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Definition and exploitation of trends of evolution about interaction

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ABSTRACT

In the last decades, there have been researches on development processes that focused on technological evolutions, aiming at anticipating future product releases. The information obtained has been formalized in trends of evolution, and systems to manage and exploit these have appeared on the market. One of the most important examples comes from the TRIZ theory. It uses a set of technological trends of evolution to suggest innovative engineering solution concepts. The research described in this paper analyzes the TRIZ approach to trend discovery and exploitation and applies it in the interaction design domain. A set of trends of evolution about interaction is highlighted first; a method for their effective exploitation is then developed. This is followed by an integration of this method in an existing interaction design framework, and an early validation in the field represents the current state of the research.

1. Introduction

The need for an analysis of product evolution emerges when the availability of products on the market far exceeds customer demand. This analysis focuses on how a product's functions and technological features change as time goes by [1]. The results allow hypotheses to be formulated about possible evolutions of that product, as well as generating design suggestions for similar products. What drives both the analysis of the evolution and the exploitation of the results is the desire to reach the ultimate design goal faster, namely product ideality. A product is ideal when the ratio between its positive aspects and its drawbacks is equal to infinity [2,3]. In the real world this ratio is always finite, because it is impossible to eliminate all drawbacks; they must be minimized, together with an attempt to best meet the customers' requirements.

Up to now analyses have mainly been focused on technological aspects, in several domains, e.g. industrial manufacturing or the development of new communication media. In the first case, the focus is on enhancing the flexibility of production systems [4], while the second deals with the improvement of learning tool effectiveness [5]. In both of these, the starting point is the description of real situations where specific technologies are used; pairwise comparisons allow interaction changes to be placed in ordered sets, named trends of evolution. Trends can be seen as suggested paths to follow, describing the states through which a product could evolve [6]. These states are a sort of snapshot of current product characteristics, and do not usually give any indication about how the products move from one state to the next [7].

One of the best known sets of trends of evolution is the one developed in TRIZ, the Russian acronym for the inventive problem solving theory [8]. It was generated by analyzing a vast number of technological patents, and specific tools have been developed to make the outcomes of this analysis as effective as possible in design activities.

Other trend-based design paradigms have been developed in several domains, by approaching the trend search in different ways. In [9], the age of the product is the main parameter that, together with other empirical data, allows the generation and exploitation of trends, mainly focusing on the relationships between technological issues and marketing requirements. The research described in [1] tries both to foresee the dynamics and effectiveness of design efforts by representing them as equations, and to make them as linear as possible by statistically analyzing the evolutions of similar

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products. Unfortunately, these all lack a method and/or some tools to effectively exploit the knowledge base of the collected trends of evolution in design activities.

Instead of focusing on technological matters, the research described in this paper deals with human–machine interaction [10–12]. The term interaction refers to the dialog between user and product, and is based on the definition of usability. As the ISO 9241 standard states, usability is "the effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments" [13,14]. This definition assigns the same importance to user satisfaction as to product effectiveness and efficiency.

Interaction design – ID – is a recent discipline that focuses on the correct interpretation and implementation of the user–product dialog [15]. ID allows products to be generated that are ready to be easily and intuitively used by most users, and accepted from the outset, thus avoiding problems such as soft reliability issues [12], etc. Although ID is a quite new research field, there are already many methods and tools focused on user satisfaction, because the newer definitions of product quality are heavily based on this. Early tools related to usability were collections of principles and guidelines, mainly used for evaluation purposes. Some examples of these are the seven dialogic ISO principles and the eight Shneiderman's golden rules [16]. From the design point of view, the most interesting methods couple the analysis of user needs with the generation of design solutions starting from those needs. Some examples are the interdisciplinary approach with a user-system focus [12], the user action framework [17], and the intent method [18].

All of this is witness to the fact that interaction concerns are fundamental in order to design successful products. They thus cannot be neglected when predicting the future evolution of products. There are currently no research efforts focused on trends of evolution about interaction; so, the first goal of this research is the generation of a set of trends of evolution about interaction, starting from the investigation of the user–product dialog in several situations in a wide set of different environments. The focus then moves towards the second goal of this research, the development of a method to exploit these trends for the generation of design suggestions. This will happen through the integration of the set of trends of evolution into an existing design framework, the IDGL — Interaction Design Guidelines, developed by the research group, in order to assign it a precise role and maximize its effectiveness in the product development process.

The paper starts with an outline of the relevant background for this research: the TRIZ trends of evolution and the IDGL. It then describes the activities to generate the trend knowledge base. The next section deals with the exploitation of these trends, both as a stand-alone method and as an integrated component in the IDGL, by describing an early validation in the field with two products, a fuel delivery system for cars and a refrigerator. This is followed by a discussion about positive outcomes and drawbacks and the conclusions with some hints about future work.

2. Background

This section describes the TRIZ theory approach to discovering, managing and exploiting trends of evolution in technological fields. An overview of the IDGL is then presented.

2.1. TRIZ and its trends of evolution

TRIZ is the Russian acronym for the inventive problem solving theory, initially developed by G. Altshuller in the 1950s. It can be considered as a design aid, consisting of a collection of related tools, that aims at generalizing and systematizing the product development process, in order to boost the generation of innovative ideas, concepts and products [8]. Starting from the analysis of thousands of patents, Altshuller highlighted that there were very few original ideas, and that the others always referred to these. Old ideas were quite often considered as innovations only because they were applied in completely different domains from the original ones. From this work, he developed a set of tools to manage many design aspects, mainly mechanical, such as the forty inventive principles, the thirty-nine features and the contradiction matrix.

The inventive principles [8] give the designers suggestions about alternative solutions in order to overcome psychological inertia [7] and the NIH – not invented here – syndrome [19]. In fact, they suggest and exhort exploiting results from domains sometimes far removed from the familiar ones. Each principle has a description and a set of examples helping its comprehension and exploitation. One of the principles is "taking out: separate an interfering part or property from an object, or single out the only necessary part (or property) of an object". Two examples of this are "locate a noisy compressor outside the building where compressed air is used" – this could be done to avoid the noise disturbing the working activities inside the building – and "use fiber optics or a light pipe to separate a hot light source from the location where light is needed" — in the case of equipment needing laser beams, etc., the suggestion would be to place the light source at a distance to avoid interference in the equipment operation [20].

The thirty-nine features describe improving and worsening aspects of the product under development. They can be easily put into relationship with engineering requirements, because descriptions mainly refer to physical, quantifiable aspects [8]. Two examples of the features are "durability of moving object" and "loss of substance". The first refers to the time that the product can perform the action, while the second is about partial or complete, permanent or temporary, loss of some of a product's materials, substances, parts, or subsystems.

When designers' attempts to satisfy a specific TRIZ feature – an engineering requirement – seem to negatively influence another one, a contradiction arises. In this case, the contradiction matrix suggests the best inventive principles that could help in resolving it. For example, a contradiction can occur between the features "weight of moving object" and "length of moving object" when dealing with modern airplanes. They become longer to carry more passengers. This implies an increase in their weight. The suggested principles are "dynamics", "anti-weight", "pneumatics and hydraulics", "discarding" and "recovering" [20]. By exploiting the principle "anti-weight", it is suggested that designers focus their design efforts on the wing and fuselage shapes in order to reduce the air density above the wings and help the airplane fly more easily, lowering fuel consumption.

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