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# An examination of usability and usability engineering with the contemporary systems thinking lenses

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**Abstract:**

*The subject of usability and usability engineering has long been an influential one in the computer science field, notably in the subject of Human-computer interaction. Meanwhile, the importance of developing usable new software products has been widely recognized in the business community. Nevertheless, the theoretical and methodological strengths and weaknesses of usability engineering methodologies have not been seriously examined in the usability field. The writer draws on the experience on this topic of evaluation of various strands of systems thinking in the systems thinking field to inform this topic in the usability subject. It argues for the theoretical justification to adopt the theoretically enriched view on usability and usability engineering (TEVUAUE), which is essentially grounded on multi-perspective, systems-based research thinking (Ho, 2013) and creative holism (Jackson, 2003). As a vaguely conceived notion, the paper encourages further research effort to develop the notion of the theoretically enriched view on usability and usability engineering (TEVUAUE).*

**Key words:** Creative holism; Multi-perspective, systems-based research; Systems thinking; The theoretically enriched view on usability and usability engineering (TEVUAUE); Usability; Usability engineering methodology (UEM)

## Introduction

The topic of usability is a prime one in the computer science field, particularly in the subject of Human-computer

interaction. At the same time, the practical and commercial value of usable software products has been well recognized in the Information Technology sector. In this paper, the writer examines the topic of Usability and Usability Engineering in order to achieve two objectives:

Firstly, quite some of the writer's computer science students are interested to employ usability engineering in their final-year dissertation projects. The writer deems it vital that students have a good comprehension of not just the usability engineering methodology and techniques, which have been well explained in the usability engineering literature, but also the underlying theoretical paradigm of usability engineering, which has not been examined clearly in the literature. Here, the paper takes up the challenge of reviewing the theoretical paradigm of usability and usability engineering as well as their related theoretical concerns so as to make further theoretical and methodological development of the usability notion.

Secondly, the writer makes use of contemporary systems thinking, notably critical systems thinking, as the analytical lenses to evaluate the notions of usability and usability engineering so as to illustrate the analytical power of contemporary systems thinking for such kind of evaluation exercise.

These two objectives are related and meeting them have clear practical, pedagogical and academic values to students, professionals and academics in the computer science and systems thinking fields.

## The notion of Usability: a brief review

Despite the proclamation by Dix *et al.* (1998) that usability cannot be defined totally, for a system cannot be said to be usable by "obeying a set of formal principles", usability has indeed been defined in the usability literature, which does offer usability principles and rules:

1. Usability means "quality in use", covering a number of quality factors such as such as execution time, performance, user satisfaction and ease of learning (Karahoa *et al*., 2010).
2. Usability is a "measurable characteristic of a product user interface"; its broad dimensions cover "how easy to learn the user interface" and (ii) "how easy to use… the user interface", among others (Mayhew, 1999).
3. Usability is "the glue that holds together all the pieces that (hopefully) fit together to make up any product" (Mandel, 1997). The pieces that Mandel has in mind are business processes, technology, user interface and electronic performance support, which together contribute to four usability factors, namely, usefulness, effectiveness, learnability and attitude (Mandel, 1997). This definition portrays Usability as an emergent property of a set of interacting elements making up a system (e.g., a new software product).
4. Usability is "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" (ISO 9241-11: Guidance on usability as cited by Bevan (2001).).

From these definitions, one can say that usability is not an objective quality characteristic of a software product: a product can be conceived as usable by one user but not so by another user; or a product can be considered as usable under one context of use but not the case under another context of use. In the words of Dix *et al.* (1998), the "ultimate test of a product's usability is based on the measurements of users' experience with it". In the same vein, it has been pointed out that usability is affected by the users, users' goals and the context of use (usabilitynet.org, 2015a). Nielson (1992) is more specific by stressing that "user differences and task variability are the two

factors with the largest impact on usability". On this usability notion, it is useful to note the recent survey with usability professionals by Hertzum and Clemmensen (2012). In their survey, they reveal that, in general, usability professionals' notion of usability is mainly goal-related and individual-level focused rather than organizational- and environmental-level focused. This finding sheds further light on the usability notion as it is understood by the usability professionals. Undoubtedly, usability is well accepted by software product designers as vital for the commercial success of a software product. Dix *et al.* (1998) also identifies a set of principles to support usability grouped into three categories, namely, learnability, flexibility and robustness; by doing so, these writers manifest a rather objective and engineering view on usability.

