CAN EXISTING USABILITY TECHNIQUES PREVENT TOMORROW'S USABILITY PROBLEMS?

Christelle Harkema, Ilse Luyk-de Visser, Kees Dorst, Aarnout Brombacher
Eindhoven University of Technology - Department of Industrial Design

ABSTRACT
Product usability is a product quality that ensures efficient and effective products which satisfy users. In spite of the many usability techniques that are available many users still experience usability problems when using electronic products. In this paper we present two studies that explore the (mis)match between the types of uncertainty addressed by existing usability techniques and the types of uncertainty in the product development process that can eventually result in usability problems. To explore this (mis)match, two studies are presented. The first study is to discover which usability techniques are used in practice to retrieve usability information to address the different types of uncertainty. The second study is a case study in product development practice which explores the types of uncertainty that causes the usability problems of a specific product. The overall contribution of this paper is that it offers greater insight into how usability techniques (do not) address uncertainty in the product development process.

Keywords: Usability, Usability Techniques, Usability Problems, Decision-Making, Uncertainty, Awareness.

1 INTRODUCTION
Product development has changed rapidly over the last few decades. One of these changes is that consumer electronic products have become exponentially more complex [1], not only because of the increasing number of features but also because of the increasing product adaptability [2]. When developing innovative products many new and unknown aspects come into play, resulting in a significant lack of (usability) information. This lacking information is defined as uncertainty [3]. An important and obvious solution for reducing usability uncertainty in the product development process (PDP) is retrieving the relevant and required usability information [4], which also improves the quality of the decision [5] and thus prevents usability problems. Many good and useful usability techniques are available at the various phases of the PDP to retrieve usability information [6], [7], [8]. However, despite the many available usability techniques users still experience usability problems when using electronic products [9], [10], [11].

One possible explanation for this situation is that these usability techniques are not adequate to address the different types of uncertainty in the PDP. To explore this idea the following research question is defined: *"Is there a (mis)match between the types of uncertainty that existing usability techniques address and the types of uncertainty that can result in usability problems?"*.

Uncertainty is conceptualized in various ways [4], [12], [13]. For the purpose of this paper we distinguished from literature two types of uncertainty; 'unaware' and 'aware'. Unaware uncertainty is when the product developer has not perceived or foreseen the effects of a decision on usability. 'Aware' uncertainty is where the usability variables and values on which to base a decision are known [14], [15], [16].

These two types of uncertainty can be further specified as to the degree of uncertainty. For example the uncertainty is *high* when risk cannot be defined because of unknown usability variables [12]. A *medium* degree of uncertainty is when probability distribution is unknown [17] - in other words, the value of the usability variable is unknown. The degree of uncertainty is *low* when the usability variables and values are known and only the interaction between them is unknown [12], [13],[18]. The types and degree of uncertainty are illustrated in Figure 1 the degree of uncertainty is structured to an ordinal scale.

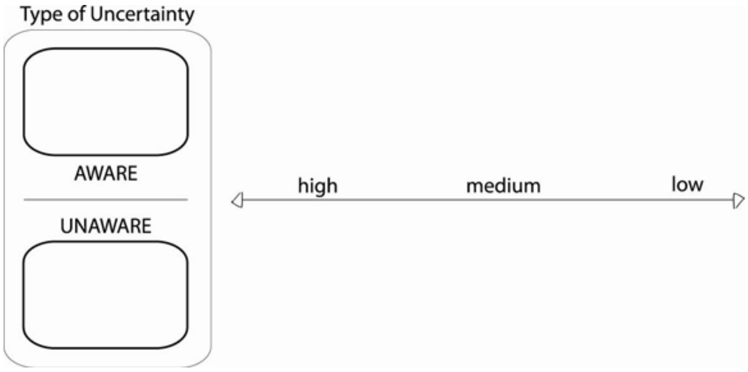

Figure 1: Types of Uncertainty

Exploring the (mis)match between the type of uncertainty that existing usability techniques address and the type of uncertainty that can result in usability problems is important to clarify the issue of why usability problems still occur. A better understanding of how usability techniques (do not) address uncertainty in the PDP will make it possible to define future research directions into addressing uncertainty to improve usability decision-making. The present research is part of a larger usability research project on which various researchers work.

To explore the (mis)match two studies are presented in the following structure. The first study is to discover which usability techniques are used in practice to retrieve usability information to address the different types of uncertainty. The second study describes a case study in product development practice which explores which types of uncertainty caused the usability problems of a specific product. Following this, the results of both studies are discussed to describe the (mis)match. Lastly, the paper presents conclusions and suggestions for future research.

2 STUDY 1 - CATEGORISING USABILITY TECHNIQUES

This section describes how usability techniques are categorised to the different types of uncertainty; in order to define which usability techniques are used in practice to address the different types of usability uncertainty. To be able to categorise the usability techniques to the different types of uncertainty, a clear list of usability techniques is created. Subsequently an intermediate step is required, namely mapping the usability techniques on a framework. This is done, because categorising the usability techniques directly to the types of uncertainty causes difficulties. Via this framework the usability techniques are categorised to the uncertainty types. This categorisation procedure is first verified in a pilot study with 5 usability professionals, followed by a much larger study with 25 professionals. All the professionals are working in the field of product development and are familiar with the application of usability techniques during their daily work to gain usability information to support their decision making processes.

