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Enabling allied concurrent engineering through distributed engineering information management

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Abstract

The management of engineering information to ensure that the right information is quickly provided to the right place at the right time in the right format is one of the most critical tasks in the engineering process. Within the practice of allied concurrent engineering, the importance and difficulty of engineering information management is increased due to the issues of inter-enterprise communication and process control, system heterogeneity, information and system security, differing engineering data formats and multi-database formats. This paper presents an engineering information management approach for the practice of allied concurrent engineering (ACE). An ACE-based engineering information management methodology is proposed under the concept of enterprise integration. This methodology includes an information management life cycle, a distributed management framework, and rules and methods for information management. Based on this methodology, an ACE-based engineering information system was developed using Unified Modeling Language (UML) modeling techniques. The result of this research will enable the practice of allied concurrent engineering and consequently help increase product development capability and quality, reduce development cycle time and cost, and hence increase product marketability.

Keywords: Virtual enterprise; Concurrent engineering; Engineering information system

1. Introduction

Allied concurrent engineering, by unifying the concepts of virtual enterprise [1] and concurrent engineering [2,3], is viewed as one of the most promising business strategies for enterprises to address global competition. In practice, it is implemented by performing a distributed and collaborative engineering process, where people in different disciplines from differing enterprises cooperate to design a product and develop related processes through remote coordination, communication, and control [4]. Like conventional concurrent engineering, the key to the success of an allied concurrent engineering process is a complete understanding and effective sharing of product and process data through the entire development cycle [4].

Systems such as engineering data management (EDM), product data management (PDM), product information management (PIM), technical document management (TDM), technical information management (TIM) and others are commercially available for the practice of concurrent engineering [5]. They provide a structured way to orderly and efficiently store, integrate, manage and control both the data and engineering process from design, manufacturing to distribution [5].

The essence of these systems is the management of engineering information to ensure that the right information is quickly provided to the right place, at the right time, in the right formats. However, within the practice of allied concurrent engineering, the importance and difficulty of engineering information management are increased due to the issues of inter-enterprise communication and process control, system heterogeneity, information and system security, differing engineering data formats and multi-database formats. Moreover, since the management of engineering information is highly related to the nature of an engineering process and the strategy of engineering process management, engineering information management is more a part of a "*unified*" enterprise integration "*solution*" than a "*point*" of EDM or PDM system functionality. Due to the

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product-centered and dynamic-configurability, *project-based*, *flexibility and heterogeneity*, *hierarchical and recursive structure*, *and distributed and cooperativeness* properties of allied concurrent engineering [4], the traditional information management approach does not completely fulfill the requirements of allied concurrent engineering.

This paper presents an engineering information management approach for the practice of allied concurrent engineering (ACE). An ACE-based engineering information management methodology is proposed under the concepts of enterprise engineering and integration [6,7] to manage the information along engineering processes in an integrated fashion both within the enterprise and outside the enterprise's allied engineering partners. This methodology includes an information management life cycle, a distributed management framework, and rules and methods for information management.

Based on this methodology, an ACE-based engineering information system was developed using unified modeling language (UML) modeling techniques [8]. The system was developed under the principles of (i) complying with commonly acceptable modeling techniques, (ii) applying proven models and architectures, and (iii) compatible and interoperable with other EDMS modules and enterprise systems.

The result of this work includes (1) a methodology for engineering information management in the context of allied concurrent engineering, (2) an ACE-based engineering information system with the characteristics of reconfigureability and flexibility, platform independence, and cooperativeness, and (3) an UML-based enterprise system development procedure. These results will enable the practice of allied concurrent engineering and consequently help increase product development capability and quality, reduce development cycle time and cost, and hence increase product marketability.

2. Overview of the concept

This section presents an overview of the development of the proposed engineering information management approach. It includes two developmental phases. Phase one is the development of engineering information management methodology and phase two is the development of an ACE-based engineering information system. Each phase involves several steps of activities as shown in Fig. 1.

Phase 1: Methodology development. During this phase, the definition of allied concurrent engineering is given based on the concepts of virtual enterprise and concurrent engineering. The characteristic analysis of an allied concurrent engineering process is then conducted based on the definition. According to the characteristics of allied concurrent engineering, the life cycle of ACE-based engineering information management is proposed. An

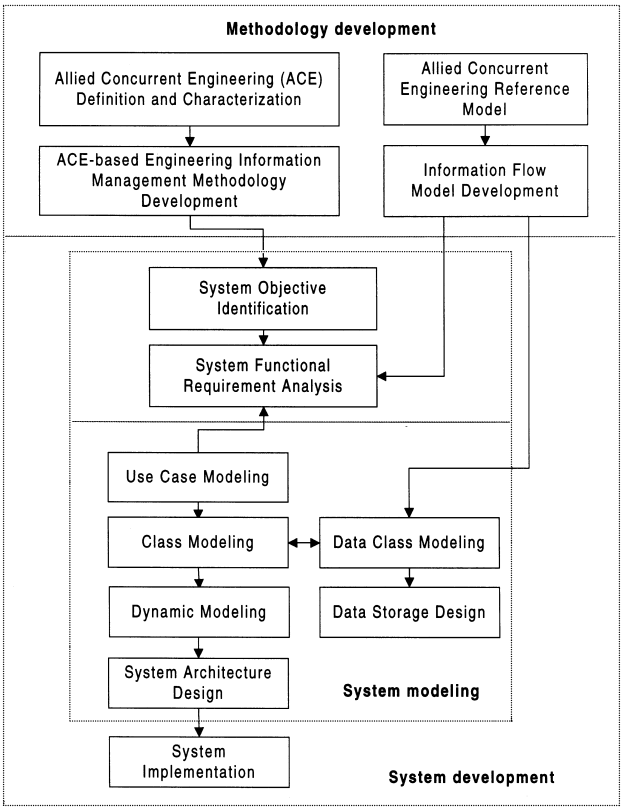

Fig. 1. Overview of proposed ACE-engineering information management approach.

ACE-based engineering information management methodology is then developed based on the proposed life cycle. The result of domain investigation is an ACE-based engineering information management reference model for system development.

Phase 2: System development. Tasks in system development include *objective identification*, *functional requirement analysis*, *system modeling*, *system architecture design*, and *system implementation*. According to the proposed methodology, the objective of the ACE-based engineering information system is first identified, which is followed by system functional requirement analysis. System functional requirements define what the system must do and provide the guidelines for system development.

System modeling aims to build a design model based on the results of functional analysis but containing implementation details. The details are added to the design model in accordance with the strategy established during system design. In the proposed approach, UML modeling techniques are employed to define the structures and behaviors of the elements in the system as well as the relationships among the elements. The result of system modeling is a set of object classes that corresponds to the elements in the system.

According to the results of system design and modeling, the system architecture is designed for system