## The usability profession and the notion of usability engineering methodology (UEM): a brief review

One usability professional body, the User Experience Professionals Association explicitly expresses interest in practices on usability, user-centered design[1] and user experience[2]. The topics of usability and usability engineering are taught in the established subject of Human-Computer Interaction, see, for examples, Dix *et al.* (1998) and Mandel (1997). Academic journal articles on usability can be found in *ACM Journal of Computer Documentation*, *Applied Ergonomics* (Elsevier), and *International Journal of Human-Computer Studies* (Elsevier). Basic information on usability tools and methods are introduced in usabilitynet.org (2015c) and simple usability heuristics have long been offered to usability practitioners (e.g., Nielson (1992: p. 16).

[1] Kontogiannis and Embrey (1997) offer a clear introduction to the user-centred design approach.

[2] In the subject of usability, *user experience* (UX) focuses on "a deep understanding of users", while also taking into consideration a new product development project goals (usability.gov, 2015).

In order to improve usability of software product design, usability professionals[3] and academics participate in the development and practices of usability engineering, notably via the employment of usability engineering methodologies. On the topic of usability engineering methodology (UEM), the writer mainly draws on the works of Mayhew (1999), Nielson (1992) and Hackos and Redish (1998) for the review here. As a methodology, a UEM consists of a number of phases, each of which specifies a set of specific techniques to use. Typically, a UEM also specifies a set of guiding principles. For Nielson (1992)'s version of UEM, the main phases are as follows:

0. Consider the larger context
1. Know the user
    a. Individual user characteristics
    b. Functional analysis
    c. Evolution of user
2. Competitive analysis
3. Setting usability goals
4. Participatory design
5. Coordinated design of the total interface
    a. Standards
    b. Product identity
6. Guidelines and heuristic analysis
7. Prototyping
8. Empirical testing
9. Iterative design
    a. Capture the design rationale
10. Collect feedback from field use

As to Mayhew (1999)'s more elaborated version of UEM[4], it consists of the following three phases:

[3] Main usability professional bodies include The User Experience Professionals Association and Interaction, a specialist group of BCS, The Chartered Institute for IT, see also usabilitynet (2015b).

[4] Meyhew (1999)'s UEM is called *The Usability Engineering Lifecycle*, though it is considered as an engineering methodology in this paper.

*Phase One:* Requirements Analysis, which examines topics of user profile, task analysis, platform capabilities and constraints, general design principles and usability goals.

*Phase Two:* Design/Testing/Development, covering tasks at level 1 (i.e., work re-engineering, conceptual model design, conceptual model mockups, and iterative conceptual model evaluation), level 2 (i.e., screen design standards, screen design standards prototyping, iterative screen design standards evaluation) and level 3 (detailed user interface design, iterative detailed user interface design evaluation).

*Phase Three:* Installation, which covers the topic of user feedback.

While Nielson's UEM is explained in an article, Mayhew's one is expounded in a book of more than 500 pages. Regardless, there are clearly advantages of developing and using well-formulated methodologies, grouped by Avison and Fitzgerald (2003: Chapter 26) under three main "categories of rationale", namely: (i) "a better end product", (ii) "a better development process" and (iii) "a standardized process". In the case of UEM, both Mayhew's and Nielson's UEM include an explicit set of guiding principles. The writer makes an attempt to synthesize their ideas on UEM guiding principles to come up with the following nine inter-related ones grouped into the two categories of *overall orientation* (category 1) and *specific favoured practices* (category 2):

<u>Category 1 - Overall orientation</u>

i. The engineering process is highly participatory with users right from the very beginning of the design process.
ii. The engineering process is intended to be highly compatible with contemporary software engineering

methodologies, such as Object-Oriented Software Engineering and, in general, the Systems Development Life Cycle[5].

iii. The engineering process endorses cross-functional teamwork in the coordinated design process.

iv. The engineering process focuses on how-to-do rather than what-to-do in its practices.

v. Usability techniques are to be used in a flexible and adaptable mode, depending on the specific contingency factors of the project encountered.

Category 2 - Specific favoured practices

vi. The engineering process is iterative with evolutionary prototyping.

vii. The engineering process fully embraces the method of user and task analysis[6].

viii. The engineering process employs usability inspection techniques[7] and the underlying principle of empirical user testing and feedback.

ix. The engineering process highly encourages formulation and adoption of usability guidelines, e.g., general guidelines, category-specific guidelines and product-specific guidelines, as well as interface standards in the design process.

