Application of User Involvement and Quality Function Deployment to Design Intelligent Service Systems

Víctor Acinas Garzón
Communications Division
Instalaciones Inabensa S.A.
Madrid, Spain
victor.acinas@inabensa.abengoa.com

Abstract—**This paper presents a new method for capturing user needs in product design. The method links user needs to product design by combining user involvement techniques together with Quality Function Deployment (QFD). The methodology is applicable for product development as well as the design of novel products that cannot base its design on incremental improvements of existing products. The methodology is illustrated through application to the design of a novel intelligent service system that aims to create channels for communication and interaction between people with some kind of special need and their environment.**

Keywords-intelligent service system design; user involvement; quality function deployment; accessibility; inclusion.

I. INTRODUCTION

The information and knowledge society provides scant attention to users with special needs, despite the increase in number and needs [1], [2]. The information and knowledge society should not only cover mainstream user's demand, but also individuals needs through software services. It is of great importance to develop new methodologies that take users with special needs into consideration from the early steps of product design.

A widely adopted product design methodology is Quality Function Deployment (QFD). QFD is spread across different fields, including software development [3][4]. This methodology translates the voice of the customer into design requirements and product specifications through the House of Quality Matrix, see Fig. 1. However, QFD tool can find difficulties to capture [5], understand and organize user needs [6] as well as connecting technical requirements and setting targets according to quality of service [7]. Moreover, QFD can not be used in multiple product design [8] and innovative interactive systems [9].

To improve QFD and exploit its flexibility [10], QFD is combined with other methodologies such as Kano Model, FMEA, KC and TRIZ [10][11][12][13]. However, modifications to QFD lack from an active user involvement that is of special relevance for social applications [14].

For these reasons, INREDIS (RElationship INterfaces between the environment and DISabled people) project [15] developed a design methodology that on one side researches user needs, including user with special needs, in connection with the information and knowledge society and, on the other, current and emerging technological solutions that can meet user needs through tailored software services.

The design methodology was used to design an intelligent service system that creates channels for communication and interaction accessible to all users. INREDIS on-going work is to develop the intelligent service system that will enable the creation of channels for communication and interaction among people with special needs and the information and knowledge society according to the design methodology results. The intelligent service system goal is to deliver accessible software services that meet a wider range of needs than current technological solutions and is capable of evolving in relation to the needs of the users and the environment. As a result, in this paper INREDIS design methodology is illustrated in connection with the design of INREDIS intelligent service system design. Thus, in connection with the design of INREDIS intelligent service, Section II describes the design methodology, Section III presents the design methodology results and Section IV the conclusions and future work.

II. DESIGN METHODOLOGY

INREDIS design methodology consists of four major steps as outlined in Fig. 1. These steps represent a comprehensive analysis of technological solutions and users, including those with special needs. This methodology overcomes traditional QFD difficulties in capturing [5] understanding and organizing user needs [6] by complementing traditional methods used in QFD [5] with user involvement. Furthermore, by relying on user involvement, it is possible to develop novel products [9] [16].

The first step of the intelligent system design is to research the relationship between users, including those with special needs, and technology, in particular with technologies that are characteristic of the information and

 ISBN: 978-1-61208-117-5

knowledge society. This analysis seeks to identify the main barriers that users with and without functional diversity encounter in using technology.

For this, user tests [17][18], heuristic analysis [19], surveys [20], interviews [14][21] and the people led innovation methodology [16] were carried out in order to understand the real-world problems in interaction between users, devices and technologies in the environment and pinpoint interoperability issues among devices and systems in different contexts. This step yields a list of user requirements as well as importance values of each requirement.

