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Feature-based Process Planning Based on STEP

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Abstract
This chapter begins by describing characteristics a process planning language should have. Then it discusses the extent to which four process planning languages have these characteristics. The first two of these are STEP standard process planning languages (all of AP 240 and part of AP 238). The third is part of ISO 14649. The fourth, called FBICS-ALPS, is a version of the ALPS language adapted for FBICS, a system that does automatic feature-based process planning. Next the chapter summarizes the machining features available in AP 238, ISO 14649, and AP 224. The way in which FBICS does feature-based process planning is presented and a system is described that translates FBICS plans into ISO 14649 plans (which are conceptually identical to AP 238 plans). Finally, the chapter is summarized, and improvements in FBICS needed to make it industrially useful are presented.

2.1 Introduction

ISO 10303 and ISO 14649 include several parts that deal with process plans and features and, hence, are used or could be used in STEP-NC. In addition, a Feature-Based Inspection and Control System (FBICS) has been built at the U.S. National Institute of Standards and Technology (NIST) that uses STEP methods and standards. This chapter discusses process plans, features, and process planning (the act of making a process plan that uses features). For each of these three topics, issues are discussed, the relevant sections of ISO 10303, ISO 14649, and FBICS are presented, and these sections are compared.

This chapter uses many STEP concepts introduced in Chapter 1. Readers who are not familiar with STEP should read Chapter 1 before tackling this chapter. Throughout this chapter, it should be borne in mind that (with a few exceptions) AP 238 and ISO 14649 have identical semantics, since ISO 14649 provides the ARM for AP 238.
2.2 Process Plans

The first subsection of this section defines process plan and discusses the desirable characteristics of a process planning language. The other four subsections are devoted to presenting three STEP-based process planning languages and discussing the extent to which each of them has the desirable characteristics.

2.2.1 Definition and Desiderata

A process plan, in general, is a recipe for transforming some input materials or partially finished products into finished or (more) partially finished products. Process plans may be for continuous processes (as in oil refining) or discrete processes. Discrete process plans consist of individual operations. Since we are interested in manufacturing using NC machines, which is done with individual operations, we deal here only with discrete process plans, primarily plans for machining by milling or turning. FBICS can also write and execute plans for inspection using a coordinate measuring machine (CMM) or a machining centre equipped with a touch trigger probe, but few details of that aspect of FBICS are given here.

Since process plans must be stored, a file format for representing them is required. The STEP way to get a file format, as explained in Chapter 1, is to write an EXPRESS schema giving the semantic content of an information model and then to use either the Part 21 rules or the Part 28 rules to obtain a file format from the schema. We will assume in the rest of this chapter that EXPRESS is used to define information models for process plans, and Part 21 is used for writing process plan files. The combination of EXPRESS and Part 21 constitutes a process planning language. If Part 28 or some other format were used for writing process plans according to the same EXPRESS model, that would constitute a different language. It would have the same semantics but different grammar and syntax.

Several characteristics of a process planning language for feature-based manufacturing are desirable. Namely, the language should:

- Be machine-readable
- Be machine processable into a serviceable application programming interface (API)
- Have a generic core suitable for all types of machining (and other discrete processes)
- Be vertically extensible to be suitable for several levels of a hierarchical control system
- Be horizontally extensible so that it is suitable for various types of machines
- Be capable of refinement in stages

Machine-readable

Since we have assumed the language is modelled using EXPRESS and Part 21, the language is sure to be machine-readable. Several of the STEP systems described in Chapter 1 are able to read EXPRESS and Part 21 files. Many of those that read Part