Apparently, the usability professionals play a vital role in a UEM. For Mayhew, there are three main usability roles, namely, usability engineer, user interface designer and user interface developer. These roles demand a broad range of technical and non-technical skills. For instance, in their

[5] The Systems Development Life Cycle (SDLC) has four main phases: Phase 1 (Planning), Phase 2 (Analysis), Phase 3 (Design) and Phase 4 (Implementation) (Dennis *et al.*, 2005).

[6] Hackos and Redish (1998) offers a detailed account on the *User and Task Analysis* approach.

discussion of User and Task Analysis, which is a vital task in a UEM, Hackos and Redish (1998) acknowledge the required intellectual knowledge of User and Task Analysis from Anthropology and ethnography, Cognitive psychology, Document design and rhetoric, Instructional systems design, Market research, Scientific management and the Scandinavian model of participatory design. Knowledge from these disciplines is also explained in Human-computer interaction textbooks, such as Dix *et al*. (1998) and Mandel (1997). Current usability engineering practices, while inevitably drawing on the intellectual inspiration from all these disciplines, work on new application domains, such as usability for mobile applications and devices, see, for examples, Lai and Wu (2014), Kjeldskov and Stage (2004) and Othman, Petrie and Power (2013). It is unmistakably a dynamic subject with a strong emphasis on usability know-how mastery. From an Information Systems development methodology perspective (Avison and Taylor, 1997), a UEM is an engineering methodology possessing specific methodological strengths and weaknesses, thus suitable for certain types of problem situation. Specifically, Avison and Taylor (1997) distinguish 4 classes of problem situation:

*Class 1:* "Well-structured problem situations with a well-defined problem and clear requirements".

*Class 2:* "well-structured problem situations with clear objectives but uncertain user requirements".

*Class 3:* "Unstructured problem situations with unclear objectives".

*Class 4:* "Situations where there is a high user interaction with the system".

As an engineering methodology with strong emphasis on user participation, prototyping, and integration with software engineering methodologies, UEMs are suitable in those problem

[7] Nielson and Mack (*editors*) (1994) is a collection of articles on Usability Inspection Method.

situations that are unitary in nature, i.e. with insignificant disagreements and conflicts between stakeholders of the software development project. In this case, Class-3 problem situation, being highly pluralist (or inter-subjective), poses insurmountable difficulties for an UEM application, as a UEM offers insufficient guidelines to cope with inter-subjectivity. Class-4 problem situation is also unfavorable for a UEM application due to the presence of systemic complexity, including soft complexity, in such a problem-situation. One has to bear in mind that the usability professionals tend to focus usability issues more at the individual rather than organizational level (Hertzum and Clemmensen (2012) while an organization-wide perspective is warranted in this situation. It is especially challenging for UEM application if problem-situation of Class-4 is embroiled in major disagreements between its stakeholders. In short, Avison and Taylor (1997)'s work on types of problem situation for Information Systems development methodology evaluation neatly reveals the methodological strengths and weaknesses of UEMs although their paper is a review on information systems development methodologies, not on UEMs per se. Such methodological issues of UEMs are examined further based on contemporary systems thinking in the next section.

## Theoretical issues on UEMs as considered with the contemporary systems thinking lenses

Working on the same intellectual theme of evaluating methodologies based on problem situation type in a much earlier time, Jackson and Keys (1984) propose a framework called a system of systems methodologies (SOSM) to evaluate the strengths and weaknesses of various systems methodologies, e.g., hard systems methodologies, soft systems methodologies, and critical systems methodologies, etc. In this framework, problem situations are classified based on two

