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Journal of Materials Processing Technology 101 (2000) 231–237

Journal of Materials Processing Technology

www.elsevier.com/locate/jmatprotec

The development of the software for the controller of an automatic machine workshop by object-oriented programming

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Received 30 October 1998

Abstract

The material presented is to introduce how an advanced object-oriented programming (OOP) technique can be applied to an automatic machine workshop. It is a user-friendly and well-manipulated software which uses a semantic net of information representation by applying a hierarchy of various object components and/or structures. It has already been proven to be a very useful software concept in handling a flexible, automatic manufacturing system. In order to discuss further the application of the OOP concept in detail, an automatic machine workshop is used as an example to illustrate the applications. It is found that this kind of object-based approach offers a swift tool to integrate objects into a manufacturing environment to make the control of an automatic machine workshop possible.

Keywords: Object-oriented programming; Flexible manufacturing system; Semantic net

1. Introduction

A modern machining workshop is an integrated computer-controlled manufacturing system, which should merge most of the current technologies in a system. A typical machining workshop could be formed by a cutting machine tool, a material flow transport system, tooling, fixtures, work-stations and a set of computer-controlled monitoring modules. It is designed such that these kinds of machine workshops should be very easily and quickly adjusted to meet current marketing changes. Thus, usually, this sort of system can be categorized as a kind of variable and small batch production system.

A company that implements this kind of highly efficient, automatic manufacturing workshop should be much more competitive since it includes different hardware such as machining centers, material handling devices, measuring machines, etc. In order to manipulate this kind of system an advanced system controller with various functions supporting control software has become essential for shop floor information flow and the whole system management.

There is a recommended programming concept: object-oriented programming (OOP) [1], which has become the main-stream in the field of software development in this field. The concept of OOP can be applied easily to various kinds of automatic workshops just by carrying out their controller software implementation and developments. A numerous advantages have been shown in using such a hierarchical structured programming method especially in a very complicated, automatic manufacturing system.

2. Object-oriented programming

How to set up intelligent and user-friendly control software becomes an important task at the stage of system development. OOP provides a special method of information representation by applying the hierarchy of different components or structures of various organizations, has proven to be a very useful programming concept for flexible automatic manufacturing system. The relationships amongst the components, objects and tasks of a system can be described clearly and well represented by OOP.

OOP is actually based on a frame-based structure. It could be referred to as a semantic net of knowledge representation in an Expert System. The term ‘semantic net’ is used to

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0924-0136/00/$ – see front matter
PII: S0924-0136(00)00469-6

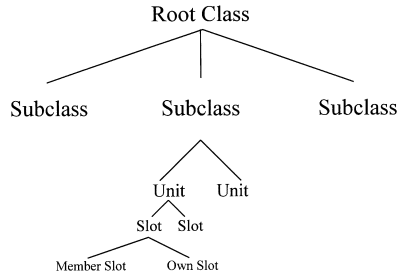

Fig. 1. The hierarchical relationship between classes and slots.

describe the relationship structure here, and it has been well developed to simulate the human intelligence. A semantic net consists of nodes and links. Nodes stand for objects, concepts or events, and links describe the relationships amongst the nodes. Fig. 1 illustrates a semantic net as well as the hierarchical relationship between the classes and the slots.

Just as the items in the semantic net, OOP takes root class as an initial or basic class and subclass as a child class created by the root class. The class represents a group of closely related objects. As shown in the figure, there is an initial (root) class, which creates several subclasses. The end node of a class is called a unit. There are some attributes or slots in the unit. A slot is a fundamental object that holds information regarding a particular attribute of a class. The slots can also be classified as member slots and own slots. Member slots represent the value of the slots that will be inherited by those of the subclass; whilst on the other hand, own slots represent the value of the slots that will not be inherited.

By applying the OOP concept, a programmer can apply code components that have been developed previously. The codes, which represent objects or tasks, can be reused and adjusted easily by the subsequent user. He or she does not have to take care of the types, functions or variable names of the data. The following is an example of the object world for the inventory world (Fig. 2).

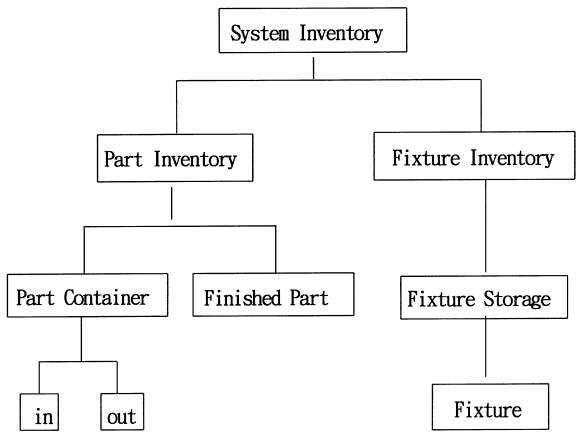

Fig. 2. An object world of inventory.

3. Pre-planning stage of an automatic machine workshop

In order to consider the requirements of various aspects and the usage of an automatic machining workshop (AMW) [2], a pre-planning analysis has been made which is described below:

1. Collecting and analyzing the current and the past manufacturing information of various products and the types of parts that have shown its major proportion. In addition, when considering the manufacture of the most complicated parts in the future, it is advised that the CNC machine center should be selected.
2. In order to determine the production requirements, further analysis of production time requirements has been processed. Other factors such as the future marketing trend, the manufacturing strategy and the total economic environment in the world, are taken into consideration before a decision is made.
3. The installation of an AMW should include the following technical items: flexible manufacturing modules, automatic guided vehicles (AGVs), a monitor/control system and a computer-control measurement system. The first two items can be easily achieved by applying currently existing technology. The monitor/control system is a key element to the success of an AMW, and has to be developed. The computer on-line control measurement system is another technical area that has been explored lately. Therefore, the most urgent needs will be the development of a monitor/control system.
4. A good monitor/control system should provide on-line scheduling, monitoring of AGVs, a flexible manufacturing module, and instant trouble shooting and system diagnosis capabilities. The system should be flexible to face a lot of challenges during testing and provide for instant modification. Another essential technology considered is an off-line computer aided simulation technique which should be capable of predicting precisely the actual machining time of an AMW.
5. Fixture design and tool life are further topics to be considered in the running of an AMW. They are important because they can provide a very strong back-up to keep the system running smoothly. CAD/CAM simulation technique and NC part programming functions are also fundamental tools for the installation of an AMW.

4. The configuration of an automatic machining workshop control system

In order to make this project possible and workable, a proposed AMW is planned, which includes the following hardware [3], a system cell controller, machine centers,