THE COMPUTER-AIDED GROUP TECHNOLOGY CLASSIFICATION AND CODING SYSTEM FOR THE CASTING INDUSTRY - METHODOLOGY AND ITS APPLICATION

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ABSTRACT

A group technology(GT) classification and coding system could provide a better integration of CAD/CAPP/CAM in the casting industry and could streamline the design, process planning and manufacturing operations. The paper presents a methodology and applications of a computer-aided classification and coding system for casting industry. The system is centred around a code structure database, which can accommodate the needs of different system users, and allow for change and expansion. The difficulties in developing a classification and coding scheme for casting industry is also enumerated. The GT system developed were implemented in a company to support process planning operation.

INTRODUCTION

Casting manufacturers are often diverse in nature and manufacturers frequently specialise in selected product lines. In addition, with rapid development of manufacturing technology, products which have new features and new manufacturing technologies are introduced constantly. As a result, it is often difficult to develop a classification and coding GT system for manufacturing of casting.

Computer aided classification and coding is a relatively recent enhancement to GT occuring mainly within the past decade(1). A number of computerised coding and classification programs have been noted in the literature (2,3,4,5,6). As recently as 1981, however GT professionals still shared mixed views on application of computers to classification and coding(7). Almost all the programs has been developed for a specific coding scheme, with little or no flexibility. With the advent of new technology and the prolification of computers, a great deal of attention has been focused on applying these general principles to casting industry. Unfortunately, traditional classification and coding systems such as OPITZ and K-K series are grossly inadequate when applied to foundry industry. A unique classification and coding system for casting parts and assemblies is needed to realise the economics of GT.

Since the classification and coding system provide the system integration (SI) foundation on which subsequent applications are based, there are very few such applications for casting industry. One of the most important of the GT based functions in a CIM system is process planning, which bridges the gap between design and manufacturing.

The paper outlines the methodology and application of a GT based computerised classification and coding system for casting which was conducted in joint collaboration with a major casting manufacturers in the United Kingdom. The GT system was designed to support process planning operation of the company.

DIFFICULTIES IN DEVELOPING A CLASSIFICATION AND CODING FOR CASTING

The management of foundry operations is in many ways an exercise in - the measurement of imponderable, the manipulation of uncertainities and the making of decisions by sheer guess work. One of the major reasons for this is the enormous difficulty in making any quantitative assessments in a production process with what is often said to a continually varying product mix.

The major problem facing development of GT code lies in the relative complexities of casting production. The important design and manufacturing information that should be captured by a coding system for casting is often difficult to express through traditional geometric and dimensional classification. Code attributes which are relevant for casting components are fundamentally different from machined parts. Compounding the problem many attributes relevant to one sub-set of casting parts are often inappropriate for others, making development of an all-inclusive coding system a difficult task.

CLASSIFICATION OF CASTINGS

Classification of castings is both the most logical means of proceeding towards group manufacture in foundries. Classification is in terms of both quantifiable and subjective parameters(or characteristics) which may include some of the following:

Casting weight
Casting size(linear or volumetric)
Casting material
Casting process sequence
Complexity of form or manufacture
Demand for casting(number per month /year, etc)
Casting quality
Inspection requirement
Production difficulties
Surface finish / Dimensional requirements

The selection in a given situation depends entirely on the nature of the product and whether it is made in sand or permanent dies and the main purpose of the classification system.

TYPES OF CLASSIFICATION SYSTEM FOR FOUNDRY

The type of classification system used will depend mainly upon the type of foundry involved and to a lesser extent on the purpose of the system.

For instance, in a mass production automotive iron foundry, families of castings may appear self apparent. Unfortunately, splitting into groups based on functional name can be very misleading as small differences in product shape can have material influence on the manufacture methods and cost of production. It is important that for any foundry contemplating GT to produce a classification which accurately defines the product mix with particular emphasis placed on the definition of shape and complexity.