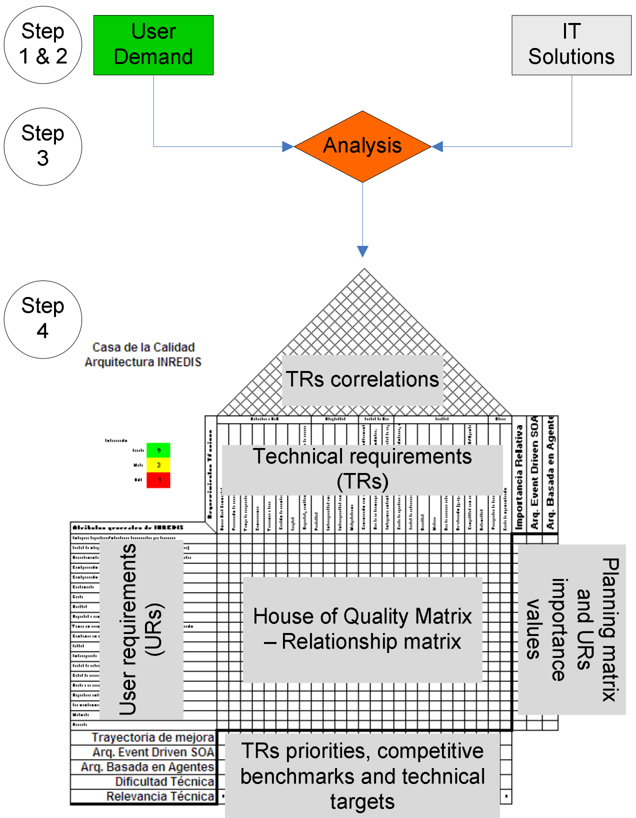

Figure 1. INREDIS intelligent service system design methodology outline.

The contexts of study are: telecare, domestic, urban, banking, buy/sell, educational and work. Furthermore, six types of user profiles with specific special needs are evaluated, visual, hearing, mobility, handling, cognitive and elderly. These contexts and profiles are considered across all the design steps.

The second step is to analyze the current technological environment, taking into account different emerging technologies that may contribute to the development of the technological environment and to further the state of the art of these technologies. Thus, this step investigates the phenomenon of converging technologies in the information and knowledge society and relevant to users with special needs, while it takes into account other usage social considerations. This step yields a list of technical requirements as well as their correlations.

Hence, the results from step one and two are analyzed in step three to select the most relevant issues for the design and development of an intelligent service system for users with special needs. This analysis yields the values to include in the QFD, which are, on one side, the technical requirements, priorities, targets and competitive benchmarks with other solutions, and, on the other, the planning matrix. The selection of these is done through different group sessions that include experts from INREDIS project with user and technical backgrounds. The resulting issues form the starting point for the next and final step.

Drawing from the information gathered to this point, the fourth step ensures relating user and technical perspectives through a QFD [3][22]. The House of Quality function deployment matrix provides a cornerstone to engage technical and user experts in a discussion on the relative importance and relationship among technical characteristics and customer attributes when designing and developing an intelligent system for users with special needs. Furthermore, this will enable to prioritize technical solutions requirements relevant to the information and knowledge society and in line with users with special needs. This is done by weighting the importance of the user input together with the technical requirements and their relation.

III. Design Methodology Results

The described design methodology surfaced accessibility and usability barriers as well as preferences with interconnected with technical characteristics. These shows the way to develop novel solutions or implementations that break down barriers with the information and knowledge society to provide more efficiently and effectively software services. The design yielded that the most relevant technical characteristics when designing an intelligent service system to create accessible channels for communication and interaction are:

1. Openness: must be based on standards and/or free and open source technologies to ease adoption.
2. Interoperability: the intelligent service system has to interoperate with the widest range of software services and technological solutions.
3. Portability: the intelligent system must be able to operate on different devices with different platform solutions.
4. Implementation cost: the intelligent service system must be easy to access/install and use as well as to update.
5. IT architecture compatibility: the intelligent service system must be compatible with other IT architectures and paradigms such as service oriented, event driven and intelligent agent architectures.