2.1 Procedure of mapping usability techniques to framework

The list of available usability methods and techniques from literature, e.g. [7], [8] and internet [19] is enormous and of a wide variety. To create a consistent list of usability techniques we first distinguished the usability methods from the usability techniques. Methods structure the design process, they describe on an abstract level how to organise this process. On the other hand usability techniques are a description of how to execute specific tasks, more like a recipe [20]. Usability techniques can be used to collect required information to support the developer in making proper usability decisions. Unfortunately the terms ‘methods’ and ‘techniques’ are often used interchangeably. So in this paper, we distinguish the techniques from the methods by judging their level of application; when it can be used directly by the developer to obtain usability information it is labelled as a technique. Secondly, the list of usability techniques was filtered on similar techniques with different names. For example the technique ‘guideline evaluation’ and ‘heuristics’ are essentially the same but are named differently and in this study ‘heuristics’ will be used. The same applies for

other similar techniques. These two actions resulted in a clear list of 46 commonly used usability techniques[1].
An attempt to categorise the usability techniques from this list to the different types of uncertainty (Figure 1) immediately posed difficulties. Several techniques could be used in different phases and with different purposes resulting in different usability information. To prevent this ambiguity of the interpretation of a technique, a framework (Figure 2) is used to interpret the usability techniques in a unique way. Mapping usability techniques on the framework by the professional is an intermediate step before categorising the usability techniques to the different types of uncertainty. The usability techniques are mapped on the framework according to their goal and their application phase in the design process as used by the professional during the project. The framework is not meant to create a consistent categorisation of all usability techniques. Mapping the technique to its specific goal is done because the same technique can be used to obtain different types of information, depending on the goal of the developer. For example, the technique 'user observation' can be used to obtain information about: who the user is, how he is using the product, how he is experiencing the product, etc..

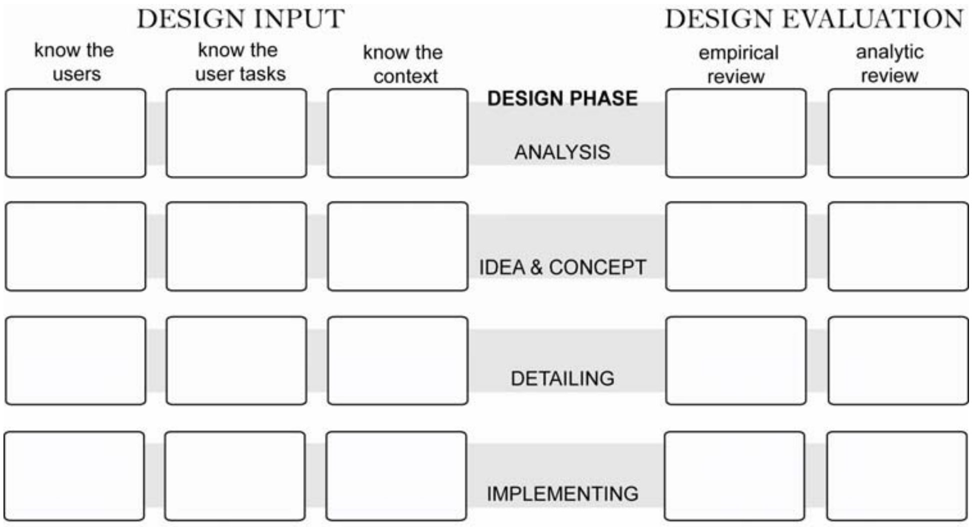

Figure 2: Framework for usability techniques in product development

A technique may therefore have several goals, addressing different types or degrees of uncertainty. The goals can be first distinguished between design input goals (acquiring information for design) and design evaluation goals (getting feedback on the product design). Design input can be subdivided into three items (left three columns in Figure 2): user characteristics, user tasks and context of use [21]. Design evaluation can be subdivided into two items (right two columns in): empirical review (user feedback) and analytic review (expert feedback) (right two columns in Figure 2).
The second mapping action is to organise the techniques according to their phase of application in the design. A focus group at the beginning of the design process will provide other information than a focus group at the end of the design process. Therefore, the organisation of techniques according to the phase of application is necessary. Based on a commonly accepted description, the design process can be roughly divided into the following four phases (four rows in Figure 2): analysis, idea and concept, detailing and implementing [22]. In the analysis phase, the problem is analyses and the requirements are set. The idea and concept phase generates product solutions. In the detailing phase all the product details are specified and in the implementation phase the products are prepared for production. This framework is intended to create an unambiguous starting point to categorise the in practice used usability techniques to the types of uncertainty.

[1] This list of 46 usability techniques is available via the first author.

2.2 Procedure of categorising usability techniques

This section describes how usability techniques are categorised to the types of uncertainty. Within the procedure the 'closed card sorting' technique is used [23]. By the application of this technique the usability techniques are categorised via the framework to the types of uncertainty through four actions. These actions are performed by each usability professional:

1) Select the known usability techniques from the 46 cards
2) Select from the known techniques those usability techniques that are often used by them
3) Map the usability techniques on the framework
4) Categorise the mapped techniques to the types of uncertainty

The usability professionals are selected based on their industrial work experience in the field of product development and their involvement in applying usability techniques in the product development process. Each professional has to perform the four mentioned actions which will be briefly explained. The first action is to select the usability techniques known by the professional from the 46 given cards. This is done to exclude those techniques unknown to the professional, to prevent personal interpretation of the techniques. Action two is done to select the usability techniques that are actually used by the professional in the field of product development. The professional was allowed to select a maximum of 10 cards for time management reasons and to limit the cognitive load during the study. The third action is mapping the selected cards on the framework (Figure 2). Each technique can be categorised more than once, because a technique can be used for various purposes (goals) and in various phases. If the professional wanted to map the usability technique to various categories, more (numbered) cards of the same techniques were provided. Mapping the usability techniques on the framework made clear how the professional interprets the usability technique. The last action professionals have to take is to categorise the usability techniques from the framework to the types of uncertainty. Next to the types overview there is a section 'not applicable' in case the professional is not able to categorise the technique to the types of uncertainty.

The last two steps are illustrated by an example. The card with the usability technique 'interview' is placed in the category 'analysis' and 'know the user'. This technique is also placed in the category 'implementing' and 'empirical review'. The framework category is remembered when mapping the cards on the uncertainty scale. The first card 'interview' is assigned to 'high uncertainty'. The second card, based on its framework category is assigned to 'low uncertainty'. The reference to the framework category when mapping the card on the uncertainty scale is essential in the last step.

2.3 Pilot study

To verify whether the described procedure for categorising usability techniques is a suitable way of categorising, an initial pilot study is performed. Within this pilot study it is also verified whether the proposed framework (Figure 2) is indeed an unambiguous starting point to categorise the usability techniques to the types of uncertainty.

The five professionals (all trained in usability engineering) are currently working or have worked in a product development team, have had 3 to 20 years of industrial work experience and were familiar with using usability techniques within the product development process. All professionals were able to map all selected usability techniques in the framework and to categorise them to uncertainty types. No usability techniques were placed in the section 'not applicable'.

