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Change management in concurrent engineering from a parameter perspective

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Abstract

Information and communication technologies (ICT) have altered the balance of cost between activities within a firm and activities between firms. Easier co-operation allows companies to focus on their core strengths, while forming relations with other firms to supply the other needed skills to bring a product to market. Design, in one firm or in a consortium, is iterative and does require change. The ability of companies to better manage engineering changes (ECs) during product development can decrease cost, shorten development time, and produce higher quality products.

This paper concerns engineering change management (ECM) when product development involves more than one company. A review of ECM related papers finds a lack of those that address multi-company design efforts. This approach is based upon recent work in collaborative engineering, which uses elementary engineering decisions, captured as parameters, to drive the collaboration. The relationship between parameters determines the involvement of suppliers and engineering partners. This allows design partners to be informed early as to the impact of design changes. We describe the use of this approach in simultaneous ECM, its implementation within a product data management (PDM) system, and initial test results. We term this approach as 'intelligent' because it is based upon knowledge captured in the design process itself.

Keywords: Engineering change management; Product development; Design management; Concurrent engineering; Virtual enterprise

1. Introduction

Information and communication technologies (ICT) have altered the equilibrium of costs between performing activities within a firm and co-operating with other firms to obtain needed services. Many product development firms have found this equilibrium shift allows greater co-operation between firms in the design of new products.

Firms have also found that product development efforts benefit from the early involvement of many functions besides product design. Among these other functions can be representatives of other engineering disciplines, manufacturing or marketing. This approach to design has been called simultaneous or concurrent engineering (e.g. [1]).

While organisational aspects of change management have received much attention, relatively little research has addressed engineering change (EC) support in manufacturing companies related to product development [2–4].

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This paper contributes to the ECM literature by describing a new approach that support tracking design change in a concurrent environment that crosses company borders. The work reported in this paper is partially based upon work in the SIMNET[1] research project. This paper is organised in seven sections. Section 2 specifies the focus of this paper, facilitating engineering changes in a multi-partner relationship. Section 3 is an overview of recent and relevant literature dealing with ECM. Section 4 presents requirements for advanced ECM in a multi-partner relationship. Section 5 introduces a new approach to address the extensions identified in the review of current approaches and to fulfil the new requirements. Section 6 presents initial implementation and test results. The last section summarises the key elements of the paper and identifies new perspectives.

2. The need for distributed engineering change management

Product development is increasingly performed in a distributed environment. This requires distributed engineering change management. Product development is also an iterative process. Making design decisions early has benefits but often requires modifications or engineering changes (ECs) [5]. These may arise in order to satisfy design constraints and objectives [6], to ease manufacture, to eliminate a design conflict, or to deal with an emerging product requirement (for example, requested by marketing or the customer). Among the requirements for successful multi-firm concurrent design are:

- Close and early co-operation between companies.
- Concurrent engineering, (close early co-operation between disciplines).
- Fast response to required engineering changes.
- Support of information and technology.

Firms may co-operate with suppliers and engineering partners for several reasons. They may find it quicker or more cost effective to bring in a needed skill rather than develop the capability in-house, or they may seek partners in order to respond quickly to the changing needs of customers [7]. When these partnerships are of short or intermediate term duration they may be referred to as virtual enterprises (e.g. [8,9]). For example, designing passenger railcar "bogies", shown in Fig. 1, requires the co-operation of many engineers from several companies (Fig. 2).

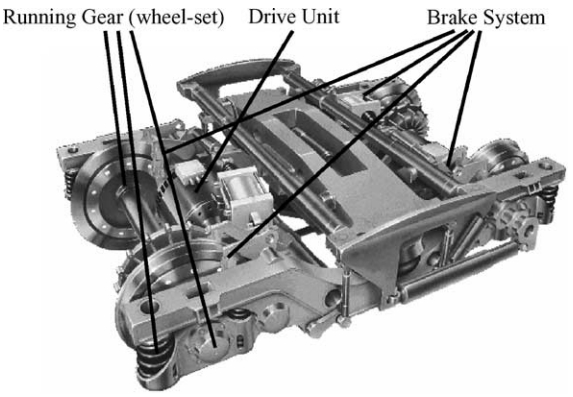

Fig. 1. Bogie, an example of complex product.

The effort may be co-ordinated by the firm responsible for component assembly, while others supply major components (such as the running gear, drive unit and brake system). Each participant brings only its core competency while relying on the others to complete the co-operative effort. The rail–car bogie is the test subject presented in Section 6.

Producing product to customer order can follow several strategies, such as make-to-order, assemble-to-order, and engineer-to-order [7]. Make-to-order involves combining standard parts into a finished product. As the parts already exist, the engineering effort is in choosing and documenting the combination. Engineer-to-order (such as designing the above bogie), the focus of this paper, usually requires considerably more design effort. Each product is new and carries the implication of a large number of design choices. In a concurrent environment, these decisions may be made early using approximate values and then tightened or changed later (e.g. [10]). This iterative process will often lead to ECs. Co-operation between companies in engineer-to-order requires exchanging and maintaining the validity of a large engineering data set. This is especially important when engineering changes are in process. Fig. 2 shows documents

[1] Workflow Management for Simultaneous Engineering Networks (SIMNET). SIMNET was a project funded by the Commission of the European Communities under the ESPRIT programme (EP 26780), see Acknowledgement for list of participants.