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Robotics and Computer-Integrated Manufacturing 22 (2006) 456–467
Robotics and Computer-Integrated Manufacturing
www.elsevier.com/locate/rcim

STEP-NC compliant process planning as an enabler for adaptive global manufacturing

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Received 10 October 2005; accepted 14 November 2005

Abstract

Manufacturing firms are seeking more efficient methods of CNC manufacture. ISO14649 informally known as STEP-NC has been proposed as a high-level hierarchical manufacturing information model as a replacement for the low-level machining instructions of ISO6983 and RS274D. In this paper, the applicability of STEP-NC as an enabler for creating an adaptive global manufacturing system is examined. The overall framework of the system is presented followed by an outline of its information requirements. Suitability of STEP-NC to support each requirement is then studied with the necessary additions highlighted. Finally, a test component is used in conjunction with a prototype of the advanced global manufacturing system to demonstrate the applicability of the STEP-NC standard to support manufacturing information in such a system.

Keywords: CAD; CAM; CNC; STEP-NC; Information modelling; Integrated manufacturing

1. Introduction

The global demand for CNC-manufactured products has been on the rise since the advent of numerical control. Due to this ever-increasing demand and the increase in the transportation costs, in many cases it is no longer profitable to manufacture a product at one site and ship it to destinations around the world. To maintain profitability, companies have started moving their production facilities closer to their markets where cheaper labour is available. It is not uncommon for a company nowadays, to have several satellite CNC manufacturing venues around the world to address the demand of the global market.

One of the problems for implementing this "global" manufacturing model is the fact that the facilities, manufacturing capabilities, knowledge and systems available in each local manufacturing venue can be different to those that exist in other venues. Having diverse CNC machining resources entails coping with numerous programming specifications. This frequently translates into the requirement for additional post-processors, manufacturing engineers and in many cases rework.

Current CNC manufacturing chains are incapable of satisfying the requirements of a global manufacturing enterprise due to the resource-specific nature of the manufacturing information they rely on (i.e., G&M Code post-processing) and the restricted information flow among the components.

To create an adaptive global manufacturing system that can manufacture identical products using different resources, it is necessary to utilise a resource-independent interoperable process plan. This process plan should include the information required to manufacture a component without being specific to the resources, which will be used in the manufacturing process.

This paper explores the application of ISO14649 (STEP-NC) compliant process plans to support an adaptable global manufacturing system. A review of current integration techniques for CAD/CAM/CNC chains is presented followed by an overall framework for the adaptive manufacturing system. Information requirements within the framework for representing manufacturing data are then outlined. The applicability of STEP-NC compliant

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doi:10.1016/j.rcim.2005.11.003

interoperable process plans containing manufacturing process and product data models for achieving resource independence and enabling adaptability is then studied as the major emphasis of this research. A test case is then presented where a prismatic component is process planned using a multi-agent-based STEP-NC compliant process planning system. The generated process plan is then interpreted both as a feature-based manufacturing instruction file (i.e., the Siemens ShopMill CAM suite) and a low-level G&M Code ISO6983 compliant part program file by the adaptive manufacturing system to demonstrate the interoperability of the STEP-NC compliant process plan.

2. Current status of CAD/CAM/CNC integration

Currently, for a manufacturing firm to manufacture a product on various machines with different controllers and tooling configurations, CAD files are sent across the world to the company's subsidiaries. The files are then interpreted by engineers at each facility and local process plans are generated according to that facility's particular configuration. [1,2].

