

A distributed change control workflow for collaborative design network

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Abstract

Collaborative product development is becoming more valuable because of the increasing coordination and management complexity of organizational information, responsibilities, schedules, deliverables, product information, and business process. As outsourcing and globalization increase the number of design chain participants, a collaborative product development speeds up the decision-making of trusted partners, employees, suppliers, and customers in design chains. Due to continuous changes in design projects, delays in product developments are common. Thus, a change control workflow is needed among design chain participants for product development. A distributed change control workflow for design network is therefore proposed in this study. This type of workflow is a two-layer approach derived from the principles of configuration management and routing algorithm. It has been validated that the consistencies of designs from each participants in design chain is maintained by applying the proposed distributed change control workflow.

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1. Introduction

The trend of component manufacturing has been changed from electronic manufacturing services (EMS) provider to joint development manufacturer (JDM). EMS is an industry based on providing contract design, manufacturing and product support services on behalf of original equipment manufacturers (OEMs). However, all intellectual property of the new product belongs to the OEM. JDM is a company that helps design parts of a product for OEM customers. Unlike EMS, JDM may own the copyright of its design and provide joint design services to its OEM customer. The core competitions of JDM are joint design and productivity of manufacturing. Once basis requirement is hand-off from customer, JDM takes the job of completing the design, performs design verification, assembles and tests prototypes, assembles and tests qualification units, assembles and test proof manufacturing units, and finally produces the production units [6]. Lots of stakeholders have recognized that the earlier the manufacturer becomes involved in the design process, the better the product. When a product is outsourced to OEM, the OEM then outsources it to the lower

tiers of JDMs, resulting in a design chain. In order to design a product, JDM has to joint design with its OEM customer and also collaborate with other JDMs in a design chain environment.

Design chain is a subset of supply chain. The major collaborative activities between suppliers and manufacturers are design activities. Therefore, how to manage the design flow in a design chain is as important as how to manage the material flow in a supply chain. Andi and Minato [1] pointed that around 50% of defective designs are caused by changes. It includes requirement changes, specification changes, design document changes, etc. They further showed that 44% of the 79 Japanese construction contractors experienced significant number of design document problems, while 10% had fewer and no experiences. According to the bullwhip effect theory, a slight change would cause huge changes along the supply chain. Therefore, how to control the changes of design documents for maintaining the consistence among design documents is a significant issue. Hameri and Bachy [4] also described that lack of discipline in design change control is one of the fundamental problems of not achieving the project goals.

In this paper, we propose a distributed change control workflow for maintaining the consistence of design documents among JDMs in a design chain. It is basically a workflow derived from the closed-loop change control process of

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configuration management II (CMII), a variant of configuration management (CM), and a distributed routing algorithm.

The remainder of this paper is organized as follows. In Section 2, we review configuration management and routing algorithm literatures. The proposed distributed change control workflow is presented in Section 3. Section 4 presents the simulation result to validate the change control workflow. In the final section, we make a summary of our study, discuss the limitations, and suggest future researches.

2. Literature review

2.1. Configuration management

Configuration management was first introduced by the US Department of Defense in 1992 [8]. It is a discipline applying technical and administrative direction, and a surveillance over the life cycle of configuration items to:

- identify and document the functional and physical characteristics of configuration items (CIs);
- control change of CIs and their related documentation;
- record and report information needed to manage CIs effectively, and the status of the proposed and approved changes and
- audit CIs to verify conformance to documented requirements.

Some forms such as enterprise change request (ECR) and enterprise change notice (ECN) are commonly used in the

configuration management. The forms used in the configuration management process serve two purposes. They are:

- to provide authorization to do the work and
- to provide a historical record and proof of conformance.

The Institute of Configuration Management [5] described a closed-loop change control process (see Fig. 1) within the CMII principles. In addition to CM principles, CMII shifts the emphasis of CM to (1) accommodate change, (2) accommodate the reuse of standards and best practices, (3) assure that all requirements remain clear, concise and valid, (4) communicate (1), (2) and (3) to each user promptly and precisely and (5) assure conformance in each case. As shown in Fig. 1, an enterprise change request (ECR) is provided and passed to Change Administration I, when a document in the baseline is intended to be changed. ECR is a kind of document that records what to change, the reason to change and the priority of changes. Change Administration I accepts or denies the ECRs based on the results consulted from professionals in charge with each configuration item. Accepted ECRs are then passed to change review board (CRB) or original creators for approval and then for making business decision based on further discussion in CRB meetings. Approved ECRs are organized as enterprise change notices (ECNs) by Change Administration II. ECN is a document recording how to change and when to change. Change implementation board (CIB) is held by Change Administration II for planning the detail of ECN implementations. Finally, Change Administration III audits the consis-

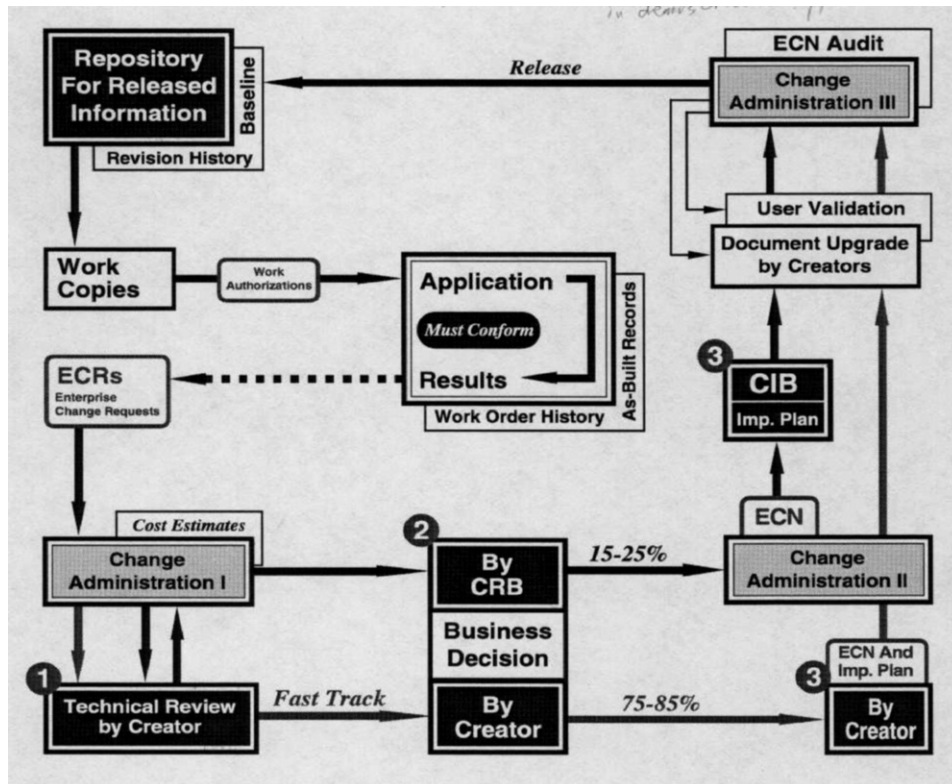


Fig. 1. Closed-loop change process [5].

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