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Running Process Planning System with Feature Library for Wiki-based Development

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Abstract

A manufacturing feature is just a geometric shape plus the manufacturing information required to make the shape. A feature library is essential in the extraction of manufacturing features with their associated manufacturing information in a feature-based process planning system. However, in order to manage manufacturing information flexibly, it is necessary to create an easily modifiable feature library. A Wiki-based feature library is presented in this work.

Keywords: *Feature library, feature ontology, process planning, Wiki, Media Wiki. Manufacturing feature*

INTRODUCTION

COMPUTER Aided Process Planning (CAPP) enables the integration of a Computer Aided Design (CAD) system, which automates product design, and a Computer Aided Manufacture (CAM) system, which automates manufacturing. Feature technology has emerged as the enabling technology to translate CAD product data to manufacturing information in order to allow the CAD system to communicate with the CAPP system [1]. Many methods for extracting characteristics from CAD product data have been developed [2].

To extract manufacturing features for the production of process plans, a feature library comprising pre-defined features and manufacturing information to establish the shape of the features must be developed [3].

Manufacturing information includes needed machine and tool data, expected cost and time data, and so on [4]. Because manufacturing technologies are evolving and manufacturing information utilised in one factory may differ from that used in another, it is vital to create a feature library that is simple to edit or customise. However, in general, feature libraries are not designed to be easily modified, especially by those with little expertise in information technology. Wiki, on the other hand, has shown to be a user-friendly interface in the context of web collaboration. For example, the community of Wikipedia.org, the free content encyclopaedia, is growing. More than 450,000 people have made contributions to Wikipedia, either by creating or editing articles. Wiki is a collaborative tool, a conversation medium, and a store of ideas. It is a straightforward publishing system that is simple to understand and utilise [5]. Wiki users may build or amend Wiki pages by writing text in a simple syntax. As a result, it is reasonable to assume that an expanded Wiki will be beneficial for the creation of a feature library that is simple to edit.

This paper describes the creation of a Wiki-based feature library. The function feature ontology and the manufacturing feature ontology comprise the feature library. Sub-classes of function features are formed depending on the needed functionalities of the face parts that construct the features as the designers intended. To produce the form of the manufacturing features, sub-classes of the manufacturing features are created based on current production processes. The relationship between the two onto logiest is specified to make the feature library helpful for the extraction of manufacturing information to generate the shape of the manufacturing features. Section 2 describes the evolution of the feature library's structure. Section 3 shows how to modify Wiki software to create a Wiki-based feature library. The study conclusions are presented in Section 4.

The Feature Library's Organization

Taking into Account the Designer's Intention for the Extraction of Manufacturing Features with Their Correct Manufacturing Information It is critical to comprehend the designer's purpose in order to extract correct manufacturing information to generate the shape of manufacturing features. Depending on why the designer intended the geometrical shape, one through-hole feature may require cylindrical grinding to generate the shape, while another through-hole feature

may require threading to make the shape. As a result, for the extraction of manufacturing features with their correct manufacturing information, it is vital to evaluate the designer's aim.

The functions of the face elements that form the features in this study show the designer's aim. A face element is defined as a geometrical object with a collection of edges. The functional data of the face elements may be divided into three categories: fundamental function, mechanism used to realise the basic function, and motion condition and direction. Other studies [6][7] provide a detailed description of the functional data items.

Table 1 displays the functional qualities of face elements utilised in the construction of the function feature ontology.

Table 1 Content of Functional Properties

Basic Function	Mechanism utilized for realization of the basic function	Condition and direction of the motion
Transmission of motion	1: friction-mech., 2: gear-mech., 3: link-mech., 4: cam-mech.	1: liner, 2: smooth-liner, 3: very-smooth-liner, 4: round, 5: smooth round, 6: very smooth round
Constraint of motion	1: rigidity-mech., 2: ball-bearing-mech., 3: sliding-mech.	1: liner, 2: weak-radial, 3: strong-radial, 4: weak-thrust, 5: strong-thrust
Fixation of motion	1: bolt-and-nut, 2: bolt-only, 3: friction-mech., 4: bearing-fit, 5: key-fit, 6: river-fit, 7: shrinkage-fit	1: stationary-object, 2: revolutionary-object

Creation of the Function Feature Ontology, the Manufacturing Feature Ontology, and the Relation between the Two Onthologies

Figure 1 depicts the function feature ontology, the manufacturing feature ontology, and their relationship. The following are two processes for developing the function feature ontology, the manufacturing feature ontology, and the relationship between the two ontologies.