This pilot study shows that usability professionals are able to categorise the usability techniques to the types of uncertainty by defining the usability techniques in an unambiguous way via the framework using the four step procedure. No discussions or questions arose during the last step, so goal and phase were sufficient indicators to interpret the techniques in a unique way.

2.4 Study 1 – Results and Conclusions

The pilot study showed that the four step procedure for categorising usability techniques to the types of uncertainty via the framework is an unambiguous way of categorising. The four step procedure is also used for a larger group of professionals with the purpose of relating the usability techniques to the types of uncertainty during decision-making in the development process. So, in this study, it is not the issue how the usability techniques could or should be used, but how the usability techniques are used in product development practice.

This larger study involved 25 professionals from the product development field, all of them trained in usability engineering. The professionals were familiar with using usability techniques within their current function as product designer, graphic designer, interaction designer or usability engineer. In step two every professional selected about 10 cards with usability techniques which they used within recent projects. These selected techniques were categorised in the framework in step three. Finally, the techniques were categorised to the types of uncertainty.
Which specific usability techniques were selected is outside the scope of this paper. Therefore the results of this categorisation process to the types of uncertainty are visualised by the percentage of selected usability techniques to the type and degree of uncertainty.

The results provided by all 25 professionals who categorised their usability techniques to the type and degree of uncertainty are presented in Figure 3. This figure shows the percentage of cards which were distributed between the types and degree of uncertainty. Unaware cannot be specified to the degree of uncertainty as they are unaware of it.

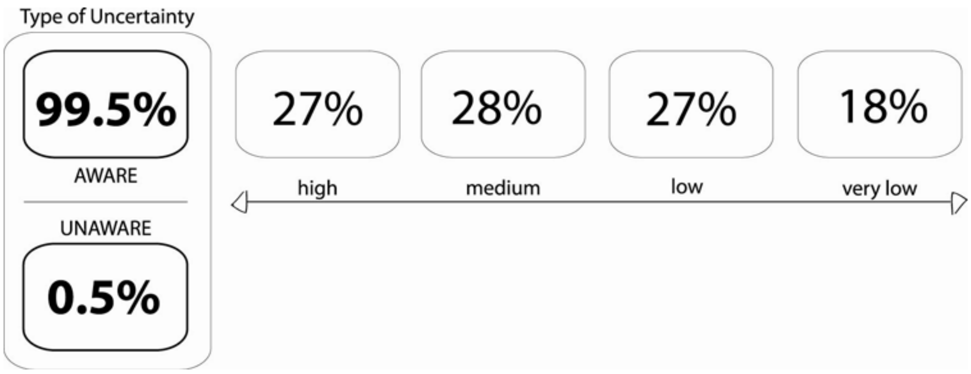

Figure 3: Usability techniques categorised to types and degree of uncertainty

Each professional could map the selected techniques more than once in the framework. Therefore the total number of cards mapped on the framework is 683. Of these 683 cards, 557 cards are categorised to 'aware' and only four cards are categorised to 'unaware'. The 557 selected cards with usability techniques are almost equally divided between the degrees of uncertainty. 181 (27%) usability techniques address high uncertainty, 191 (28%) address medium uncertainty and 185 (27%) address low uncertainty. The professionals also put cards next to low uncertainty in case they used usability techniques to verify the design, to confirm that the made decisions are correct. So, 122 (18%) cards are related to a very low degree of uncertainty.
It can be concluded from the exploration in study 1 that, the in practice used usability techniques mainly address the type of uncertainty; 'aware'. The used techniques evenly address the different degrees of uncertainty. The type of uncertainty 'unaware' is not addressed with the used usability techniques.

3 STUDY 2 - CATEGORISING USABILITY PROBLEMS

This third section presents a case study which is done to categorise specific usability problems to types of uncertainty. This case study explores how usability problems result from uncertainty during decision-making in the PDP, in order to categorise the usability problems to the different types of uncertainty. Within this elaborate case study the situations of decision-making that resulted in usability problems are traced back by retrospective interviews. These interviews are performed within a single project team (14 team members) in a company that is considered best in class for consumer electronic product development. Moreover, this company aims for products with good usability as mentioned in their mission statement.

3.1 Procedure for categorising usability problems

This section describes the various aspects of the methodology for categorising the usability problems to the different types of uncertainty. First, a case study at a company is selected. Second, a list of usability problems of the selected product is composed. Third, the retrospective interviewing technique which is described. Fourth, the results from the case study are processed and analysed and finally these results are categorised to the different types of uncertainty. All five aspects will be explained in the following sub-sections.

1) Selecting company and product

The empirical inquiry concerns one consumer electronic product with usability problems. The product for the case study is selected according to the following criteria:

- To fit within the focus of the overall research, the product should be a consumer electronic product.
- The product must be an innovative product, to assure that uncertainty is present during decision-making.
- The company involved should aim for usable products and apply usability techniques.
- The product should suffer from usability problems; otherwise the relation between uncertainty en usability problems cannot be explored.

2) Composing a list of usability problems

When a case study with the selected product is approved by the company, a list of usability problems is generated. This list is based on internet statements by users, use tests and call centre feedback. Internet statements on forums are used for a first indication of the existing usability problems. The use tests are performed for a better understanding of the usability problems. The call centre feedback is used for quantitative support. The selection procedure based on these three sources results in a non-biased list of usability problems.

3) Interviewing

Within the approach of empirical inquiry the technique of retrospective interview is used to retrieve information about lacking information during decision-making in the PDP. The retrospective interviews are deployed to retrieve information about the finalised project in hindsight. The interviews are semi-structured to ensure the possibility for the interviewee to recall information, to immediately elaborate on the topic and to give the interviewer structure during the interview. The following aspects are addressed during the interview: the role of the team member (the interviewee) within the project, the development process of the product according to the team member, the description of the usability problem, the cause(s) of each usability problem, the decision that led to the cause, and the ground on which the decision was made. The usability problems are described and presented to the interviewee on cards. So each time the usability problem is explained in the same way. Each interview is recorded and processed into transcripts for further analysis.