Interestingly, these technical characteristics can be summarised, leaving implementation costs aside, as a surge

 ISBN: 978-1-61208-117-5

towards an intelligent service system that interoperates with current or upcoming solutions whether open, private or standardised. Furthermore, as to integrate its usage and functionality in the daily life of the user and the contexts under study, it shall also be available everywhere. For these reasons, the main focus shall be placed on creating an intelligent service system that is accessible, interoperable and ubiquitous to users with special needs, and, thus, to everyone, see Figure 2.

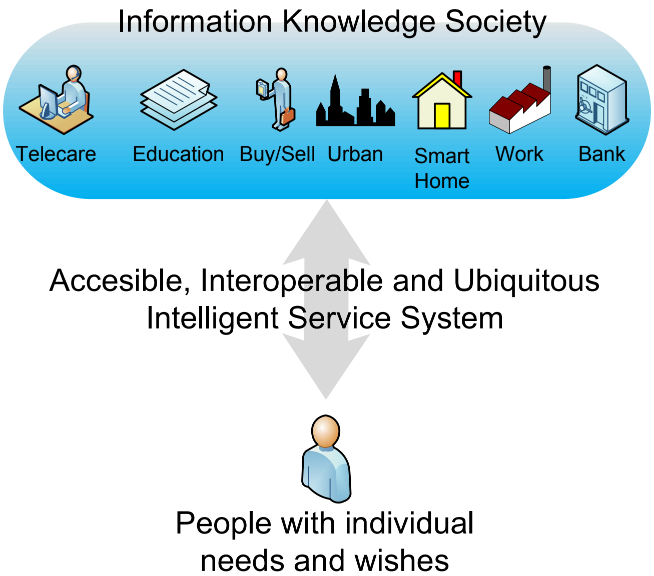

Figure 2. Outline of intelligent service system design.

Only by implementing an intelligent service system focused on accessible, interoperable and ubiquitous technical characteristics users will adopt it to impact daily life. Ultimately, users with special needs can communicate and interact with the information and knowledge society in virtually all contexts.

A. *Current software services market*

Despite the growing needs and number of users with special needs, according to the design studies in step 1 and step 2, the current market scenario does not offer accessible software services that fulfil all needs. So far, the trend has been to incorporate technological advances as adaptations to existing software services that make them accessible and usable by e.g. elderly and people with disabilities. However, the studies show that, often, adapted software services do not even entirely cover targeted user needs. Since these services were planned from inception to mainstream users, adaptations to cover other needs are at best, troublesome and costly and at worse, unattainable. Fig. 3 shows the current market situation, software services depicted in a fading colour indicate needs not fully covered.

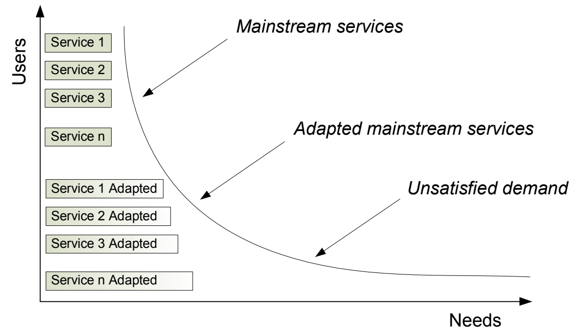

Figure 3. Market software services situation according to the number of users and needs.

For instance, despite banking software services may increase the fonts to enable its use for people with visual impairments; the user may require plain language to fully understand what is shown. Even more, adaptations often involve heterogeneous modifications that hinder the development of standardized technologies that can operate with any type of device [23]. This creates a fragmented and non-structured market jeopardising user involvement in the information and knowledge society.

B. *Future software market*

For these reasons, the future market of software services should address fully the user needs and overcome software service adaptation deficiencies [24]. Hence, according to the design methodology an intelligent service system has to create channels for communication and interaction which provide tailored services to fulfil user's special needs comprehensively through accessible, interoperable and ubiquitous software services. In doing so, the services may need to be, not only aggregated with others but complemented with assistive technologies. Fig. 4, illustrates the composition of tailored software services.

