TOWARDS A RATIONAL BASIS FOR USER INTERFACE DESIGN METHODS

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ABSTRACT

This paper contributes towards a rational foundation for User Interface Design (UID) methods. Currently UID process is primarily based on the trial-and-error approach, supported with miscellaneous testing techniques. In fact, we lack a scientific model for UID, explaining the objectives and concepts of UID and clarifying the solutions. There is an emergent need for a UID process to be not only broad enough to be applicable in different situations but also to be accurate enough to be applicable for specific cases. The current UID methods are based on an iterative process approaching the satisfactory solution in a successive chain of activities. In this paper, we strive to constitute the foundation of this challenging, rational design process. Usability may be defined as "quality of use" and it must be planned and engineered from a human perspective. Therefore, we need to systematically respect human needs, opinions, values, feelings, skills and limitations. Since the usability of a system stems from user, task, and context of use, we base our structure on the knowledge of these three elements. We construct our design model based on a pyramid of three elements: User-System-Context Needs, Concepts, and Principles. By means of AD theory, we linked these elements together to form the overall structure in which User-System-Context Needs, Concepts, and Principles play the roles of Customer Needs (CNs), Functional Requirements (FRs), and Design Parameters (DPs), respectively. The top level contains user-system-context needs, followed by Concepts (FRs) and Principles (DPs). Through AD approach, we seek the underlying concepts and principles in UID process. This model brings about both documenting design knowledge and facilitating communication. AD provide a good format for capturing background information and describing generically good solutions.

Regarding these objectives, we act according to the following stages:

1- Recognition of user-system-context needs
2- Defining Functional Requirements (FRs)
3- Mapping between the domains
4- Decomposition of FRs and Design Parameters (DPs)

The product, a user interface, is designed in a top-down approach. However, for implementation, a bottom-up approach should be followed.

Keywords: design, axioms, software, object-oriented

1 INTRODUCTION

An appropriate user interface shall be defined as any user interface that is intuitive, easy to use, and allows the user to maximize his efficiency, effectiveness, and satisfaction.

"Interface design is a creative, iterative, and cooperative activity. The design of high-quality interfaces requires scientific reasoning, artistic imagination, and aesthetic judgment; involves many rounds of revisions; and usually takes places in a multidisciplinary team environment" [1].

"The design process is the set of activities by which designers develop and/or select the means to achieve a set of objectives, subject to constraints" [2]. The design is interpreted as a conversion function of input to output. The output, any satisfactory solution to the design problem, is called the design object [2]. In the case of user interfaces, we lack a rational design process. "Beside knowledge aspects, research is still weak on ways for ensuring usability *during* the design process" [3]Welie et al. 1999?].

On the one hand the UID process must be so broad to describe the activities of any design. On the other hand it must consider the uniqueness of each design problem. This paradoxical problem could be solved by AD in which the design problem is decomposed into sub-problems in the different domains with the one-by-one relationship between domains. This structure provides a knowledge infrastructure, supporting the decision-making.

Keeping in mind that it is better to do it right for the first time, UID needs a scientific foundation instead of iterative prototyping and trial and error approach. Since it is an urgent need to bridge between theory and practice in UID, AD methodology can act as a pattern to describe generic solutions to common problems in UID. The pattern in question presents a way to capture and

communicate knowledge from previous designs and will act as tools for guidance and support of the usability engineering tasks.
In addition to the need of documenting both successful and unsuccessful experiences, we have to deduce the design knowledge from past experiences. But we reuse information and design solutions for similar projects impromptu based on personal experiences and the individual's ability to exchange experiences.

Human operators are more liable to err than well-proven hardware/software systems and thus the system ability to detect and compensate for errors is crucial [4].

Like the case of production systems [Houshmand & Jamshidnezhad 2003], an ideal UID method should be:
1. Comprehensive to consider all aspects
2. Simple to be widely used
3. Efficient to rapidly come up with solutions
4. Versatile to be applicable in different situations
5. Prescriptive instead of descriptive
6. Analytical instead of heuristic to find the optimum solution
7. Powerful in trade-off analysis

Needless to say, current UID methods fall short of achieving these objectives. This paper is an attempt to tackle this problem by means of AD methodology.

2 AXIOMATIC INTERFACE DESIGN (AID)

User, task, and context of use are three factors playing the key roles in UID. Therefore, we must gain sufficient knowledge about them to successfully design a system from usability standpoint.

"Quality of use" describes the fit between product, users, tasks and environment. It is a characteristic indicating the extent of matching among product, users, tasks, and environment [6].