4) Processing and analysing the interviews

Subsequently, to categorise the results of the interviews into a categorisation of usability problems to the types of uncertainty several steps need to be taken. Per interviewee each interview is processed into a transcript. The transcript is coded by the aspects usability problems, causes, decisions, and ground on which the decision is taken. The results from the coding are presented per team member in a block-diagram. The blocks represent the usability problem, its cause, the underlying decision, and its ground on which the decision is taken, all according to the interviewee. These block-diagrams with the

results per interviewee are transformed to block-diagrams per usability problem. In these block-diagrams the results still can be traced back to the interviewee.
The last step before a categorisation can be made a small interpretation based on the retrieved data is necessary. In the specific usability problem block-diagram two blocks are added by the interviewer. The block ‘lacking’ describes which information was lacking in the decision process in hindsight. The block ‘awareness’ indicates, whether the decision-makers were aware of the lacking information. These final block-diagrams are verified with two involved company team members.
An example of an empty block-diagram per usability problem is presented in Figure 4. The problem is presented in a rounded corner rectangle, the cause in a rectangle, the decision is presented in a hexagon, the ground and lacking in rectangles and the awareness is presented in a circle. The number in the blocks refer to the interviewees, bold numbers indicate which interviewee made the mentioned statement.

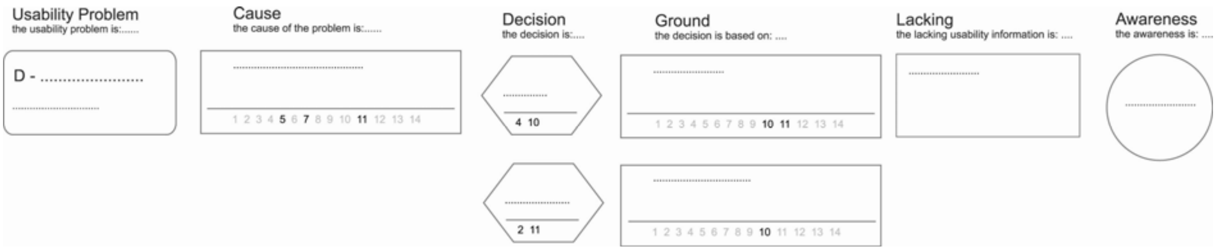

Figure 4: Example block-diagram per usability problem

5) Categorising usability problems to uncertainty types

The last two blocks of the block-diagram are needed to define the type of uncertainty in order to relate the usability problems to these types. The block ‘lacking’ defines the degree of uncertainty while the block ‘awareness’ indicates whether the decision makers were aware of this lacking information at the moment of decision-making.

3.2 Study 2 – Results and Conclusions

The selected case involves a consumer electronics product from a world leading company, first introduced on the global market in 2008. This product was selected for its newness to the market, since at the time of the case study was conducted, the product had been commercially available worldwide for only 18 months. The company which developed the product aims to develop usable products, yet in spite of this aim, users still experience usability problems with the product.
The list of usability problems is based on:

- Internet statements (84 negative, out of a total of 255 collected statements)
- Results of two different use tests
- Call centre feedback

Within the case study, 14 usability problems were analysed using information gathered in 14 interviews of about 90 minutes each. These were conducted with core team members of the product development team, including a product architect, product designer, product leader, and usability engineer. The interviews resulted in 14 transcripts and a block-diagram per usability problem. Some examples of descriptions of usability problems included: “the user does not know which button is for which functionality” and “it is difficult for the user to confirm the settings”.
The interview data was interpreted and verified, following which a list was created, detailing all 14 usability problems and whether the developers were aware of the lacking information at the moment of decision-making. The data from the interviews shows how usability problems result from uncertainty during decision-making in the PDP.

Some usability problems and the situations in which the developers made decisions are described to illustrate how usability problems resulted from different types of uncertainty. The first example illustrates a problem that resulted from the uncertainty type ‘aware’. The user does not have enough time to establish settings because the interface automatically returns to the main menu after a few seconds of no input. At the moment of decision-making the developers were aware of this usability problem. They also realised the opposite usability problem, that users would have to wait too long before returning to the main menu. The decision was made between the alternatives of adding a return button or automatic return. So in this situation the decision-makers made a conscious choice between the alternatives knowing the usability consequences.

The second example demonstrates a usability problem resulting from the uncertainty type ‘unaware’. The usability problem was discovered after market introduction. The users were calling because they were not sure if the volume was turned off as the volume level was indicated from 0 to 3. This usability problem was not foreseen; developers were not aware of it at the moment of decision-making. Fortunately the problem could easily be solved with a running change: changing ‘0’ into ‘OFF’.

A third example illustrates another usability problem resulting from the uncertainty type ‘unaware’. When performing a verification test on the first complete prototype it was discovered that users were not sure which button was linked to which functionality. The cause for this problem was that the display and buttons were on different sides of the product. At the moment of decision-making developers did not realise that this would be a problem for the user as many other products have the same positioning of buttons and display. By the time they realised this would be a problem, it was not possible to make the necessary changes to solve it. In this example the usability test was initiated by a very low degree of ‘aware’ uncertainty which led developers to verify the design and ultimately discover the unforeseen usability problems.

The results of this case study are that seven of the 14 usability problems can be categorised according to the uncertainty type ‘unaware’ and the other seven according to the type ‘aware’. The seven usability problems that are categorised as ‘unaware’ can be traced back to situations in which the decision-maker was not aware of the lacking information and the potential consequences for product usability. Most of the usability problems resulting from ‘unaware’ were discovered before market introduction, but the project progress limited the possibilities of changing the design to eliminate the usability problem.

The seven usability problems that are categorised as ‘aware’ can be traced back to situations in which the decision-makers were perfectly conscious of the possible usability consequences of the specific decision – a conscious decision. In these situations compromises were made to the disadvantage of usability, either because other aspects were considered more important or because they felt that alternative solutions would be even worse for usability.

It can be concluded that usability techniques are used to discover unforeseen usability problems but that they are not initially used to address ‘unaware’ uncertainty.