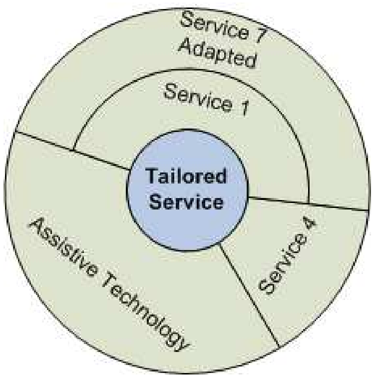

Figure 4. Example of tailored software service composition.

Interestingly, tailored software services are not only of use for people with special needs. A common example is the difficulties everyone experiences when looking rich-colour interfaces under direct sunlight. It would be of help to all users if the interface changed automatically to a high-contrast. Fig. 5 shows how tailored software services generated through an accessible, interoperable and ubiquitous intelligent service system can fullfil users' needs demand through service aggregation.

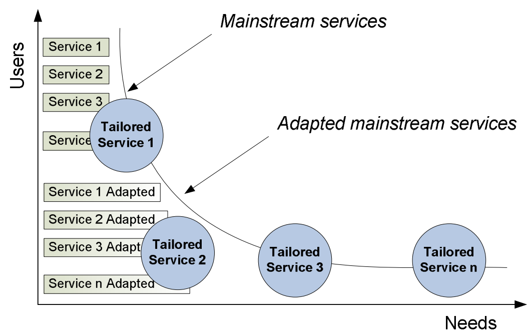

Figure 5. Market scenario according to the number of users and needs.

Thus, rather than developing or modifying software services an accessible, interoperable and ubiquitous intelligent service system builds on existing software services and creates, in line with user needs, channels for communication and interaction with the information knowledge society [25]. Furthermore, this design leaves the door open to all software service providers to interoperate with the intelligent service system and, thus, improves user satisfaction, while co-existing with current mainstream (adapted) software services.

IV. CONCLUSION AND FUTURE WORK

The application of user involvement together with the Quality of House function deployment presented in this paper enables building an intelligent service system to meet comprehensively user needs for software services. This approach points out the importance to create tailored software services that meet not only mainstream users but also users with special needs. These tailored software services can be created through the design of an intelligent service system that implements the characteristics of accessibility, interoperability and ubiquity and takes into account the user preferences. In this way, current software services can be accessed and use anywhere together with others to provide tailored services that match with the user needs and wishes.

In line with the presented design, the next step is to develop INREDIS intelligent service system to build tailored software services that meet both mainstream users and users with special needs. Later on, INREDIS intelligent service system will be validated in real life tests within the considered project scenarios; mobility, electronic media, telecare, domestic, urban, banking, shopping, educational and work.

ACKNOWLEDGMENT

The research described in this paper arises from a Spanish research project called INREDIS (INterfaces for RElations between Environment and people with DISabilities) [http://www.inredis.es]. INREDIS is led by Technosite and funded by CDTI (Industrial Technology Development Centre), under the CENIT (National Strategic Technical Research Consortia) Programme, in the framework of the Spanish government's INGENIO 2010 initiative.

The opinions expressed in this paper are those of the authors and are not necessarily those of the INREDIS project's partners or of the CDTI.

REFERENCES

[1] MeAC. Measuring Progress of eAcessibility in Europe. Assessment of the Status of eAccessibility in Europe. Main Report. October (2007).

[2] Ageing characterises the demographic perspectives of the European societies. Eurostat report 72/2008.

[3] L. Chan and M. Wu, "QFD: a literature review", European Journal of Operational Research, Vol. 143, pp.463-497, 2002.

[4] J. R. Sharma, S.A. Tabarno, and A. M. Rawani, "Integrating QFD with software development engineering for higher customer satisfaction", Indian Journal of Information Science & Technology, May, Vol. 1, No. 2, pp.35-43, 2006.