dimensions, namely, the systems dimension (from mechanistic to systemic) and the participants dimension (from unitary to pluralist, then to coercive). Jackson and Keys then argue that hard systems methodologies are the suitable choice for application in a unitary problem situation; soft systems methodologies are the appropriate pick for employment in a pluralist problem situation. Finally, emancipatory systems methodologies are the right ones to be used in a coercive problem situation. The details of their argument are quite well known in the systems community, thus not repeated here. (Jackson and Keys are mainly concerned with evaluating the theoretical and methodological strengths of various strands of systems methodologies, rather than the development of a contingency framework on systems methodology employment.) Interested readers are referred to Jackson (1991) and Flood and Jackson (1991) for further explanation of this system of systems methodology (SOSM) framework. As to this paper, the writer offers a theoretical justification, based on Avison and Taylor (1997) and Jackson and Keys (1984), to claim that UEMs, as an engineering methodology (or a hard systems methodology expressed in the language of the systems community), work well in a unitary problem situation, but not in a pluralist, nor a coercive problem situation. It is what the SOSM framework reveals to us. This then is the major theoretical consideration that is not made clear in the present usability engineering literature. In addition, even in the unitary problem situation, if the usability professionals, who are involved in a usability engineering project, are not prepared to take up a more organizational (thus more systemic) perspective in their tailor-made version of UEM for the usability project worked on, their UEM employment would also encounter tremendous challenges in such usability engineering practice. The application difficulties arise from the specific theoretical worldview upheld by the engineering methodology (i.e. a hard systems methodology), and which is what an UEM is about. This

engineering (hard systems) worldview, in contrast with the soft systems worldview, has been described by Checkland (1984) in the following way:

> *"For the hard systems thinking worldview, reality is systemic; methodology is systematic and optimization is possible; in contrast, for soft systems thinking worldview, reality is problematical; methodology is systemic and learning is possible."*

The hard systems worldview as reviewed here clearly is adopted in Mayhew (1999)'s UEM, which states that "…the lifecycle as it is described in this book is oriented towards development projects that have already been defined, planned, and scope…" and whose discussion on UEM-related organizational issues projects a hard systems view on organization as a social entity set up so as "to seek to achieve goals" (Checkland and Holwell, 1998: Chapter 2). This indicates that such a methodology is intended to apply in a unitary problem situation with the hard systems worldview. Nevertheless, with its emphasis of participatory design and iterative process, UEMs also uphold the organismic and cultural metaphors (Flood and Jackson, 1991) as minor ones in the methodologies, thus being somewhat sensitive to the soft systems worldview.

It is quite appropriate for the usability professionals and academics to develop usability engineering methodologies to tackle usability concerns in new software product development. Just that UEM practitioners and participants need to grasp the underlying theoretical worldview of UEM, which enables them to comprehend better the methodological strengths and weaknesses of UEMs. Besides, they need to more explicitly declare and anchor their methodologies on a specific theoretical worldview as a perspective anchoring endeavor. This would contribute to the theoretical advancement of UEM. Usability engineering professionals are also encouraged to consider multiple theoretical worldviews and usability project roles (i.e.,

as a technical analyst, a facilitator, a radical analyst and an emancipatory analyst, see Bell and Wood-Harper (1998).), so as to conduct UE in a holistic, critical and creative way. This then amounts to recommending the theoretically enriched view on usability and usability engineering (TEVUAUE) based on contemporary systems thinking, especially with critical systems thinking and critical holism (Jackson, 1991; 2003) as well as the multi-perspective, systems-based view on organizations (Ho, 2015). Indeed, the subject of Human-computer interaction, and thus also usability engineering, is aware of the relevance of systems methodologies to usability engineering, but they are mainly considered as methods and techniques to use in specific usability tasks, e.g. as models of the user in design (Dix *et al*., 1998: Chapter 6) rather than as sources of intellectual inspiration at the theoretical level. A brief evaluation exercise on a case example from a journal article using this theoretically enriched view is taken up in the next section.

## A fresh look at problems encountered in usability engineering with a case study based on a journal article

An attempt is made to examine a case study on wearables, with special reference to Apple Watches, as reported in *The Economist* (2015) based on the theoretically enriched view on usability and usability engineering (TEVUAUE). The examination exercise is presented in Table 1 with twelve extracts at the left column and corresponding comments based on the TEVUAUE at the right column.