1. Developing function feature ontology. A function feature is defined here as a geometric form and its intended functions. To begin creating a function feature ontology, features such as slot, step, and so on are listed. This study employs the list of characteristics presented in [8]. Then, by specifying the needed functionalities of the face elements that compose the features, sub-classes of these features are generated. The manufacturing feature ontology is being developed. To begin, manufacturing characteristics such as step, slot, and so on are specified. Sub-classes of these manufacturing characteristics are developed by specifying the parent classes' general production procedures. Sub-classes of these sub-classes are defined in order to be related to the function feature ontology. The relationship between the classes in the manufacturing feature ontology's lowest level and the function feature ontology shows how manufacturing features should be built to satisfy the needed functions of the face parts that compose the manufacturing feature.

2. Development of the manufacturing feature ontology. To begin, manufacturing characteristics such as step, slot, and so on are specified. Sub-classes of these manufacturing characteristics are developed by specifying the parent classes' general production procedures. Sub-classes of these sub-classes are defined in order to be related to the function feature ontology. The relationship between the classes in the manufacturing feature ontology's lowest level and the function feature ontology shows how manufacturing features should be built to satisfy the needed functions of the face parts that compose the manufacturing feature.

In Fig.1, a "internal turning and milling blind-hole" feature class is constructed to connect the manufacturing feature ontology's round blind-hole feature class with the "round blind-hole with 2 faces

require: Fixation (basic), Mechanism (bearing fit), Motion (stationary-object), 1 face requires: The function feature ontology's "Basic: constraint, Mechanism: ball-bearing, Motion: strong-thrust" class.

This is done because internal turning and milling can provide the spherical blind-hole that the designer envisioned. Then, during the feature library development process, a collection of possible manufacturing information, such as machine and tool data, should be prepared for the instances of the "internal turning and milled blind-hole" feature class, so that when a round blind-hole feature is extracted by a feature recognition method, and the functional properties of face elements that construct the round blind-hole feature lead to the extraction of the "internal turning and milled blind-hole" feature class. As a result of building the feature library based on the suggested structure, the feature library can be used for the automatic extraction of manufacturing features together with their associated manufacturing information.

The automated extraction of manufacturing features with their associated manufacturing information is extremely beneficial for the implementation of a manufacturing feature-based CAPP system.