To develop an interface by means of AD method, we require first conceptualizing the user (customer) attributes and then translating these attributes to Functional Requirements (FRs). Following this way of thinking, we have decomposed the top functional requirement (FR0) to three functional requirement at the next level (See Figure 1) based on the fundamental objectives of usability cited in ISO 9241-11. In the next stage, we have to find solutions to achieve these FRs. According to the definition of efficiency, reflected in Table 1, the less the resources spent to achieve goals, the more efficiency will be. The key point to minimize the required resources is to design based on user tasks and objects (DP1) to perform the basic functions satisfying users. The next functional requirement is to maximize effectiveness (FR2). Effectiveness is defined as the accuracy and completeness with which user achieve specified tasks (See Table 1). This functional requirement means that we must go beyond just to embed basic functions in the user interface and think of features constituting the usefulness of the system. That is why "quality of use" has been selected as the design parameter (DP2) of this functional requirement. The last functional requirement is to maximize satisfaction (Refer to Figure 1). Since the perceived

enjoyment and fun has a strong effect on the user satisfaction, it has been considered as the design parameter (DP3) of FR3. The decomposition of FR3 is more difficult than other functional requirements because there is no exact definition for satisfaction. Therefore, more research is needed to elaborate on the concept of user satisfaction.

The suggested model serves as an efficient tool to describe this accumulated knowledge and experience in a useful framework, yet could not be the only source of design knowledge. However, it points out the generally valid information (for a specific domain) and the designs having proved to be good in similar projects.

The better the harmony between human abilities and system requirements, the less usability problems.

Knowledge about UID could be classified as *guidelines* and *design patterns* [3]. "Guidelines deal with both structural (the dialogue) and presentational aspects of a design"[3]. Design patterns describe generalized problems and proven solutions that can be immediately used in practice [3].

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].

Table1. Usability criteria definitions [ISO9241-11]

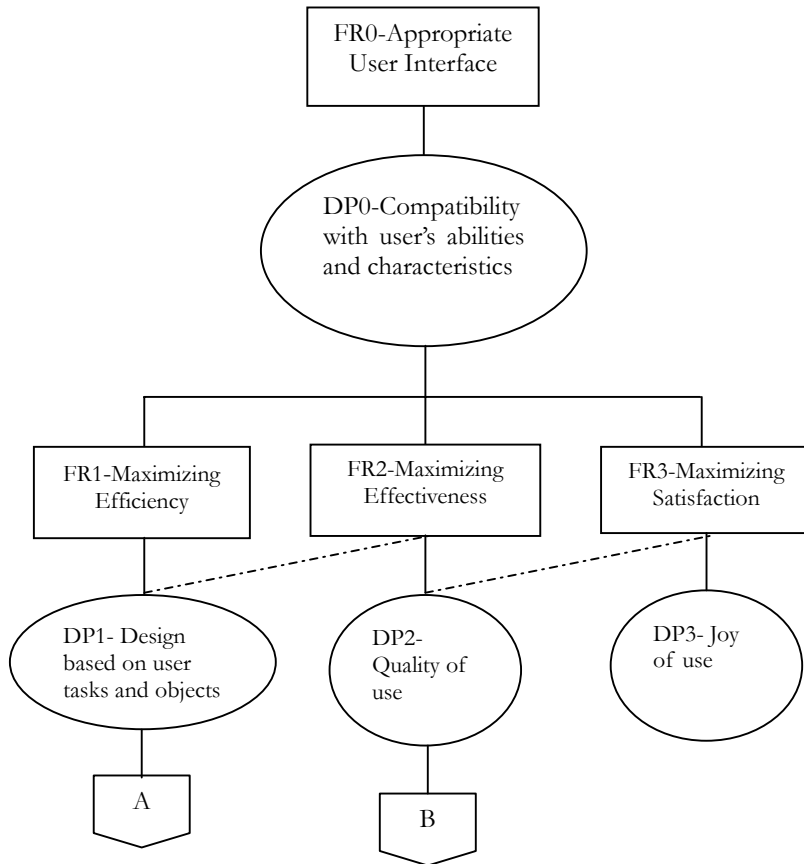| Criterion	Definition
Efficiency	Resources expended in relation to the accuracy and completeness with which users achieve goals
Effectiveness	Accuracy and completeness with which users achieve specified tasks
Satisfaction	A subjective measure for the comfort and acceptability of use by end users

□

Figure 1. Top Level of the AD structure

2.1 DECOMPOSITION OF FR1 AND FR2

The first level of the structure is too abstract to be used. Therefore, we have decomposed it in Figure 2 and Figure 3. It is difficult to closely differentiate between FR1 and FR2 branches because there are no clear-cut definitions for the features resulting in effectiveness and efficiency. The decomposition of FR1 and FR2 are shown in Figure 2 and Figure 3 respectively.

