific applications that require new usability heuristic.

STEP 2 re-examines the very meaning of usability and its characteristics, in the context of the examined applications.

If literature provides no specific and/or related usability heuristics, Nielsen's 10 well known and extensively used heuristics are used as a basis at STEP 3.

The standard template used at STEP 4 is the following:

- *ID, Name and Definition*: Heuristic's identifier, name and definition.
- *Explanation*: Heuristic's detailed explanation, including references to usability principles, typical usability problems, and related usability heuristics proposed by other authors.
- *Examples*: Examples of heuristic's violation and compliance.
- *Benefits*: Expected usability benefits, when the heuristic is accomplished.
- *Problems*: Anticipated problems of heuristic misunderstanding, when performing heuristic evaluations.

STEP 5 evaluates the set of heuristics defined at STEP 4 against Nielsen's heuristics, in specific case studies. The application is evaluated by two separate groups of evaluators, of similar experience, in equal conditions. One group uses only the set of heuristics defined at STEP 4, while the second group uses only Nielsen's heuristics. Usability problems founded by the two groups are then compared. Three categories of problems are expected:

- (P1) Problems identified by both groups of evaluators,
- (P2) Problems identified only by the group that used the set of heuristics defined at STEP 4,
- (P3) Problems identified only by the group that used Nielsen's heuristics.

New heuristics works well when (P1) and/or (P2) include the highest percentage of problems. Question arises with problems (P3). Why these problems are not identified when using the new set of heuristics? There are basically two possible reasons:

(1) New heuristics are not able to identify these problems, either because there are no appropriate heuristics, or because the heuristics are not properly specified.

(2) Evaluators using new heuristics subjectively ignored the problems.

Hypotheses (1) and (2) may be validated or rejected by complementary evaluations and/or user tests.

STEP 6 refines the set of heuristics defined at STEP 4. Stages 1 to 6 may be applied iteratively. Specific usability checklist may also be developed, detailing usability heuristics and helping heuristic evaluations practice.

III. APPLYING THE METHODOLOGY IN PRACTICE

A. Usability Heuristics for Grid Computing Applications

Grid computing is a relatively new, distributed computing technology, which relies on the coordinated use of different types of computing resources of an unspecified number of devices, which are not necessarily at the same geographical location. The process is transparent for users, allowing the use of resources as a single supercomputer.

Nowadays many Grid Computing based projects offer access to their services through Web applications, by Web portals. It is expected that in the future the technical knowledge of grid users will decrease. That is why usability Grid Computing applications' usability will become a main issue.

The methodology described in the previous section was applied in order to establish specific usability heuristics for Grid Computing Applications. A set of 12 new heuristics was developed, grouped in three categories: (1) *Design and Aesthetics*, (2) *Navigation*, and (3) *Errors and Help*. A summary of the proposed heuristics is presented below, including heuristics' ID, name and definition.

Design and Aesthetics Heuristics:

(CGH1) *Clarity*: A Grid Computing application interface should be easy to understand, using clear graphic elements, text and language.

(CGH2) *Metaphors*: A Grid Computing application should use appropriate metaphors, making the possible actions easy to understand, through images and familiar objects.

(CGH3) *Simplicity*: A Grid Computing application should provide the necessary information in order to complete a task in a concise (yet clear) manner.

(CGH4) *Feedback*: A Grid Computing application should keep users informed on the jobs' progress, indicating both the global and the detailed state of the system. The application should deliver appropriate feedback on users' actions.

(CGH5) *Consistency*: A Grid Computing application should be consistent in using language and concepts. The forms of data entry and visualization of results should be consistent.

Navigation Heuristics:

(CGH6) *Shortcuts*: A Grid Computing application should provide shortcuts, abbreviations, accessibility keys or command lines for expert users.

 ISBN: 978-1-61208-117-5

(CGH7) *Low memory load*: A Grid Computing application should maintain the main commands always available. It should offer easy to find elements, functions and options.

(CGH8) *Explorability*: A Grid Computing application should minimize navigation and should provide easy, clear, and natural ways to perform tasks.

(CGH9) *Control over actions*: A Grid Computing application should offer ways to cancel a running task or process. It should allow undo and/or changes of actions.

Errors and Help Heuristics:

(CGH10) *Error prevention*: A Grid Computing application should prevent users from performing actions that could lead to errors, and should avoid confusions that could lead to mistakes.

(CGH11) *Recovering from errors*: A Grid Computing application should provide clear messages, hopefully indicating causes and solutions of errors.

(CGH12) *Help and documentation*: A Grid Computing application should provide an easy to find, easy to understand, and complete online documentation. It should provide contextual help and glossary of terms for novice users.