The classification system need for example only be a simple coding covering four main areas:
(i)Shape, (ii)complexity, (iii)weight, and (iv)material

Steel foundries will almost always require a more comprehensive system of digits than a iron foundry and benefits will ensure from having the following areas classified:
(i)weight,(ii)material/process route,
(iii) quality, (iv)shape, (v)volumetric size

METHODOLOGY FOR DEVELOPING A CLASSIFICATION AND CODING SYSTEM FOR CASTING

Casting manufacturers are often diverse and complex in nature and frequently specialise in selected product line. An initial breakdown into major family is a first step in developing a classification and coding system. Each families are characterised by its own set of attributes. These attributes are defined based on their applications of the code. For the classification of parts, the hierarchy decision tree is the most suited in terms of being able to group, divide and search through different application concepts. The multicode structure is usually uses an hierarchical tree to define product families, each with its own polycode set of attributes. The first level of the tree consists of the basic parts families. Each family of parts is mutually exclusive in terms of design attributes and geometric considerations. One of the major element in the development of an appropriate coding scheme is the ability to identify families and parts that possess similar characteristic. In order to identify such groups the application of coding system should be taken into consideration. A coding scheme for process planning may require definition of major families which could be different from those developed to support design functions, since the part characteristic and attributes for both applications are different. Although it is possible to develop a single coding system to encompass several application areas, e.g. design, process planning, manufacturing. A survey and analysis of all the important attributes for each application will help to develop meaningful families to support single coding system.

Most casting industry have some form of crude classification of general types which can provide the initial input for the definition of part families. A survey by the author identified the following functional categories for casting manufacture:
(i). Pattern, (ii). Core (iii). Moulding (iv). Finishing

At this stage it was necessary to define the application-related attributes for each major family in order to identify the major attributes that distinguishes like and unlike parts. A single set of attributes was defined for each major family. This set should be applicable to all the parts which are included in the family and should encode parts features which are relevant to the application for which the code is designed. Each attribute was assigned a set of distinguishing values and should capture the differences between parts of a given family. The values may be discrete or non-discrete type, a continuous scale or division of values into appropriate ranges as in the case of melting temperature of metal, weight of casting etc.

In developing the definition of the attributes and various attribute values , the knowledge of experienced process planner and designers and pattern makers proved to be invaluable. The code developed should have flexibility in the coding structure to take into account the future changes in technology and their application. The final stage in developing the coding system is to incorporate the part/assembly attributes into a compact code. This was achieved by assigning code digits to each selected attributes.

The coding follows each level of the decision tree; one digit assigned to each level. Once the tree is defined and the parts classified, the coding identifies the parts and could be used in computer applications. The number of digits which was assigned to describe each attributes depends on the number of attribute values. An attribute with ten or less value was assigned with a single decimal digit. The alphabetical codes or hexadecimal digits was used for attributes with more than ten values. The decimal and hexadecimal digits are preferable in some computer applications. This could facilitate the use of bar-coding scanner for reading the GT codes. When an attribute has a wide range of possible values, several digits was used to describe it and an hierarchical structure is derived. For example, when describing part families, the first digit may be used to define a major product family while the next digit was used to define groups within that family. Fig. 1 shows use of such a hierarchical code to describe major family groups identified in a coding and classification system for casting. One of the major advantage of using polycode scheme is its scope for future expansion. Because of the infinite variations in the design, technical content, methods of manufacture, new parts always need to be created , classified and added to the data base. Thus there must be room to expand the hierarchical tree and the code. The ploycode scheme allows for room to grow and is therefore best suited for the purpose of the research. Fig. 2 illustrates the process of classification and user code design.