4 DISCUSSION AND CONCLUSIONS

To answer the research question of this paper we compared the outcomes of Studies 1 and 2 to explore whether there was a match or mismatch between the type of uncertainty that existing usability techniques address and the type of uncertainty that can result in usability problems. Although Studies 1 and 2 were partly conducted with different professionals some of the results can be compared. The results from Study 1 show that the usability techniques mostly address the type ‘aware’. The results from Study 2 show that the type of uncertainty that can result in usability problems is both ‘aware’ and ‘unaware’.

At first glance could be concluded that there is a mismatch for both types of uncertainty as usability problems evenly result from these types. However, a closer look at the usability problems of the type ‘aware’ shows that these problems resulted from conscious choice. In some situations, the decision maker was perfectly aware of the possible consequences but considered these less serious than the consequences of other solutions. In other situations the decision-maker was aware of the possible consequences but considered other aspects more important. These results suggest that usability techniques addressing the type 'aware' are adequate as there are no unexpected usability problems resulting from this type of uncertainty. This suggests that there are no new usability techniques necessary that address 'aware' uncertainty. However, since the usability techniques mentioned in Study 1 were not necessarily the usability techniques that were used in the project described in Study 2, further analysis of the project in Study 2 is therefore required before a final conclusion can be made. For the type 'unaware' a mismatch could be the case. There are hardly any usability techniques addressing this uncertainty type even though usability problems do result from 'unaware'. The results of Study 2 clearly show that usability problems result from situations in which the decision maker is unaware of the lack of information. However, the results of Study 1 are less clear. Almost no usability techniques are categorised to address the type 'unaware' but what is the reason for this? Are there no usability techniques that address 'unaware'? Or has the decision-maker no knowledge about this type of uncertainty and therefore is unable to use any technique to address this type of uncertainty? The described usability problems and decision-making situations in 3.2 suggest that usability techniques are adequate in discovering unforeseen usability problems but that they are initially not intended to address 'unaware' uncertainty.

This possible mismatch indicates an interesting direction for further research – namely, how can usability unawareness in the decision-making process be addressed to ensure that decision-makers become aware (on time) within the PDP.

With these results the question in the title is partly answered. Although product developers of tomorrow's innovative products will encounter unawareness [24] the existing usability techniques can probably not prevent tomorrow's usability problems, since there are no usability techniques used by professionals that address 'unawareness'.

The uncertainty type 'unaware' needs a further exploration to whether various types of unawareness exist in development processes. Probably a different approach is needed to address 'unaware' than that of applying usability techniques to retrieve usability information. Creating awareness in uncertain situations is not done simply by applying one of the existing usability techniques. Inspiration for solutions can probably be found within a broader academic perspective and within other research areas, for example, creating awareness by learning [24], [25] or coping with uncertainty [4], [26], [27]. The focus of future research will therefore be on how to support the product developer in usability decision-making, in situations in which he is unaware.

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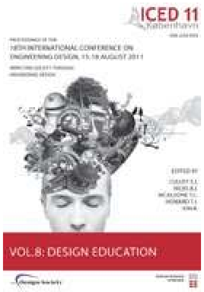

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event: ICED11: 18th International Conference on Engineering Design

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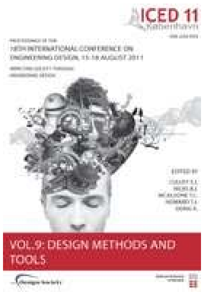
DS 68-9: Proceedings of the 18th International Conference on Engineering Design (ICED 11), Impacting Society through Engineering Design, Vol. 9: Design Methods and Tools pt. 1, Lyngby/Copenhagen, Denmark, 15.-19.08.2011



Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J.; Dong, A. (eds.) • 2011

ISBN 978-1-904670-29-2
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DS 68-10: Proceedings of the 18th International Conference on Engineering Design (ICED 11), Impacting Society through Engineering Design, Vol. 10: Design Methods and Tools pt. 2, Lyngby/Copenhagen, Denmark, 15.-19.08.2011

Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J.; Dong, A. (eds.) • 2011

ISBN 978-1-904670-30-8
The ICED series of conferences is the Design Society's "flagship" event. ICED11 took place on August 15-18, 2011, at the campus of the Danish Technical University in Lyngby/Copenhagen, Denmark.
The Proceedings of the conference are published in 10 individual volumes, arranged according to topics.
Vol. 10 covers the second part of the area of Design Methods and Tools. Please note that there is a first part on the topic (Vol. 9).
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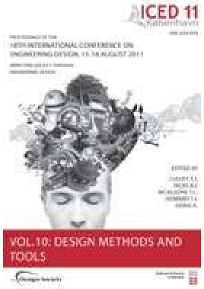

event: ICED11: 18th International Conference on Engineering Design

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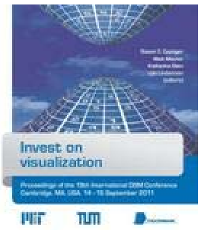
ICORD 11: Proceedings of the 3rd International Conference on Research into Design Engineering, Bangalore, India, 10.-12.01.2011

Chakrabarti, A. (ed.) • 2011

DSM 2011: Proceedings of the 13th International DSM Conference



Eppinger, S.D.; Maurer, M.; Eben, K.; Lindemann, U. (eds.) • 2011

ISBN 978-3-446-43037-2
Carl-Hanser-Verlag, Munich, 2011

The International Dependency and Structure (DSM) Conference is the annual forum to discuss, how complex systems can be managed by understanding, modeling and designing the dependencies in a complex system.

The DSM 2011 event took place on 14.-15.09.2011 at the Massachussetts Institute of Technology (MIT), Cambridge, MA, USA.

Since 2007, the series of DSM Conferences is an event endorsed by the Design Society and closely connected to the Design Society's Special Interest Group on Managing Structural Complexity.

event: DSM 2011 - The 13th International Conference on Dependency and Structure Modelling (DSM) Techniques

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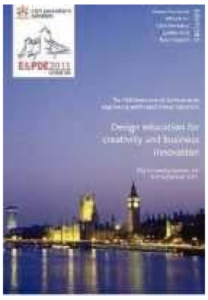
DS 69: Proceedings of E&PDE 2011, the 13th International Conference on Engineering and Product Design Education, London, UK, 08.-09.09.2011



Kovacevic, Ahmed, Ion, William, McMahon, Chris, Buck, Lyndon and Hogarth, Peter • 2011

Design Education for Creativity and Business Innovation: Proceedings of the Thirteenth international Engineering and Product Design Education Engineering and Product Design Education conference, held at City University, London, 8-9 September 2011

event: E&PDE 2011 Design Education for Creativity and Business Innovation

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DS 67: The Future of Design Methodology

Birkhofer, H. (ed.) • 2011

In this book, leading experts in design methodology, most of them active in the Design Society, reflect the great progress that has been made, but also identify the challenges of future development of the topic.