Following the proposed methodology, the set of Grid Computing usability heuristics was specified, validated and refined in a three-cycle iterative process [7] [8]. New heuristics proved to work better than Nielsen's heuristics in two case studies. Problems (P1) and (P2) were dominant in both cases. Problems (P2) scored 41% in the first case study, and 46% in the second one.

B. Usability Heuristics for Interactive Television

Interactive Digital Television (iTV) exceeds the analog TV in several aspects: capacity, better use of the spectrum, greater immunity to noise and interference, better sound and picture quality, potential for transmission of data simultaneously, saving power transmission. However, the main iTV advantage is that the user may interact with the application. Interactivity allows the user to be an active part of the programming, providing the ability to access or extend the information presented, combining multimedia content (audio, video, text), to participate in forums and to control the sequence of information presented [9].

Stages 1 to 4 of the proposed methodology were performed for iTV applications [10]. A set of 14 specific usability heuristics were developed. Stages 5 and 6 are still to be performed. Heuristics were grouped in three categories: (1) *Design and Aesthetics*, (2) *Flexibility and Navigation*, and (3) *Errors and Help*. A summary of the proposed heuristics is presented below, including heuristics' ID, name and definition.

Design and Aesthetics Heuristics:

(ITVH1) *Match between the system and the real world*: iTV should use words, phrases and concepts familiar to the user; the sequence of activities should follow user's mental processes; information should be presented in a simple, natural and logical order; metaphors should be easy to understand; important controls should be represented on screen; there should be an intuitive mapping between them and the real controls.

(ITVH2) *Aesthetic and minimalist design*: iTV should have simple, intuitive, easy to learn and pleasing design; the system should be free from irrelevant, unnecessary and distracting information; icons should be clear and buttons should be labeled; the use of graphic controls should be intuitive; the need for scroll should be minimized; navigation facilities should be present at the bottom of the screen.

(ITVH3) *Consistency and standards*: iTV should use terminology, controls, graphics and menus consistent throughout the system; there should be a consistent look and feel for the system interface; iTV should be consistent with the related standard TV programs, and colors should be consistent between the two systems.

(ITVH4) *Visibility of the system status*: Feedback on system status should be continuously provided.

(ITVH5) *Physical constraints*: Screen should be visible at a range of distances and in various types of lighting; the distance between targets (e.g. icons) and the size of targets should be appropriate; size should be proportional to distance.

(ITVH6) *Extraordinary users*: iTV should use appropriately color restricted; it should be suitable for color-blind users.

Flexibility and Navigation Heuristics:

(ITVH7) *Structure of information*: iTV should have a hierarchical organization of information, from general to specific; related pieces of information should be clustered together; the length of text should be appropriate to the display size and interaction device; the amount of information should be minimized; page titles and headlines should be straightforward, short and descriptive; textual content should be kept to a maximum of two columns.

(ITVH8) *Navigation*: iTV should provide navigational feedback (e.g. showing a user's current and initial states, where they have been, and what options they have for where to go) and navigational aids (e.g. find facilities).

(ITVH9) *Recognition rather than recall*: Help and instructions should be visible or easily accessible when needed; relationship between controls and their actions should be obvious; input formats and units of values should be indicated.

(ITVH10) *Flexibility and efficiency of use*: iTV should allow for a wide range of user expertise; it should also appropriately guide novice users.

(ITVH11) *User control and freedom*: iTV should provide "undo" (or "cancel") and "redo" options; exits should be clearly marked (when users find themselves somewhere unexpected); facilities to return to the top level should be provided, at all stages.

Errors and Help Heuristics:

(ITVH12) *Error prevention*: iTV should offer a selection method provided (e.g. from a list) as an alternative to the direct entry of information; user confirmation should be

required before carrying out a potentially "dangerous" action (e.g. deleting something).

(ITVH13) *Help users to recover from errors*: Error messages should adequately describe problems; they should assist in diagnosis and suggest ways of recovery in a constructive way; error messages should be written in a non-derisory tone and refrain from attributing blame to the user.

(ITVH14) *Help and documentation*: iTV should offer clear, direct and simply help, expressed in user's idiom, free from jargon and buzzwords; help should be easy to search, understand and apply.

C. Usability Heuristics for Virtual Worlds

A virtual world is a computer-based simulated persistent spatial environment that supports synchronous communication among users who are represented by avatars [11]. There is interaction between avatars and between avatar and environment. Each virtual world has its own rules.

Stages 1 to 3 of the proposed methodology were applied to some Virtual Worlds case studies. Stage 4 is currently undergoing. To the date, a set of 16 usability heuristics were established. A brief summary, including only heuristics' ID and name, is presented below.