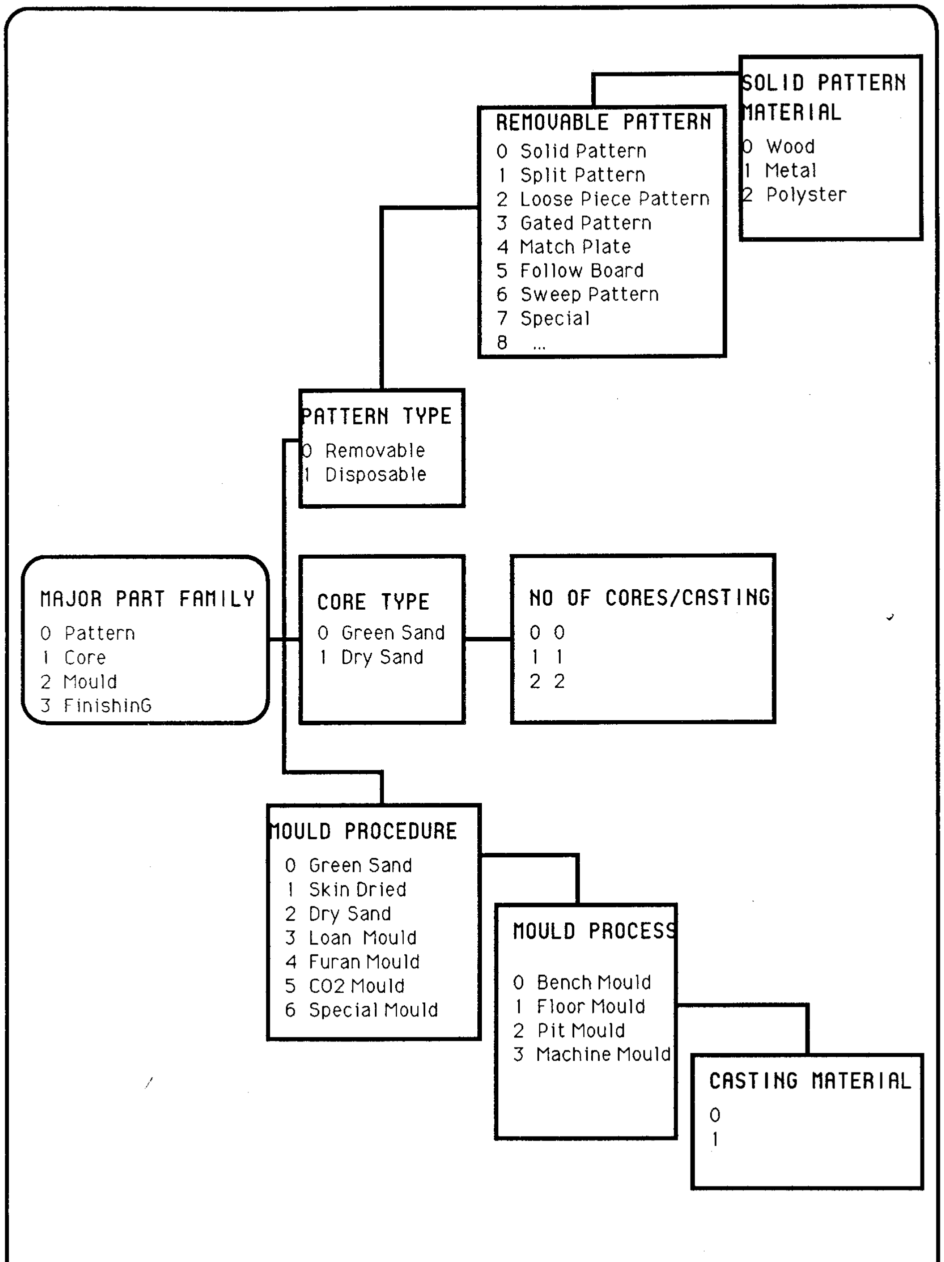

FIG. 1 THE PARTS CLASSIFICATION OF MAJOR FAMILY GROUPS OF CASTING

[COMPLETE CLASSIFICATION NOT SHOWN]