**Table 1: an examination of a case study on wearables based on the TEVUAUE**

| ***Extracts from The Economist (2015) on wearables, with special reference to Apple Watch*** | ***Comments based on the TEVUAUE*** |
|---|---|
| *Extract 1*: "Watches and other wearables can help people monitor their activity and encourage them to | This topic can be clarified in Mayhew's UEM Phase 1 of Requirement Analysis and Phase 2 of Design/Testing/Development. |

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| exercise." | |
| *Extract 2*: "Apple's watches provide "haptic feedback"….to give alerts to wearers…" | This topic can be clarified in Mayhew's UEM Phase 2 of Design/Testing/Development. |
| *Extract 3*: "Thanks largely to the smartphone boom, chips and sensors have become smaller and cheaper.." | This topic is addressed in Mayhew's UEM Phase 1 under the topic of Platform Capabilities and Constraints. |
| *Extract 4*: "… have a short battery life…" | This topic is addressed in Mayhew's UEM Phase 1 under the topic of Platform Capabilities and Constraints. |
| *Extract 5*: "Many consumers have little interest in another device that cannot serve as a substitute for what they already carry around…" | This topic is addressed in Mayhew's UEM Phase 1 under the topic of User Profile. |
| *Extract 6*: "Wearables have so far lacked the elegant design and ease of use that helped smartphones ring in such success…" | This topic is addressed in Mayhew's UEM Phase 2 of Design/Testing/Development. |
| *Extract 7*: "Having sold consumers smartphones, companies are now saying that glancing at notifications on your wrist is a more efficient use of time and more polite than using a a phone…" | These usability claims need to be verified with Mayhew's UEM Phase 1 on Requirement Analysis. Usability inspection on competitive products, in this case smartphones, is recommended in Nielson (1992)'s UEM Phase 2 of Competitive Analysis. |
| *Extract 8*: "..the biggest challenge facing wearables is the absence to date of a "killer app". .." | This problem cannot be tackled with a UEM which demands a clearly defined project objective and scope at the outset. The TEVUAUE turns to a critical systems thinking mode (Jackson, 2003) for theoretical inspiration to generate new product ideas that have potentially high usability. |
| *Extract 9*: "..It will… depend on getting developers to build apps that will make the most of wearables' possibilities…" | It is considered as belonging to the organizational issues in Mayhew's UEM, as addressed in Mayhew (1999: Part IV: 401-514). This kind of organizational issues cannot be fully covered in a UEM, thus requiring the TEVUAUE to function as a robust theoretical platform to draw in other concepts from other social science disciplines, such as business management. |
| *Extract 10*: "Some analysts think wearables' killer feature may eventually be that they will provide their users with a "persistent" digital identity, | These usability claims need to be verified with Mayhew's UEM Phase 1 on Requirement Analysis. Due to the broad and blur scope involved in this product notion, |

| | |
|---|---|
| melding the functions of a driving licence, credit card, house key…." | the TEVUAUE should be explicitly taken up to inform the UEM application to foster creative holism thinking. |
| *Extract 11*: "For companies the cost of kitting out their staff with smartwear is less of a problem than building the computer systems needed to support such devices and process their data.." | This is a problem mainly with the Systems Development Life Cycle (SDLC), though a UEM provides useful ideas to inform the SDLC so as to produce a usable new product. All conventional UEMs are designed to work in an integrated way with contemporary software engineering methodologies. |
| *Extract 12*: "As consumers quantify more of their lives and store more of their health and medical data electronically, the chance that they could be compromised rises…" | The consideration of information systems security can be incorporated into a Systems Development-cum-UEM Life Cycle. The conventional UEM is quite capable to inform this task on information systems security. |

Even in those situations that are explicitly addressed by the UEM and the SDLC, soft and political issues can pop up in various UEM-cum-Systems Development Life Cycle phases that require the TEVUAUE's guidance, primarily due to the reason that UEM and SDLC, including contemporary software engineering methodologies, are not good at dealing with soft complexity that are often found in new software design and development projects. These are the Class 3 and 4 situations identified by Avison and Taylor (1997).

## Some thought on the TEVUAUE notion and its attributes

Albeit the theoretical justification to adopt the TEVUAUE[8] to inform the employment of UEM based on contemporary systems thinking, the TEVUAUE notion is a vaguely conceived one at this early stage of conceptual development. On it, the writer offers the following four TEVUAUE notion attributes:

[8] The argument to take up a multi-perspective, systems-based perspective, based on critical systems thinking, in reviewing management notions and disciplines is provided in Ho (2013). In this case, a TEVUAUE is a multi-perspective, systems-based notion on usability.

*Notion attribute 1*: The TEVUAUE endorses the creative holism view (Jackson, 2003) of usability.
*Notion attribute* 2: The TEVUAUE encourages usability engineering methodologies to be compatible with critical systems methodologies (Jackson, 2003), and multi-perspective, systems-based thinking (Ho, 2013).
*Notion attribute 3*: The TEVUAUE endorses the multi-perspective, systems-based notion of relationship-managing organization (RMO) (Ho, 2015).
*Notion attribute 4*: The TEVUAUE encourages usability practitioners to be flexible enough to consider a broad range of analyst/ designer roles, i.e., as a technical analyst, a facilitator, a radical analyst and an emancipatory analyst (Bell and Wood-Harper, 1998).

