A ‘Plug-and-Play’ Computing Environment for an Extended Enterprise

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With the emergence of the extended enterprise where different companies are involved in the product development process, the successful implementation of collaborative product design and manufacturing across the extended enterprise has become a difficult task. This chapter deals with the issue of developing an integrated computing environment for facilitating collaborative product design and manufacturing across the extended enterprise. An application development framework is presented that is geared towards a ‘plug-and-play’ computing environment. The framework describes how design and manufacturing applications can be developed independently, yet be seamlessly integrated simply by plugging the application into common computing environments.

4.1 Introduction

Faced with a rapidly changing global environment, product development enterprises today are reformulating their strategies to be globally competitive. One strategy that enterprises have adopted is to concentrate on their core competencies and build closer relationships with their partners. The resulting organization of geographically distributed companies working together to realize a product is known as the extended enterprise and is the new unit of business competition [1]. Facilitating collaborative product design and manufacturing across an extended enterprise is a difficult task that requires various cultural and technical issues to be
resolved. The aim of this chapter is to address one such technical issue – the development of an integrated computing environment to support the collaboration across an extended enterprise, by facilitating information exchange between product designers and manufacturing process designers, and coordinating their activities. The necessary information is critical to make rapid trade-off decisions and collaboratively arrive at the optimal design and manufacturing processes of the product.

The rest of this chapter is organized as follows. Section 4.2 discusses the related research in developing integrated computing environments. Section 4.3 proposes an approach to develop design and manufacturing applications that is geared towards a ‘plug-and-play’ capability. Section 4.4 presents an illustrative example and Section 4.5 concludes the chapter.

### 4.2 Related Research

An integrated computing environment enables collaborative product design and manufacturing by providing the necessary mechanisms for exchanging information and coordinating information flow.

Early efforts in developing integrated computing environments concentrated on the integration of the various standalone computer-aided systems used in the design and manufacture of a product. Standalone systems are applications in which the entire functionality of the application is hosted on a single computer. Cutkosky, et al., [2] presented a notable work in this regard based on an agent approach. Agents were used to encapsulate the standalone applications and agent interaction was based on shared concepts and terminology for communicating knowledge across disciplines. Sriram, et al., [3] proposed the use of the blackboard architecture for facilitating communication and coordination between different standalone computer-aided systems. The blackboard was implemented as an object oriented database. The use of a central repository as a product master model was another approach described by Hoffman and Joan-Arinyo [4] to create an integrated computing environment. The clients of the master model are domain-specific standalone applications that can deposit and retrieve information from the master model. The master model repository provides mechanisms for maintaining the consistency of the deposited information structures.

Another approach is the use of standard file formats such as STEP and IGES located at central databases. Roy and Kodkani [5] proposed the use of a translator to convert CAD models into VRML-based models, which can then be viewed over the WWW. The VRML models are stored in an existing product data repository. The translator resides on a main central server and can be accessed remotely by a designer. Xie, et al., [6] developed an integrated CAD (Computer-Aided Design) / CAPP (Computer-Aided Process Planning) / CAM (Computer-Aided Manufacturing) system for sheet metal product development platform based on an information integration framework where the geometry of the product was represented in STEP files. The information integration framework was developed using Pro/INTRALINK.