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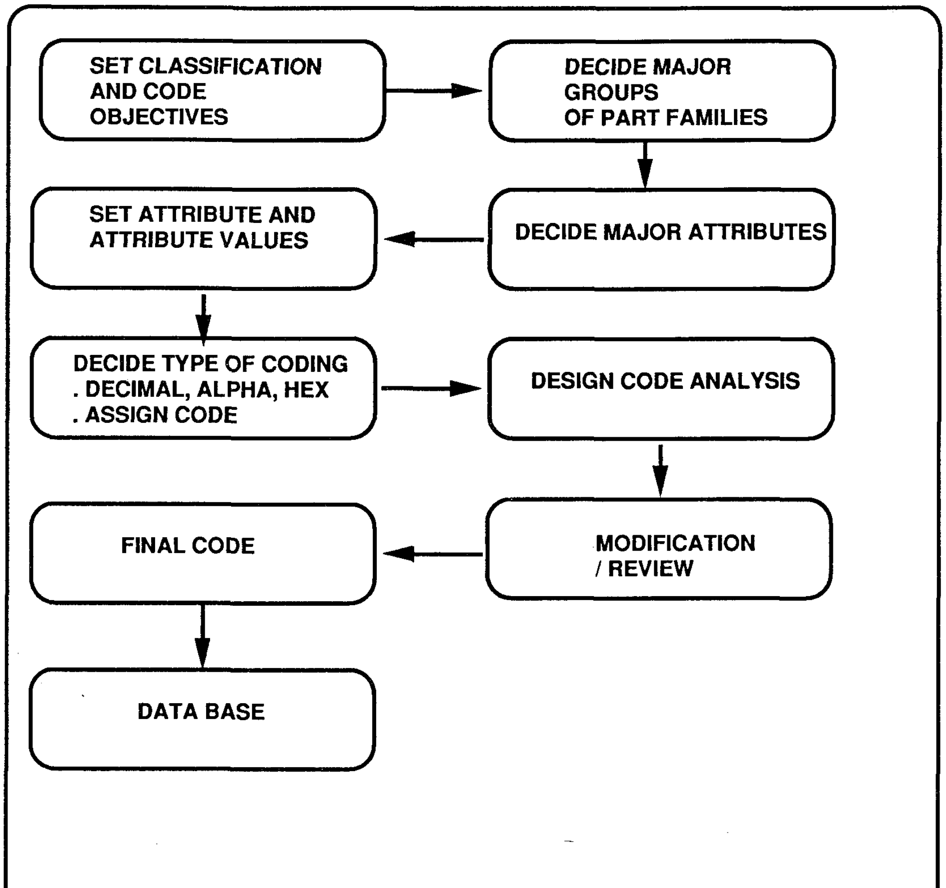

FIG 2 THE PROCESS OF USER CODE DESIGN

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One of the major objective was to apply GT principles to casting industry the classification and coding method should be computerised so as to integrate it with a computer aided process planning system. In Fig. 3 a block diagram shows how the classification and coding data could be used in CAPP or other system. In the system shown, the classification and coding concept was implemented using a relational database system. Once a casting part number is entered into the system, the database will show part families allowing user to enter search parameters. Either a match or no-match will result. If the part number already exists a distinct code is generated; otherwise, the user is asked to select similar pattern/design to retrieve a part description code for either modification or for creating a new code. The code thus generated also serves as a link between the relational database and the CAPP system, because they are separately configured.

CONCLUSION

This research was conducted in order to find an effective classification and coding scheme for casting based on GT approach and a means of integrating CAD/CAPP/CAM. A computer -aided coding and classification using hierarchical tree method and the use of interfacing with a CAPP system were described.

An effective classification and coding system is important to the casting industry in order to benefit from GT applications. It can streamline the design, process planning and manufacturing process and can provide a better integration of CAD/CAPP/CAM systems. A methodology and set of supporting tools was suggested, to help develop classification and coding system. The system is based on analysis of the difficulties inherent to development of a classification and coding system for casting components. This methodology and tools were already implemented in developing a classification and coding system to support a computer aided process planning for a foundry.

REFERENCES

[1]. Mackowiak, R.M, Cohen, P, Wysk,R "Development of group technology workstation "Proceedings of the 3rd Int. Conference on CAD/CAM, robotics and factories of the future, Springer-Verkag,Berlin, 1989

[2]. Barash, M "Group technology considerations in planning manufacturing system", Proceedings of the SME CAD/CAM IV conference, November, 1976

[3]. Carrianger, R "Interactive computer - aided classification and coding" Master of Engineering Thesis, Industrial and Management System Engineering Department, The Pennsylvania State University, 1982

[4]. Emerson, C, Ham, I"An automated coding and process planning systems using a DEC PDP-10", Computers and Industrial Engineering,Vol. 6, No. 2, 1982

[5]. Emerson, C Hon, I "Automated coding and process selection Bond, V- ACAPA", Proceedings of the IXth North American ManufacturingResearch Conference and 1981 SME Transactions, SME, May, 198

[6]. Houtzeel, A"Group technology via a computer",American Schilperoot, Machinist, Vol. 119, No. 117, 1975