(VWH1) *Clarity*.
(VWH2) *Simplicity*.
(VWH3) *Feedback*.
(VWH4) *Consistency*.
(VWH5) *Low memory load*.
(VWH6) *Flexibility and efficiency of use.*
(VWH7) *Orientation and navigation*.
(VWH8) *Camera control*.
(VWH9) *Visualization*.
(VWH10) *Avatar's customization*.
(VWH11) *World interaction*.
(VWH12) *Law of physics*.
(VWH13) *Communication*.
(VWH14) *Error prevention*.
(VWH15) *Help users to recover from errors.*
(VWH16) *Help and documentation.*

IV. CONCLUSION AND FUTURE WORKS

Heuristic evaluation is a well known and widely used usability inspection method. As it may miss domain specific problems, the use of appropriate heuristics is highly significant.

A methodology to establish new usability heuristics is proposed. The methodology facilitates the development of both usability heuristics and associated usability checklists. The methodology was applied and validated for Grid Computing applications. It is being currently applied for Interactive Digital Television applications and for Virtual Worlds. Future works should include more experiments and validation.

A right balance between specificity and generality should be follow. If heuristics are too specific, they will probably become hard to understand and hard to apply. General heuristics, complemented by specific usability checklists, will probably work better, most of the time. However, there is a need for new usability heuristics especially for applications based on emerging information technology brings new challenges.

As most of the studies recommend, heuristic evaluations should always be complemented by other usability evaluations, especially usability tests.

ACKNOWLEDGMENT

The work was highly supported by the *School of Informatics Engineering* of the *Pontifical Catholic University of Valparaiso – Chile*, especially by the members of *"UseCV" Research Group in Human – Computer Interaction*, and by the *IDIS Research Group* of *University of Cauca - Colombia*.

REFERENCES

[1] C. Wiberg, K. Jegers, and H. Desurvire, "How Applicable is Your Evaluation Methods – Really?", Proc. 2nd International Conferences on Advances in Computer-Human Interactions (ACHI 2009), IEEE Press, pp. 324-328, ISBN: 978-1-4244-3351-3, 2009.

[2] International Organisation for Standardisation, ISO 9241, "Software Ergonomics Requirements for office work with visual display terminal (VDT)", Geneva, 1998.

[3] R. Otaiza, C. Rusu, and S. Roncagliolo, "Evaluating the Usability of Transactional Web Sites", Proc. 3rd International Conferences on Advances in Computer-Human Interactions (ACHI 2010), IEEE Press, pp. 32-37, ISBN-13: 978-0-7695-3957-7, 2010.

[4] J. Nielsen, "Usability Engineering", Morgan Kaufmann Publishers, 1993.

[5] J. Nielsen, "Ten Usability Heuristics", Available at www.useit.com/papers/heuristic/heuristic_list.html (last access 12/10/2010).

[6] C. Rusu, V. Rusu, and S. Roncagliolo, "Usability Practice: The Appealing Way to HCI", Proc. 1st International Conferences on Advances in Computer-Human Interactions (ACHI2008), IEEE Press, pp. 265-270, ISBN-10: 0-7695-3086-9, 2008.

[7] C. Rusu, S. Roncagliolo, G. Tapia, D. Hayvar, V. Rusu, and D. Gorgan, "Evaluating the Usability of Intercultural Collaboration Platforms: Grid Computing Applications", Proc. 3rd ACM International Conference on Intercultural Collaboration (ICIC 2010), ACM Digital Library, pp. 179-182, ACM 978-1-4503-0108-4/10/08.

[8] C. Rusu, S. Roncagliolo, G. Tapia, D. Hayvar, V. Rusu, and D. Gorgan, "Usability Heuristics for Grid Computing Applications", Proceedings of The 4th International Conferences on Advances in Computer-Human Interactions (ACHI 2011), Gosier, France, 2011.

[9] C. Collazos, J. Arciniegas, V. Mondragón, and X. Garcia, "Directrices de diseño y evaluación de la televisión interactiva desde una perspectiva de usabilidad", Proc. Interaccion 2008, Albacete, Spain, pp. 257-260, 2008.

[10] C. Collazos, C. Rusu, J. Arciniegas, and S. Roncagliolo, "Designing and Evaluating Interactive Television from a Usability Perspective", Proc. 2nd International Conferences on Advances in Computer-Human Interactions (ACHI 2009), IEEE Press, ISBN: 978-1-4244-3351-3, pp. 381-385, 2009.

[11] J. Yoonhyuk and K. Hyunmee, "User goals in social virtual worlds: A means-end chain approach", Comput. Hum. Behav., vol. 26(2), pp. 218–225, 2010.