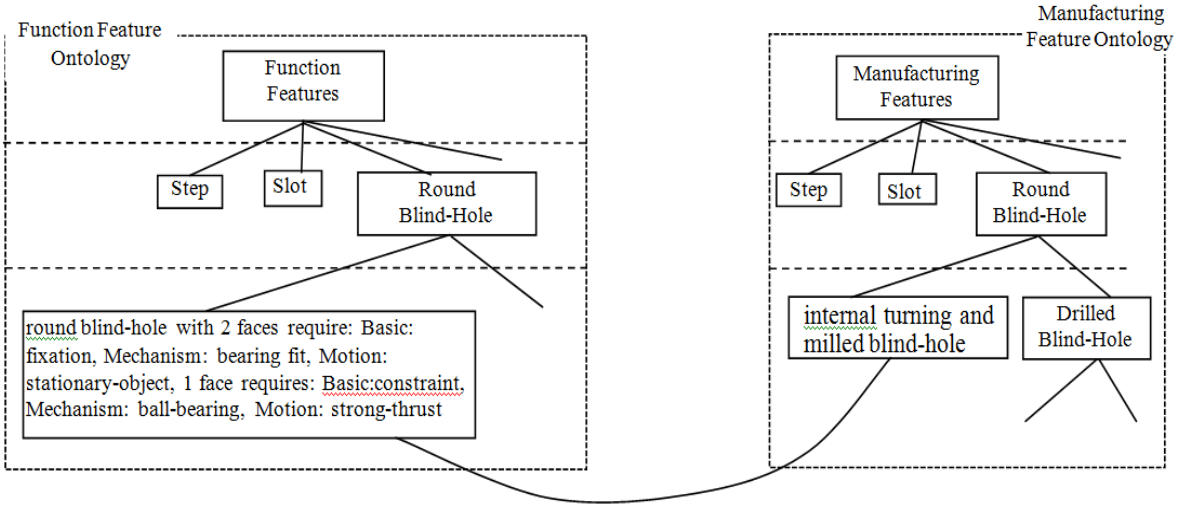

Fig. 1 Function Feature Ontology, Manufacturing Feature Ontology, and the relation between the two ontologies

THE WIKI-BASED FEATURE LIBRARY

Semantic Extension of Media Wiki

Media Wiki is Wiki software that is written in PHP and uses MySQL database. It is being used to run the Wikipedia and also other encyclopedia and dictionary sites. Media Wiki is a very useful tool for collaborative content management. An extension of Media Wiki to enable the writing of the labeled link has been proposed [9]. This extension has enabled the Wiki to write Resource Description Framework (RDF) statement, which consists of subject-predicate-object triple. The Wiki syntax is [[Term: target_page|property]]. The RDF triple is <source page><property><target page>. Each time the Wiki syntax is used, the Wiki engine will store the RDF triple into a table in the Wiki database. By directly querying the table, the labeled link relation will be displayed as follows.

1. On the source page: -> property -> target page
2. On the target page: <- property <- source page
3. On the property: source page -> target page

Fig.2 illustrates the RDF triple construction and the relation of pages displayed on the Wiki pages in the extended Media Wiki. The extended Media Wiki as an extension of Media Wiki has the benefit of having all the functions available in Media Wiki as a content management system, and can be used as an editor of metadata according to simple RDF statement. The running system of the extended Media Wiki is available at http://semanticwiki.jp. It uses the Media Wiki 1.3.11 version as the base system. The development of the Wiki-based feature library is based on the extended Media Wiki proposed in [9].

Developing a Wiki-Based Feature Library

For the development of the Wiki-based feature library, further extension of Media Wiki is done. New namespaces are created. Namespace (“FF:”) is created to deal with the function feature ontology, and namespace (“MF:”) for the manufacturing feature ontology. New tables are also created in the Wiki database to deal with the new namespaces. For the creation of the function feature ontology, the Wiki syntax [[FF: feature_subclass|subclass]] is used (see Fig.3). When the Wiki syntax is written on the parent class page, the Wiki engine will store the RDF triple into a table which deals with the namespace (“FF:”) in the Wiki database. By directly querying the

table, the labeled link relation will be displayed as follows.

1. On the parent class page: -> subclass -> feature subclass (see Fig.4)
2. On the feature subclass page: <- subclass <- parent class (see Fig.5)
3. On the subclass page: parent class -> feature subclass (see Fig.6)

The "FF: subclass" page can be used to see all the class-sub-class relations of the function feature ontology.

For the creation of the manufacturing feature ontology, the Wiki syntax [[MF: feature_subclass|subclass]] is used. When the Wiki syntax is written on the parent class page, the Wiki engine will display the labeled link relations in the same way as in the function feature ontology. The "MF: subclass" page can be used to see all the class-sub-class relations of the manufacturing feature ontology.