[7]. Hyde, W "Improving productivity by classification and coding, and database management: the key to maximising CAD/CAM and group technology", Marcel Dekker Inc., New York, 1981

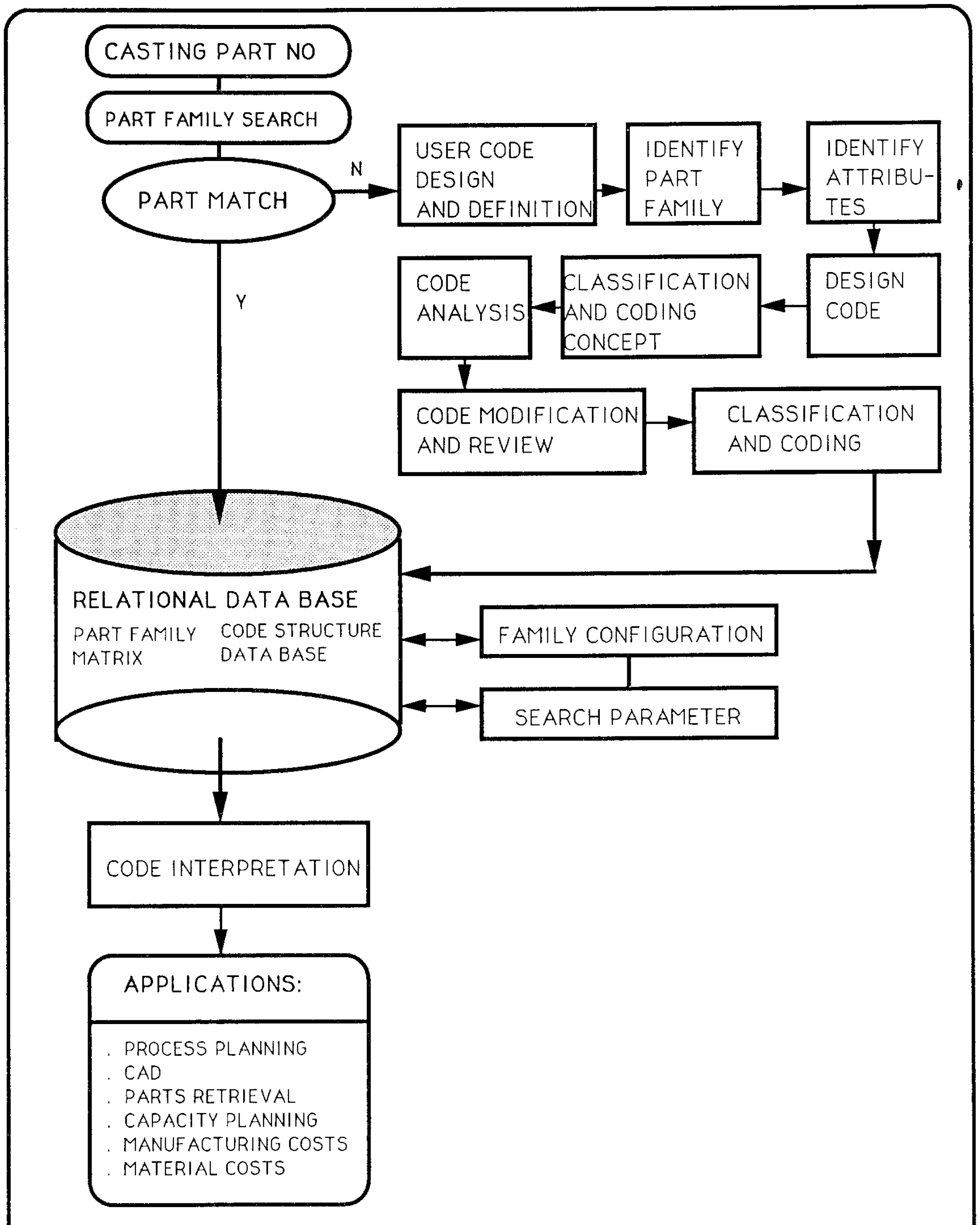

FIG. 3 BLOCK DIAGRAM FOR GT CLASSIFICATION AND CODING FOR CASTING

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20. 03. 1990