[5] R. E. Zultner, "Objectives: The missing piece of the requirements puzzle," Proc. Structured Development Froum XI, pp. 1-11, 1990.

[6] J. J. Cristiano, J.K. Liker, and C. C. White, "Key factors in the succesful application of quality function deployment," IEEE Trans. Eng. Manag., vol.48, no. 1, pp. 81-95, 2001.

[7] L. Xiaoqing and Z. Lianzhang, "Design of SOA Based Web Service Systems Using QFD for Satisfaction of Quality of Service Requirements," Proc. IEEE International Conference on Web Services, pp. 567-574, 2009.

[8] Y. Sireli, P. Kauffmann, and E. Ozan, "Integration of Kano's Model into QFD for Multiple Product Design," IEEE Transactions on Engineering Management, 54(2), pp.380-390, 2007.

[9] A. Dearden, S. Howard, "Capturing user requirements and priorities for innovative interactive systems," Computer Human Interaction Conference, pp. 160–167, 1998.

[10] A. Hassan, A. Siadat, J. Y. Dantan, and P. Martin, "Interoperability of QFD, FMEA, and KCs methods in the product development process," IEEE International Conference on Industrial Engineering and Engineering Management, pp. 403-407, 2009.

[11] S. Li, Y. Ma, G. Yang, and Y. Li, "An Integrated Mode Research of QFD and TRIZ and Its Applications," Second International Workshop on Computer Science and Engineering, vol. 1, pp.548-552, 2009.

[12] C. Ankur, R. Jain, A. Singh, and P. Mishra, "Integration of Kano's Model into quality function deployment (QFD)," International Journal of Advanced Manufacturing Technology, pp. 268-278, 2010.

[13] K. S. Chin, L.S. Zheng, and L. Wei, "A hybrid roughcut process planning for quality," International Journal of Advanced Manufacturing Technology, vol. 22, pp. 733–743, 2003.

[14] M. Valles, Técnicas cualitativas de investigación social. Reflexión metodológica y práctica profesional. Síntesis. Madrid, 1997.

[15] INREDIS: INREDIS project, www.inredis.es last visited on December 2010.

[16] Institute of Innovation for Human Well-being (I2BC), http://www.i2bc.es/inicio/pli last visited on December 2010.

[17] J. Lores, T. Granollers, and S. Lana, Introducción a la interacción persona-ordenador. AIPO. Madrid, 2002.

[18] K. Pernice and J. Nielsen, How to Conduct usability Evaluations for Accesibility: Methodology Guidelines for Yesting Websites and Intranets With Users Who Use Assistive Technology. Freemont: Nielsen Norman Group, 2001.

[19] J. Nielsen, Usability engineering. London, UK: Academia Press Profesional, Boston, MA., 1993.

[20] F. Alvira, La encuesta: una perspectiva general metodológica. CIS. Madrid, 2004.

[21] L. Alonso, La mirada cualitativa en sociología. Fundamentos. Madrid, 1998.

[22] Y. Akao, Quality Function Deployment: Integrating Customer Requirements into Product Design. Productivity Press. Cambridge, 1990.

[23] A. Sloane, Home-Oriented Informatics and Telematics, Springer-IFIP, pp. 323-335. Springer Boston, 2005.

[24] C. A. Velasco, Y. Mohamad, and J. Pullmann, “Dynamic Adaptation of Web 2.0 Applications by Combining Extended Device Profiles. Universal Access in Human-Computer Interaction. Applications and Services,” Lecture Notes in Computer Science, Volume 5616, pp. 797-802, Springer, Berlin / Heidelberg, 2009.

[25] M. Pous and L. Ceccaroni, “Multimodal Interaction in Distributed and Ubiquitous Computing,” Fifth International Conference on Internetand Web Applications and Services (ICIW), pp. 457-462, Barcelona, 2010.

 ISBN: 978-1-61208-117-5