Fig. 1 shows a typical CAD/CAPP/CAM/CNC integration chain currently in use. In this chain, the part design is computerised through the use of CAD software. The CAD drawing is then passed onto the CAPP/CAM software by using one of the industry standards, i.e. IGES, DXF or STEP. The CAPP/CAM software then determines the toolpaths necessary to manufacture the part based on a pre-defined machine, controller and tooling configuration. A manufacturing engineer supervises the toolpath generation process and after verifying the generated instructions passes them through a postprocessor, which creates machine-optimised instructions. The result is a manufacturing instruction file that is passed onto the controller. The part is then manufactured by sequential execution of

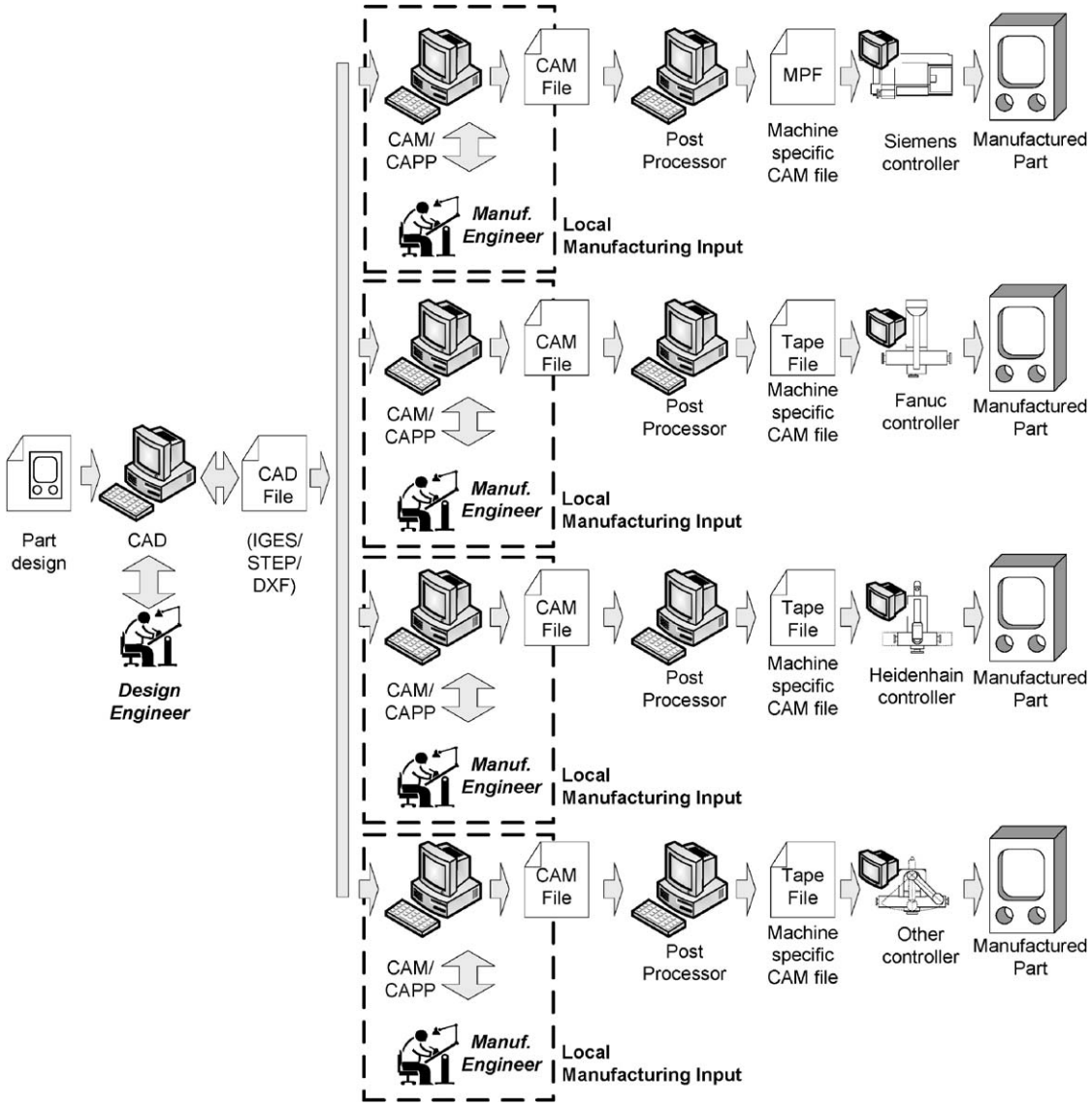

Fig. 1. Current CAD/CAPP/CAM/CNC integration schemes.