The reason that this book has been compiled was the retirement of Professor Herbert Birkhofer in 2011 after a long and distinguished career. Among other things, Prof. Birkhofer was the founding President of the Design Society and, since 2009, is a Honorary Fellow of the Society.

Some of the contributions in this book were presented in Prof. Birkhofer's "Farewell Colloquium" in Darmstadt, Germany, March 15th, 2011.

The book is published with Springer, London, 2011
ISBN 978-0-85729-614-6

download: The_Future_of_DM_contents_b.pdf [93.06 KB]

more info: www.springer.com/engineering/mechanical+eng/book/978-0-85729 ...

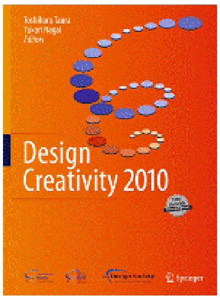
DS 66-1: Proceedings of the 1st International Conference on Design Creativity (ICDC 2010)

Toshiharu Taura and Yukari Nagai (eds.) • 2011

Proceedings of the First International Conference on Design Creativity, ICDC 2010, held in Kobe, Japan, 29.11.-01.12.2010.

Design Creativity 2010 comprises advanced research findings on design creativity and perspectives on future directions of design creativity research.

This part of the proceedings of the conference (DS 66-1, ISBN 978-0-85729-223-0) contains papers



presented with full oral presentations.

Please note that papers presented as posters with short oral presentations are listed on this website under publication no. DS 66-2 (ISBN 978-1-904670-20-9), with papers available for Design Society members.

download: ICDC_2010_contents_b.pdf [188.42 KB]

more info: www.springer.com/engineering/mechanical+eng/book/978-0-85729 ...

DS 60: Proceedings of DESIGN 2010, the 11th International Design Conference, Dubrovnik, Croatia

Marjanovic D., Storga M., Pavkovic N., Bojcetic N. (editors) • 2010

ISBN 978-953-7738-03-7 (whole)
ISBN 978-953-7738-04-4 (Volume 1)
ISBN 978-953-7738-05-1 (Volume 2)
ISBN 978-953-7738-06-8 (Volume 3)

download: D2010_TOC_and_INDEX.pdf [319.22 KB]

event: DESIGN 2010 - 11th International Design Conference

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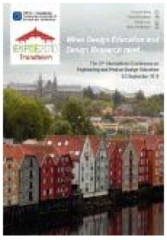
more info: www.designconference.org ...

DS 62: Proceedings of E&PDE 2010, the 12th International Conference on Engineering and Product Design Education - When Design Education and Design Research meet ..., Trondheim, Norway, 02.-03.09.2010



Boks, C.; McMahon, C.; Ion, William; Parkinson, B. • 2010

abstract: In the preparation of this year's conference, it was the programme committee's impression that in past E&PDE conferences, design research had remained relatively unexplored......

Proceedings of the 12th International Conference on Engineering and Product Design Education (E&PDE) 2-3rd September 2010 held at NTNU, Trondheim, Norway

ISBN: 978-1-904670-19-3

event: E&PDE 2010: ENGINEERING AND PRODUCT DESIGN EDUCATION 2010

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CAN EXISTING USABILITY TECHNIQUES PREVENT TOMORROW'S USABILITY PROBLEMS?

Harkema, Christelle; Luyk - de Visser, Ilse; Dorst, Kees; Brombacher, Aarnout • 2011

proceeding: Proceedings of the 18th International Conference on Engineering Design (ICED11), Vol. 10
section: Design Methods and Tools Part 2
editor: Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J. & Dong, A.
pages: 1-10

abstract: Product usability is necessary to ensure efficient and effective products which satisfy users. But despite all available usability techniques many users still experience usability problems when using electronic products. In this paper we present two studies that explore the (mis)match between types of uncertainty addressed by existing usability techniques and the types of uncertainty in the product development process that eventually can result in usability problems. For this research an uncertainty scale was developed, which is used in two studies. In the first study the uncertainty scale is used to relate usability techniques to the different types of uncertainty they address and in the second study to relate usability problems to different types of uncertainty. The overall contribution of this paper is that it offers greater insight into how usability techniques (do not) address uncertainty in the product development process.

keywords: USABILITY TECHNIQUES; USABILITY PROBLEMS; USABILITY; UNCERTAINTY; DECISION MAKING

UNDERSTANDING MANAGERS DECISION MAKING PROCESS FOR TOOLS SELECTION IN THE CORE FRONT END OF INNOVATION

Appio, Francesco Paolo (1); Achiche, Sofiane (2); McAloone, Tim C. (2); Di Minin, Alberto (1) • 2011

proceeding: Proceedings of the 18th International Conference on Engineering Design (ICED11), Vol. 10
section: Design Methods and Tools Part 2
editor: Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J. & Dong, A.
pages: 102-113

abstract: New product development (NPD) describes the process of bringing a new product or service to the market. The Fuzzy Front End (FFE) of Innovation is the term describing the activities happening before the product development phase of NPD. In the FFE of innovation, several tools are used to facilitate and optimise the activities. To select these tools, managers of the product development team have to use several premises to decide upon which tool is more appropriate to which activity. This paper proposes an approach to model the decision making process of the managers. The results underline the dimensions influencing the decision process before a certain tool is chosen, and how those tools impact the performance of cost, time and efficiency. In order to achieve this, five companies participated for the data collection. Interesting trends and differences emerge from the analysis of the data in hand, and several hypotheses are tested. A preliminary version of a theoretical model depicting the decision process of managers during tools selection in the FFE is proposed. The theoretical model is built from the constructed hypotheses.

