Chapter X
Integration of CAD/CAPP/CAM/CNC

ABSTRACT

Technologies concerning computer-aided design, process planning, manufacturing and numerical control, have matured to a point that commercialized software solutions and industrial systems can be acquired readily. These solutions or systems are, however, not necessarily connected in a seamless way, that is they are not embedded. The term “islands of automation” has been used to describe these disconnected groups of systems with no obvious integration points other than the end user. As the engineering businesses are increasingly being run in a more globalized fashion, these islands of automation need to be connected to better suit and serve the collaborative and distributed environment. It is evident that the businesses are struggling with this integration strategy at a number of levels other than the underlying technology, including CAD, CAPP, CAM, and CNC for example. In some cases, where integration does not exist among these computer-aided solutions, promising product technologies may come to a sudden halt against these barriers.

The previous chapters have focused on these individual computer-aided solutions, e.g. CAD, CAPP, CAM, CNC, and feature technologies. Some localized integration such as integrated feature technology has been studied. The following chapters, will in particular, look at the integration issues, technologies, and solutions. This chapter starts with a general description of traditional CAD, CAPP, CAM, and CNC integration models. This is followed by an industry case study showcasing how a proprietary CAD/CAM can be used to achieve centralized integration. To illustrate CAM/CNC integration, three different efforts are mentioned. They are APT, BCL (Binary Cutter Location, (EIA/ANSI, 1992)), BNCL (Base Numerical Control Language, (Fortin, Chatelain & Rivest, 2004)) and use of Haskell language for CNC programming (Arroyo, Ochoa, Silva & Vidal, 2004).
MODELS OF INTEGRATING CAD/CAPP/CAM/CNC

In the effort to achieve CAD/CAPP/CAM/CNC integration, there have been two types of traditional models in use, centralized model (Model A) and collaborative model (Model B) (Xu & Mao, 2004). In a centralized model, manufacturing activities occur within a single manufacturer or a few manufacturers that have similar information infrastructure. In this model, proprietary data formats are commonly used. In a collaborative model, a middle tier is added using for example a neutral data exchange format. As such, collaborative activities in the manufacturing environment become easier. Figure 10.1 illustrates the data flows in these two models (Xu, 2006).

In Model A, both CAD and CAM systems use the same proprietary data format. Over the years, CAD/CAM system vendors have been successful in developing different proprietary data formats to support their systems throughout design and manufacturing processes. The benefits of this model are obvious. CAD and CAM systems are unified by the same data format so that data incompatibilities between them are eliminated. Furthermore, since there is no data-transferring barrier, system vendors have more freedom to model information. In addition to pure geometry, integrated CAD/CAM systems can cater for other activities ranging from design to NC programming. Some of such systems include Pro/E® (with Pro/NC®), Catia® and UGS.

A CASE STUDY OF INTEGRATING CAD/CAPP/CAM

This section presents a case study that highlights an integrated CAD/CAPP/CAM environment for a manufacturing company (Xu & Duhovic, 2004). It represents a classical example of how companies can use today’s CAD/CAM systems to support a centralized integration model as shown in Figure 10.1.

Concurrent Product Modelling in a CAD/CAM System

The product in this case study is a small version of household refrigerator, usually mounted inside a cupboard. To allow for correct placement and adjustment, two foot levelling pads are fixed on the floor of the cupboard, into which the front levelling feet of the refrigerator sit (Figure 10.2). The case study starts from part design to all the down-stream activities related to manufacture of the part.

The foot levelling pad is designed using a 3D CAD/CAM system, i.e. Pro/Engineer®. Being a thermoplastic product, the pad is mass-produced using the injection moulding process. Tooling therefore becomes an important part of the entire manufacturing process. Design of the tooling is also carried out within the same CAD/CAM system, but using an additional module called Pro/MOLDESIGN®. The complete tooling model consists of the mould bases, insert core, insert cavity (within the top mould base), foot levelling pad and a number of small inserts (Figure 10.3). Most of the tooling components are machined on a CNC milling machine. Process planning and NC code generation are carried out within Pro/NC®, another integrated module of Pro/Engineer®.

A narrow deep circular slot, which corresponds to a small circular protrusion on the foot levelling pad (Figure 10.4) requires an EDM to produce. The tool used on the EDM
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