CFACA: component framework for feature-based design and process planning

Xiaodong Liu*

c/o Ms J. Zhang, 76 Xinsheng Street, XuZhou City, JiangSu 221003, People's Republic of China

Abstract

Automatic generation of manufacturing information from design has been the research focus in advanced CAD/CAM applications, i.e. feature-based applications for design, process planning and other automated manufacturing applications. However, our current development mode has seriously troubled research in these application fields. For example, with our current development mode, the functionality and data of one application cannot be accessed by other applications; applications are monolithic, they are time-consuming to develop and hard to customize and update for meeting the user's requirements. Typically, each researcher has to develop independently a complete set of new monolithic application almost built from scratch to create features and then perform various process-planning functionalities. This development mode leads to such a tremendous and tough work in advanced CAD/CAM applications that, though researchers in these fields have developed countless feature-based application programs, the problem of integrating CAD and CAM applications is still largely unsolved.

From the viewpoint of component technology, we seem to be wasting more time than we should be, doing ineffective work that is orders of magnitude greater and harder. The component technology, which emerged in the 1990s, has been widely regarded as the software development technology of tomorrow, and is changing the development mode of the software industry now, but has never been explored in advanced CAD/CAM application fields. The paper introduces a method of achieving the new technology in advanced CAD/CAM application fields. As an example, the paper discusses in detail the interface components in feature-based machining application domain to explain how the component technology is used in a specific advanced CAD/CAM field and how powerful the technology is. The framework in the paper is the first component framework for advanced CAD/CAM applications. Because the component technology provides developers with much more productive and powerful development mode, it is believed that this development technology is the technology of tomorrow in advanced CAD/CAM fields, and that it will change the development mode of advanced CAD/CAM applications. © 2000 Elsevier Science Ltd. All rights reserved.

Keywords: The component technology; COM; Feature-based approaches

1. Introduction

Automatic generation of manufacturing information from design has been the research focus in advanced CAD/CAM applications, i.e. feature-based applications for design, process planning and other automated manufacturing applications. However, our current development mode has seriously troubled the research in these application fields and has brought us many problems. For example, it is the character of feature-based applications that, in an application-specific field, e.g. machining application domain, while most of the work is similar, each user has a different requirement, and each shop has a slightly different set of manufacturing features and a different set of tools and processes for manufacturing these features. The "correct" development mode for dealing with such a situation is, when developers develop new applications in a specific area, they should simply combine diverse binary "modules" that come from different developers into their programs and write few specific codes to meet the user's specific requirements and quickly complete their development. However, with our current development mode and technology in advanced CAD/CAM areas, the functionality and data of one application cannot be accessed or reused by other applications; applications are monolithic, they are time-consuming to develop and hard to customize and update for meeting the user's requirements. Typically, each researcher has to independently develop a complete set of a new monolithic application almost built from scratch to create the features and then perform various process-planning functionalities. This development mode leads to such a tremendous and tough

* Tel.: +86-516-3851835.
E-mail address: liuxdg@public.xz.js.cn (X. Liu).

work in advanced CAD/CAM applications that, though researchers in these fields have developed countless feature-based application programs, the problem of integrating CAD and CAM applications is still largely unsolved. From the viewpoint of the component technology, we seem to be wasting more time than we should be, doing ineffective work that is orders of magnitude greater and harder.

The paper presents a brand new development way—the component technology to develop advanced CAD/CAM applications. The component technology emerged in the 1990s. It has been widely regarded as the software development technology of tomorrow, and is changing the development mode of the software industry now, but has never been explored in advanced CAD/CAM application fields. In this paper, the key problems that obstruct us from developing small, reusable components in advanced CAD/CAM application fields, e.g. feature-based design, process planning and other automated manufacturing, are discussed. The paper introduces a component-based framework—Component Framework for Advanced CAD/CAM Applications (CFACA)—to solve these problems. And as an example, the paper discusses in detail the interface components in feature-based machining application domain to explain how the component technology is used in a specific advanced CAD/CAM field and how powerful the technology is. It is the first component framework for advanced CAD/CAM applications. Because the component technology provides a much more productive and powerful development mode, we believe that this technology is the development technology of tomorrow in advanced CAD/CAM fields, and that it will change the development mode of advanced CAD/CAM applications.

The paper is organized as follows. Section 2 mainly introduces the background of components, and describes the specific key problems that obstruct us from developing small, reusable components in advanced CAD/CAM application fields. Section 3 sets forth the overall framework. Section 4 introduces the implementing tactics of the framework. In this section, we will give the concrete component model in feature-based machining application field as an example for demonstrating how to apply (achieve) the technology in a specific field and how powerful it is. Also the current research in feature-based applications will be discussed. Section 5 describes the current implementation and the future work. Section 6 discusses the role of CFACA in Advanced Product Information Framework. Section 7 concludes this work.

2. The background of components and the specific key problems that obstruct us from developing components in advanced CAD/CAM applications

2.1. The component technology

The component technology (also called small, reusable

components or component software) has been the long-awaited dream of software industry. In the 1990s, with the emergence of several fundamental protocols such as CORBA [1] on UNIX and COM [2–4] on Windows NT and UNIX, upon which the component technology is built, the dream—component software ultimately comes true. Without any doubt, this technology is the software development technology of tomorrow [1–5]. (Appendix A is a simple explanation from Microsoft for the new development mode.) Currently, this technology is changing the development mode of the software world. Simply speaking, components are independent EXE or DLL programs. The component technology provides the means to make a DLL or EXE program expose the functionality to other applications (called automation server), so that other DLL or EXE programs (called automation client) can manipulate, share and access the exposed functionality and data belonging to the automation server. It provides developers with a new development mode that is much more productive, flexible and powerful than various existing development technologies, such as object-oriented languages and traditional modular-based development approach. For example, it enables developers to greatly simplify and speed their work by combining or reusing diverse binary "modules" independently developed by varied teams and individuals. Components are language-independent and hardware-independent, and may work across networks if needed. Also the technology provides a much more flexible choice for customizing applications etc. So it has been widely accepted as the future software development technology. Currently, in the software world, component technology can be based on several communicating protocols, e.g. CORBA and COM (or COM +). In this paper, the component technology is based on "Automation Server Components" or "COM Objects" that are built on COM from Microsoft [2–4].

2.2. The key obstacles in applying the component technology in advanced CAD/CAM applications

The component technology would solve the problems facing the entire advanced CAD/CAM fields, and greatly simplify or improve our work if it could be used in advanced CAD/CAM areas. However, the technology has never been explored in advanced CAD/CAM application fields. How does one achieve the technology in advanced CAD/CAM applications? By analyzing the current COM component technology used in general areas and from the research in advanced CAD/CAM areas, we believe—due to the special complexity of advanced CAD/CAM fields—that we have to resolve two specific obstacles before we can apply the component technology in the fields.

1. In advanced CAD/CAM fields, advanced product information structures are much more complex than in general areas. Obviously, due to the inherent structure complexity and the complexity of interaction among the binary components in advanced CAD/CAM fields, application