keywords: TOOLS; NEW PRODUCT DEVELOPMENT; FUZZY FRONT END; DECISION MAKING

APPRICATION TO A CAR BODY FRAME BASED ON PARAMETER GUIDELINES FOR DERIVING DIVERSE SOLUTIONS USING EMERGENT DESIGN SYSTEM

Sato, Koichiro; Matsuka, Yoshiyuki • 2011

proceeding: Proceedings of the 18th International Conference on Engineering Design (ICED11), Vol. 10
section: Design Methods and Tools Part 2
editor: Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J. & Dong, A.
pages: 11-23

abstract: In the early design process, diverse design ideas are generated from a global solution search under unclear design conditions. Because it is difficult to apply conventional engineering design in the early design process, the emergent design system capable of generating various three- dimensional forms is proposed. Although this system appropriately set the parameters in every application cases, the system cannot determine whether the values of the obtained parameters are the best because the parameters are selected by trial and error. The research herein extracted the parameters that influence the diversity of form with the goal of devising the emergent design system that uses these extracted parameters to

generate forms. Then these guidelines in this emergent design system were applied to a car body frame design. The results demonstrate that diverse solutions satisfying the mechanical properties can be derived, and thus confirm the usefulness of the guidelines.

keywords: EXPERIMENTAL DESIGN; EARLY PROCESS OF DESIGN; DIVERSE SOLUTIONS

EVALUATING THE RISK OF CHANGE PROPAGATION

Oduncuoglu, Arman; Thomson, Vincent • 2011

proceeding: Proceedings of the 18th International Conference on Engineering Design (ICED11), Vol. 10
section: Design Methods and Tools Part 2
editor: Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J. & Dong, A.
pages: 114-125

abstract: The ever changing trends in current markets along with customers' rising demands for quality require many companies to continuously develop new products. Many companies use iterative design to add new features to old products. The changes from the iterative approach along with the usual changes demanded by customers and made by engineers have created a difficult environment to manage. In this environment, many changes drive other changes in the product. This paper develops a technique to evaluate the risk of change propagation by using functional analysis, domain mapping matrix (DMM), and component design structure matrix (C-DSM) methods. This technique obtains the change propagation risk for a conceptual design solution at a functional level and provides insight for future resource requirements (i.e., development effort, product cost, etc.). The objective of the technique is to increase product knowledge in the early stages of design, to provide insight on the effects of engineering change, and to support design engineers in decision making.

keywords: VALUE ENGINEERING AND FAST DIAGRAM; QUANTITATIVE RISK ASSESSMENT; PRODUCT DEVELOPMENT; ENGINEERING CHANGE MANAGEMENT; CHANGE PROPAGATION RISK

MULTILAYER NETWORK MODEL FOR ANALYSIS AND MANAGEMENT OF CHANGE PROPAGATION

Pasqual, Michael C.; de Weck, Olivier L. • 2011

proceeding: Proceedings of the 18th International Conference on Engineering Design (ICED11), Vol. 10
section: Design Methods and Tools Part 2
editor: Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J. & Dong, A.
pages: 126-138

abstract: A pervasive problem for engineering change management is the phenomenon of change propagation. This paper introduces a multilayer network model integrating three layers of product development that contribute to change propagation: namely, the product, change (process), and social layers. A baseline repository of tools and metrics is developed for the analysis and management of change propagation using the model. The repository includes a few novel tools and metrics, most notably the Engineer Change Propagation Index (Engineer-CPI) and Propagation Directness (PD), as well as others already existing in the literature. A case study of a large technical program is employed to demonstrate the model's practical utility. The case study discovers a correspondence between the propagation effects of an engineer's work and factors such as his/her organizational role and the context of his/her assignments. The study also confirms the counterintuitive possibility of indirect propagation between nonadjacent product components. Lastly, the study finds that propagation was generally infrequent and always stopped after five, and rarely more than four, generations of descendants.

keywords: NETWORK MODEL; MULTILAYER; ENGINEERING CHANGE MANAGEMENT; CHANGE PROPAGATION

CAN DESIGNERS BE PROACTIVELY SUPPORTED AS FROM PRODUCT SPECIFICATIONS?

Galea, Amanda; Borg, Jonathan; Grech, Alexia; Farrugia, Philip • 2011

proceeding: Proceedings of the 18th International Conference on Engineering Design (ICED11), Vol. 10
section: Design Methods and Tools Part 2
editor: Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J. & Dong, A.
pages: 139-148

abstract: During the design process, designers are concerned with two main types of issues - issues related to "what needs to be achieved" or "whats" and issues related to "how these needs will be met" or "hows". A literature review carried out revealed that means which proactively make designers aware of artefact life-cycle consequences (LCCs) arising from both their "whats" and "hows" and which guide them on how to minimise or avoid any negative consequences, are lacking. This research thus contributes an approach framework to meet this aim. The approach framework developed is further implemented as a prototype computer-based tool and subsequently evaluated. Based on the feedback obtained from the evaluation, future research directions are also proposed.

keywords: REQUIREMENTS MANAGEMENT; PROACTIVE SUPPORT; LIFE-ORIENTED; LIFE CYCLE CONSEQUENCES

DESIGN PREFERENCE ELICITATION: EXPLORATION AND LEARNING

Ren, Yi; Papalambros, Panos • 2011

proceeding: Proceedings of the 18th International Conference on Engineering Design (ICED11), Vol. 10
section: Design Methods and Tools Part 2
editor: Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J. & Dong, A.
pages: 149-158

abstract: We study design preference elicitation, namely discovery of an individual's design preferences, through human-computer interactions. In each interaction, the computer presents a set of designs to the human subject who is then asked to pick preferred designs from the set. The computer learns from this feedback in a cumulative fashion and creates new sets of designs to query the subject. Under the hypothesis that human responses are deterministic, we investigate two interaction algorithms, namely, evolutionary and statistical learning-based, for converging the elicitation process to near-optimally preferred designs. We apply the process to visual preferences for three-dimensional automobile exterior shapes. Evolutionary methods can be useful for design exploration, but learning-based methods have a stronger theoretical foundation and are more successful in eliciting subject preferences efficiently.