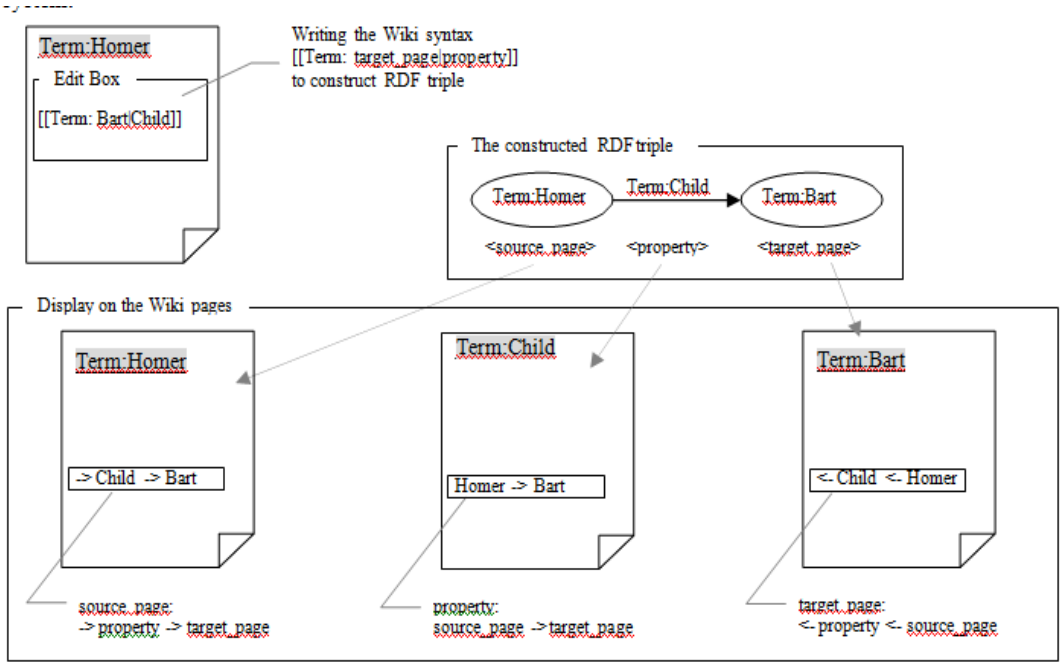

Fig. 2 RDF triple construction and the display on the Wiki pages in the extended Media Wiki

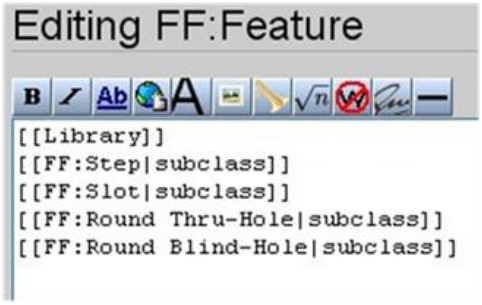

Fig. 3 Writing the Wiki syntax [[FF: feature_subclass|subclass]