These four notion attributes of TEVUAUE are related at the theoretical, methodological and application levels in the multi-perspective, systems-based thinking (Ho, 1997). With the TEVUAUE, the prevailing usability notion is considered as a mainly hard systems version of usability. This means that there could be and should be other versions of usability, namely, a soft systems version, an emancipatory systems version and a post-modern systems version. All in all, the four notion attributes need to be further developed and illustrated via empirical research and usability field practices in the future. Moreover, the implications of its adoption on the professional development strategies and the professional image of usability professionals need to be examined. Admittedly, they are intellectually daunting tasks.

## Concluding remarks

The subject of usability and usability engineering is an important one in the fields of computer science and business studies. There is a substantial literature on usability in the usability field. Nevertheless, the theoretical and methodological

strengths and weaknesses of the nature of "engineering" underlying the usability and the usability engineering notions need to be clarified to enhance its theoretical development and professional practice. The writer draws on the experience from the systems thinking field on this topic of evaluation of various strands of systems thinking to inform such a review on usability and usability engineering here. It is argued that the TEVUAUE is theoretically defensible as well as holds much academic and practical value. Such an enriched view amounts to a multi-perspective, systems-based notion on usability and usability engineering. While ideas of this kind are not new in the systems thinking movement and indeed in the field of information systems development and management (e.g., Ellis *et al*., 1995; Ho and Sculli, 1994; Sculli and Ho, 2001), it is quite novel in the usability field. The position of the writer is, much more effort to develop the notion of the TEVUAUE is worth doing as it has significant academic, pedagogical and practical values to the usability field. After all, as Woodside *et al.* (2015) make clear on the topic of designing winning products: "Quality of thinking and actions by strategies affect the effectiveness (e.g. product performance quality; customer satisfaction) and efficiency of an enterprise (e.g. profits and share price)..". This advice captures tersely what and why usability engineers are employed to achieve together with the new product development team in organizations, especially profit-making enterprises. Finally, it is hoped that the theoretical review of usability and usability engineering proposed here is able to provide intellectual stimulation to computer science students at both undergraduate and post-graduate levels doing final-year dissertation projects on the usability topic.

## BIBLIOGRAPHY:

Avison, D.E. and G. Fitzgerald. 2003. *Information Systems Development: Methodologies, Techniques, and Tools*. McGraw-Hill Publishing Company. London.

Avison, D.E. and V. Taylor. 1997. "Information systems development methodologies: a classification according to problem situation" *Journal of Information Technology* 12: 73-81.

Bell, S. and T. Wood-Harper. 1998. *Rapid Information Systems Development: a non-specialist's guide to analysis and design in an imperfect world 2/e*. The McGraw-Hill Companies. London.

Bevan, N. 2001. "International standards for HCI and usability" *International Journal of Human-Computer Studies* 55: 533-552.

Checkland, P.B. 1984. "Appendix to Chapter 4: The Changing Process of Systems Analysis: An Outline Systems Analysis" in Tomlinson, R. and I. Kiss (*editors*) *Rethinking the process of Operational Research & Systems Analysis*. Pergamon press.

Checkland, P.B. and S. Holwell. 1998. *Information, Systems and Information Systems: making sense of the field*. Wiley. Chichester.

Dennis, A., B.H. Wixom and D. Tegarden. 2005. *Systems Analysis and Design with UML Version 2.0: An Object-Oriented Approach*. Wiley. Chichester.

Dix, A., J. Finlay, A. Gregory and R. Beale. 1998. *Human-computer interaction*. Prentice Hall Europe. London.

Ellis, K., A. Gregory, B.R. Mears-Young and G. Ragsdell. (*editors*) 1995. *Critical Issues in Systems Theory and Practice*. Plenum Press. London.

Flood, R.L. and M.C. Jackson. 1991. *Creative Problem Solving: Total Systems Intervention*. Wiley. Chichester.

Hackos, J.T. and J.C. Redish. 1998. *User and Task Analysis for Interface Design*. Wiley. Chichester.