keywords: STATISTICAL LEARNING; GENETIC ALGORITHM; DESIGN PREFERENCE ELICITATION; ACTIVE LEARNING

DESIGNING TO MAXIMIZE VALUE FOR MULTIPLE STAKEHOLDERS: A

CHALLENGE TO MED-TECH INNOVATION

Aquino Shluzas, Lauren M.; Steinert, Martin; Leifer, Larry J. • 2011

proceeding: Proceedings of the 18th International Conference on Engineering Design (ICED11), Vol. 10
section: Design Methods and Tools Part 2
editor: Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J. & Dong, A.
pages: 159-166

abstract: An inductive, multi-case analysis was conducted to examine how design practices involving physicians and medical device developers influence outcomes in early stage medical device companies. This research was motivated by an interest in understanding the role of users in the device development process, specifically in terms of how user interaction influences the acceptance or rejection of new products. An analytic framework for case-based research was first developed, followed by eight retrospective case studies on entrepreneurial firms. Based on a mixed-methods analysis, the study showed that product adoption relied on maximizing benefits for product stakeholders, while minimizing required changes in physician behavior. The data further illustrated that total benefit to product stakeholders was influenced to the greatest degree by benefits afforded to hospitals and physicians, assuming patient benefit was greater than or equal to the standard of care. This study highlights the importance of identifying the often-conflicting needs of medical device stakeholders, and then optimizing devices to satisfy the needs of those with the greatest influence over product use and adoption.

keywords: USER-CENTERED DESIGN; STAKEHOLDER ANALYSIS; MEDICAL DEVICES; CASE-BASED RESEARCH

CUSTOMER VALUE IS NOT A NUMBER – INVESTIGATING THE VALUE CONCEPT IN LEAN PRODUCT DEVELOPMENT

Gudem, Martin (1); Steinert, Martin (2); Welo, Torgeir (1); Leifer, Larry J. (2) • 2011

proceeding: Proceedings of the 18th International Conference on Engineering Design (ICED11), Vol. 10
section: Design Methods and Tools Part 2
editor: Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J. & Dong, A.
pages: 167-177

abstract: Lean Product Development (LPD) is an operational philosophy aimed at maximizing customer value while minimizing non-value-added-activities, known as waste. Originating from manufacturing, the value-concept in Lean is still strongly tied to product features despite evidence that perceived value concerns more than just the physical product. This paper presents different views on customer value, as provided by the employees at a Norwegian boat manufacturer, customers, and the competition. Our research suggests that a less-than-perfect match between customer needs and product offerings may prove beneficial. Furthermore, how customers perceive product value depends on previous experience. It is also suggested that deep understanding of customer-defined value does not imply an ability to satisfy that value. A purchasing decision often relies on emotional and utilitarian value, and product developers must target both. Yet, the value-concepts used in LPD tend to revolve around utilitarian value alone. An extension of LPD towards Lean Innovation (LI) is suggested.

keywords: PRODUCT DEVELOPMENT; INNOVATION; ENGINEERING DESIGN; CUSTOMER VALUE; CASE STUDY

AN AGENT-BASED SYSTEM FOR SUPPORTING DESIGN ENGINEERS IN THE EMBODIMENT DESIGN PHASE

Kratzer, Martin; Rauscher, Michael; Binz, Hansgeorg; Goehner, Peter • 2011

proceeding: Proceedings of the 18th International Conference on Engineering Design (ICED11), Vol. 10
section: Design Methods and Tools Part 2
editor: Culley, S.J.; Hicks, B.J.; McAloone, T.C.; Howard, T.J. & Dong, A.
pages: 178-189

abstract: Today, product development is dominated inter alia by a complex and interdisciplinary working environment. As a consequence, several problems come up: design engineers need a huge amount of knowledge to design high quality products, non-compliance with basic requirements and non-compliance of machine elements with different design guidelines like Design for X. One possibility to overcome these problems is the use of knowledge-based systems in engineering design. This paper follows a different approach: the use of an agent-based system in combination with a CAD System to support design engineers in the embodiment design phase. Because of its novelty, this approach has to be investigated and several problems have to be tackled. Firstly, it is not clear in which way the ABDS has to be built up. Secondly, there is no structured method for integrating engineering design knowledge into ABDSs. Due to these two problems, there is no generic procedure for developing these ABDSs. Answers regarding these problems will be given in this paper.

keywords: ENGINEERING DESIGN KNOWLEDGE; DESIGN SUPPORT SYSTEMS; AGENT-BASED SYSTEM

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Review Process and Publication of Papers

Reviewed and accepted full papers will be published in the Conference Proceedings, provided the final papers are received by the appropriate deadline and conform to the layout guidelines. We will distribute the proceedings to the participants in electronic format which we intend to make available after the conference as ISI and Scopus indexed ISSN-registered hardcopies. Hardcopies of the proceedings will be available for order via the Design Society and various online bookstores.

The conference is attended by a number of editors from key high quality journals within the field of design research. We intend to put forward proposals for a number of journal special issues based on the themes of the conference, which we hope to recommend ICED11 papers for submission.

Papers submitted to ICED11 are currently undergoing a double blind review process, carried out by the members of the Scientific Advisory Board. The review process is based on the reviewers' qualitative assessment of each paper, along with scores for the following criteria:

- **RELEVANCE** - Is the subject of the paper relevant to the theme of the call for papers? If a paper is not relevant, no review is necessary.
- **ORIGINALITY** - Is the paper original presenting new ideas, approaches, results or insights? Does the literature review provide a clear baseline so that the reader can clearly understand the originality of the paper? Does it challenge existing assumptions? Is the work or a significant part of it as yet unpublished?
- **QUALITY** - Are the aims and objectives clearly stated? Are research questions and/or hypotheses presented? Are the research approach, results, applications and/or case studies sound and carefully described? Are the arguments valid and consistent, and are reasonable assumptions and limitations stated? Are justified conclusions drawn? Are appropriate references quoted?
- **VALUE** - What is its contribution to research, to industry, to practice, to education? Is it significant, useful and interesting?
- **PRESENTATION** - Is the content clearly presented, structured and written? Is it easy and straightforward to read? Are figures, tables and equations clear? Is the paper an even number of pages and of appropriate length? Is the English clear and of a good standard?

Last updated 09.03.2011

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