Fig. 4 Display on the parent class page

Fig. 5 Display on the feature subclass page

Fig. 6 Display on the subclass page

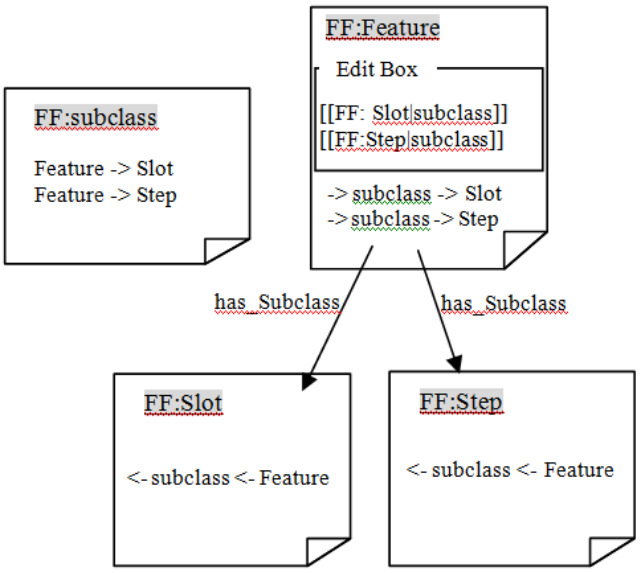

Fig. 7 Page relations in the function feature ontology

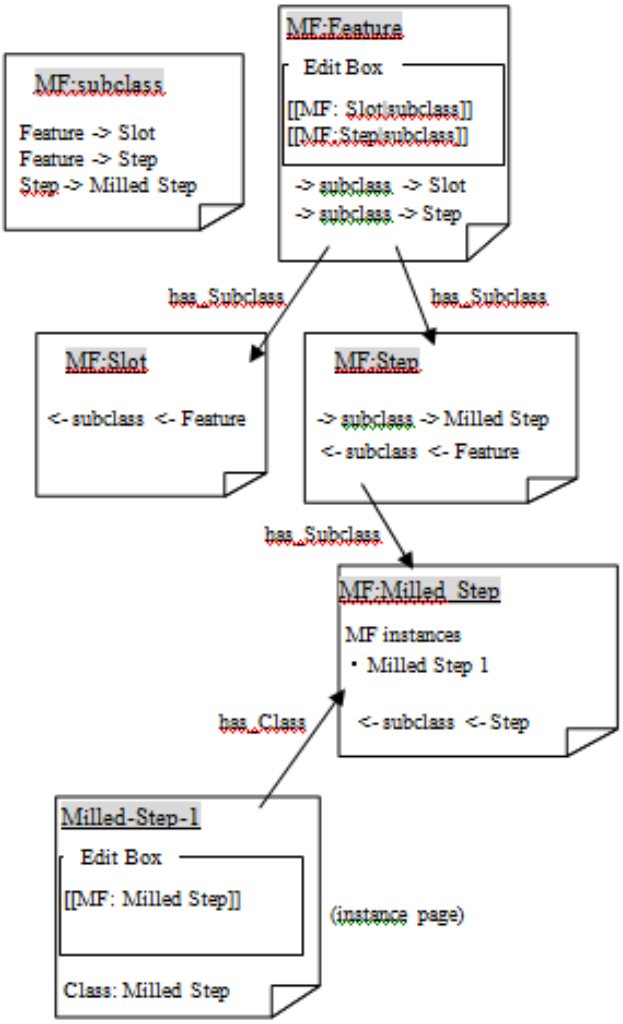

Fig. 8 Page relations in the manufacturing feature ontology

For the class-instance relation in the manufacturing feature ontology, the Wiki syntax [[MF: feature_class]] is used. When the Wiki syntax is written on the instance page, the Wiki engine will display "Class: feature_class" on the instance page. On the feature class page, the instance will be listed under the "MFInstance" column.Fig.7 and Fig.8 illustrate the page relations of the function feature ontology and the manufacturing feature ontology in the Wiki-based feature library, respectively.

To make the relation between the lowest sub-class of the function feature ontology and the lowest sub-class of the manufacturing feature ontology, the Wiki syntax[MF:manufacturing_feature_class|related] is used. Fig.9 shows the Wiki syntax writing on the function_feature_class page. When the Wiki syntax is written on the function feature_ class page, the Wiki engine will display the labeled link relation as follows.

1. On the function_feature_class page: -> related -> manufacturing_feature_class (see Fig.10)
2. On the manufacturing_feature_class page: <- related <- function_feature_class (see Fig.11)
3. On the related page: function_feature_class ->manufacturing_feature_class (seeFig.12)The "MF: related" page can be used to see all the relations between the lowest sub-class of the function feature ontology and the lowest sub-class of the manufacturing feature ontology. The Wiki-based feature library is able to construct the function feature ontology, the manufacturing feature ontology, and the relation between the two ontologies. The Wiki-based feature library can be easily, visibly and collaboratively modified. And since the original Media Wiki has the capability to manage contents, it can be used to manage the manufacturing Information flexibly.

Fig. 9 Page relations in the function feature ontology

Fig. 10 Display on the lowest sub-class of the function feature ontology

Fig. 11 Display on the lowest sub-class of the manufacturing feature ontology

Fig. 12 Display on the "MF:Related" page

CONCLUSION

This study may be summed up as follows: The function feature ontology and the manufacturing feature ontology comprise the feature library. The relationship between the classes in the manufacturing feature ontology's lowest level and the function feature ontology shows how manufacturing features should be built to satisfy the needed functions of the face parts that compose the manufacturing feature. The extraction of manufacturing

features with their correct manufacturing information for the production of process plans is made feasible by constructing the feature library based on the suggested structure.

The Media Wiki has been changed to aid in the creation of the feature library. The Wiki-based feature library may build the function feature ontology, the manufacturing feature ontology, and the relationship between the two. The Wiki-based feature library is a very simple system, and when one attempts to edit the feature library, the visual modification of the feature library may be enjoyed.

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