ADVICE: A virtual environment for Engineering Change Management

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ABSTRACT

In this paper, we analyze Engineering Changes (EC), which are modifications in forms, fits, functions, materials, or dimensions in components constituting the design. We propose a new approach for processing these changes within a Virtual Collaborative Design Environment. This environment, named Active Distributed Virtual Change Environment (ADVICE) offers an Engineering Change Management solution by merging graphical and parametric data involved in the process into a virtual platform, which improves the comprehension of users and hence decreases the time required for review. ADVICE provides smart user support for predicting Engineering Changes to be triggered due to a specific change and for offering priorities to Engineering Change Requests. This is managed by employing Sequential Pattern Mining techniques to process captured Engineering Change history with Prioritization and Change Propagation mechanisms. For verifying these mechanisms, experiments involving synthetic data are conducted. The experiments present the capability of ADVICE to facilitate Engineering Change Management.

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1. Introduction

In today's highly competitive environment, companies consider the effectiveness of design process as their primary concern for survival. In order to ensure the conformity to customer requirements and decrease the possibility of contradictions, it is a common practice to provide early involvement of functional departments such as production, quality, planning or purchasing into the design process. Today, the involvement of customers and suppliers in the product development stage is essential in order to design more complete products at the first attempt. Concurrent engineering, supply chain management and make-to-order are philosophies and/or techniques that ensure/require the cooperation among departments, customers and the suppliers [1,2]. However, the globalization of the business world can result in the geographical dispersion of parties involved in design. Companies outsourcing and expanding their operations over various locations need a medium for assuring effective communication amongst team members. Not only the ideas are shared through collaborators, but also the tasks such as Engineering Changes (ECs) are handled in the same fashion. This issue, bringing together the needs of the business world with novelties offered by research, resulted in the utilization of the emerging technology, Virtual

Reality (VR), for supporting collaborative work, which is referred to as "Virtual Collaborative Design Environments" [3,4].

There are applications in literature utilizing Virtual Collaborative Design Environments (VCDE) for supporting conceptual and embodiment design that occur in the development stage of the life-cycle of a product before a design is released for production [3,5,6]. However, design is not restricted to the development stage. A product's configuration can go through changes to improve and refine the design continually throughout the life-cycle of a product. These changes, which are defined as modifications in form, fit, function, materials or dimensions in design parameters, constituting the design, are referred to as Engineering Changes [2]. This paper focuses on the Engineering Change Management (ECM), which is the process of organizing, controlling and managing the workflow and information flow for ECs. The ECM process involves three main phases: Request, Approval, and Notification and Execution.

- In the Engineering Change Request (ECR) phase, the need for a change emerges and is placed in an ECM system by an initiator. The initiator may be a department or an engineering team member concerned with the design parameters who believes there is room for improvement [2]. An ECR contains information about: which component to change; which attributes to change; the reason for the change; and an attached technical drawing representing the change.
- In the approval phase, a team, sometimes referred to as Engineering Change Board (ECB), involving members from various functional departments, must review and accept the

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