3 CONCLUSION

In this paper, we have developed a design model for user interfaces. This model is intended to clarify the underlying principles of UID process. The core idea of the developed structure comes from the basic definitions of usability criteria mentioned in ISO 9241-11 as shown in Table 1. Axiomatic Design helps tackle UID problems in a systemic way. The structure could be the start point of future researches in this area.
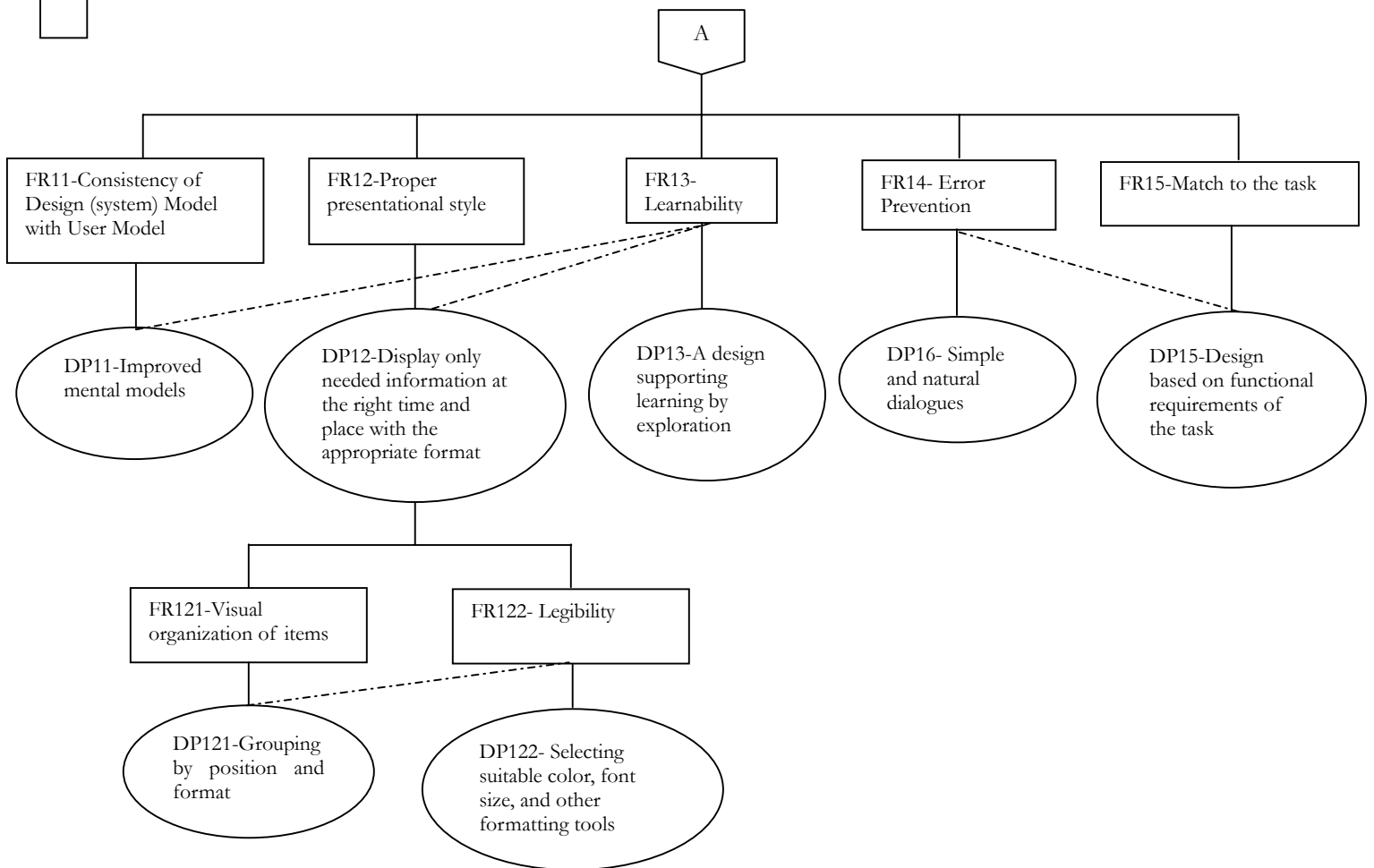
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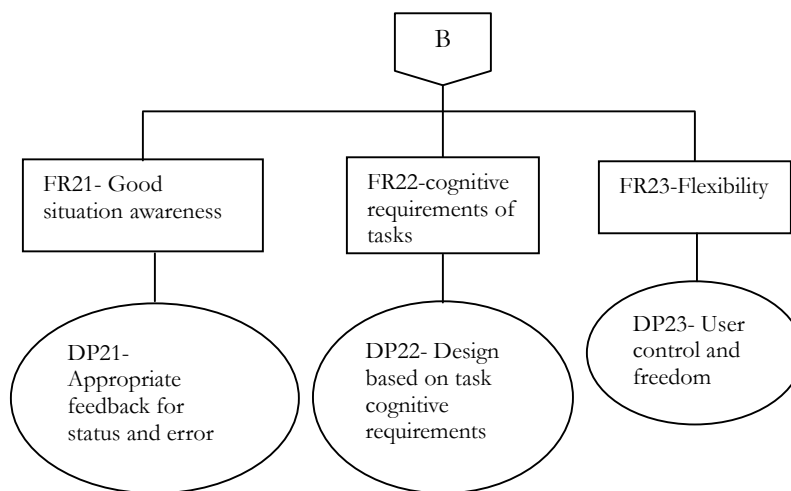
Figure 2. Decomposition of FR1

Figure 3. Decomposition of FR2