Hertzum, M. and T. Clemmensen. 2012. "How do usability professionals construe usability?" *International Journal of Human-Computer Studies* 70. Elsevier: 26-42.

Ho, J.K.K. 1997. "MPSB Frameworks and Decision Support Systems studies" *Systems Research and Behavioral Science* 14 (4). Wiley. Chichester: 287-293

Ho, J.K.K. 2013. "An endeavor to render an impressionistic image of Enlightening Management Education in Multi-perspective, Systems-based Research" *European Academic Research* 1(6), September: 1013-1034.

Ho, J.K.K. 2015. "A Multi-perspective, systems-based (MPSB) knowledge compilation exercise on the notion of relationship-managing organization (RMO)" *European Academic Research* 2(10), January: 13113-13127.

Ho, J.K.K. and D. Sculli. 1994. "A Multiperspective Systems-Based Framework for Decision Support Systems Design" *Systems Practice* 7(5): 551-563.

Interaction, a specialist group of BCS, The Chartered Institute for IT (url address: http://www.bcs.org/category/14296) [visited at March 18, 2015].

Jackson, M.C. 1991. *Systems Methodology for the Management Sciences*. Plenum Press. London.

Jackson, M.C. 2003. *Systems Thinking: Creative Holism for Managers*. Wiley. Chichester.

Jackson, M.C. and P. Keys. 1984. "Towards a system of systems methodologies" *The Journal of the Operational Research Society* 35(6), June: 473-486.

Karahoa, A., E. Bayraktar, E. Tatoglu, and D. Karahoca. 2010. "Information system design for a hospital emergency department: A usability analysis of software prototypes" *Journal of Biomedical Informatics* 43. Elsevier: 224-232.

Kjeldskov, J. and J. Stage. 2004. "New techniques for usability evaluation of mobile systems" *International Journal of Human-Computer Studies* 60. Elsevier: 599-620.

Kontogiannis, T. and D. Embrey. 1997. "A user-centred design approach for introducing computer-based process information systems" *Applied Ergonomics* 28(2). Elsevier: 109-119.

Lai, C.C. and C.F. Wu. 2014. "Display and device size effects on the usability of mini-notebooks (netbooks)/ ultraportables as small form-factor Mobile PCs" *Applied Ergonomics* 45. Elsevier: 1106-1115.

Mandel, T. 1997. *The elements of user interface design*. Wiley computer publishing. New York.

Mayhew, D.J. 1999. *The Usability Engineering Lifecycle: a practitioner's handbook for user interface design*. Morgan Kaufmann Publishers, Inc. San Francisco, California.

Nielson, J. 1992. "The Usability Engineering Life Cycle" *Computer*, March. IEEE: 12-22.

Nielson, J. and R. Mack. 1994. *Usability Inspection Method*. Wiley. Chichester.

Othman, M.K., H, Petrie and C. Power. 2013. "Measuring the usability of a smartphone delivered museum guide" *Procedia – social and Behavioral Science* 97. Elsevier: 629-637.

Sculli, D. and J.K.K. Ho. 2001. "Office automation issues viewed from a multi-perspective systems-based framework" *Human Systems Management* 20. IOS Press: 95-103.

The User Experience Professional Association (url address: https://uxpa.org/about-us) [visited at March 18, 2015].

The Economist. 2015. "Wearable technology: The wear, why and how" *The Economist,* March 14: 55-57.

Usability.gov. 2015. "User Experience Basics" Usabillity.gov. (url address: http://www.usability.gov/what-and-why/user-experience.html) [visited at March 21, 2015].

Usabilitynet.org. 2015a. "What is usability?" Usabilitynet.org. (url address: http://www.usabilitynet.org/management/b_what.htm) [visited at March 22, 2015].

Usabilitynet.org. 2015b. "Global Organisations" Usabilitynet.org. (url address: http://www.usabilitynet.org/professional/global.htm) [visited at March 22, 2015].

Usabilitynet.org. 2015c. "Tools and Methods: Contents" Usabilitynet.org. (url address: http://www.usabilitynet.org/tools.htm) [visited at March 22, 2015].

Woodside, A.G., T. Liukko and A. Lehtonen. 2015. "Concluding observations on designing winning products" in *Designing winning products*. Published online March 9, 2015. Emerald Insight (url address: http://www.emeraldinsight.com/doi/abs/10.1016/S1069-0964%2800%2910087-0) [visited at March 22, 2015].