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Reconfigurable Manufacturing Execution Systems Based on Model-driven Architecture

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Abstract. By analyzing the trend of MES (Manufacturing Execution Systems), the concept of RMES (Reconfigurable Manufacturing Execution Systems) is put forward, which takes information integration as groundwork, aims at optimization of production processes and supports organizations, resources and processes for flexible conFig.. MDA (Model-driven Architecture) is introduced to provide more flexible in the process of the development of RMES, which would adapt to different technology used by the bottom systems and provide a more effective method to build RMES. During the development of RMES, many models are created, such as the model of business analysis, the model of components and the model of deployment. An instance of the system of plan, part of RMES, is presented to show how MDA used in the process of the development of RMES. Later, an application is given to show that RMES based on MDA can decrease the costs of development and maintenance for fitting the evolution of the enterprise.

Introduction

As the bridge of the enterprise applications between management and control, Manufacturing Execution System (MES) faces the challenges not only to interior requirement of system but to the businesses contacted with it. Since 1970's, the Traditional MES (T-MES) grow from the applications of workshop, which just for the special production or function. Later, the technologies of object-oriented, message, component were applied to the development of Integrated MES (I-MES). Although the functions of MES were integrated to I-MES, it was not wildly used for the high cost and poor capacity of reconfiguring [1].

Reconfigurable Manufacturing Execution Systems

On different points of view, many scholars studied on MES such as agile manufacture, reconfigurable manufacture and software development. Those studies show the same requirement of the reconfigurable capacity. Refer to the literature[2,3], RMES can come down to: Based on the pattern of reconfigurable manufacture, MES can quickly and smoothly reconFig. in static or dynamic state by keeping the basic characters and adapting to the changes of requirement not only in the phase of development but maintain.

The notion RMES includes: (a) Based on the theory of reconfigurable manufacture, the dynamic changes of MES should be deal with in systemic viewpoint. (b) MES should be moderately and smoothly reconFig.d and the basic characters are kept which include kernel business flow and application frame. (c) The reason to reconFig. MES is that the changes of environment and requirement of end users. Those changes are the driver of RMES and to reconFig. is the aim to adapt those changes.

RMES Based on Model-driven Architecture

Domain Analysis of RMES. As the criterion of OMG, UML（Unified Modeling Language）promoted Model-Driven Architecture (MDA) and a series of standard architectures are afforded by OMG. MDA takes the model as work piece and promotes the model, until the endgame how to realize is taken into account.

By analyzing many domain models and combining the experiences of the author, a domain model for RMES is put foreword. The Fig. 1 shows it as following. An example as following is show how to reconFig. MES to support the changes from business. The content to reconFig. mainly includes the dynamic conFig. in running, restructuring the design scheme (such as getting the new child class or modifying the old class) and reconfiguring the business. [4]

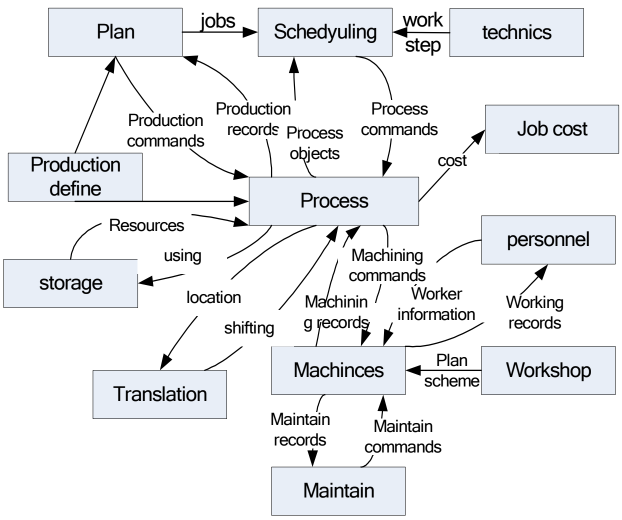

Fig.1 Domain analysis model of RMES

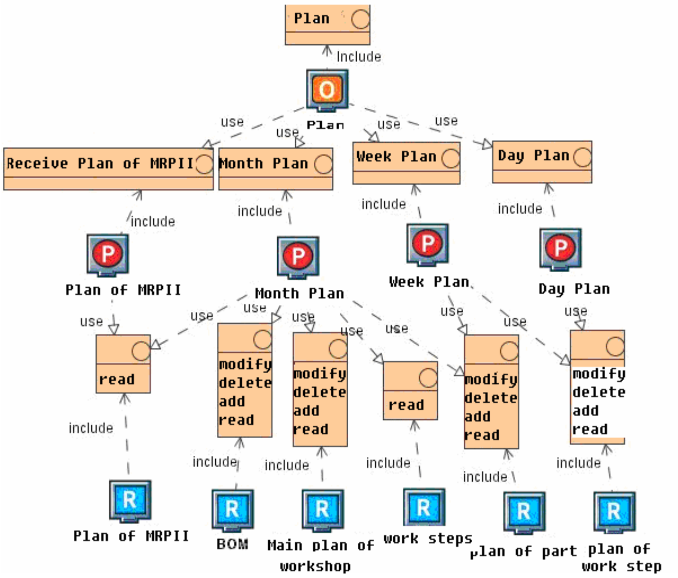

Fig.2 The plan interface model of RMES

Convergent Object of RMES. Convergent Architecture (CA) was put out by Richard. CA is used to RMES can simplify the procedure of domain analysis, which includes three classes of object: Organization, Process and Resource. The Organization is the kernel, which provide an interface model for abstract and it can be visited by client. The Process will link the other objects by distributing responsibility of Organization to every Process object. The Process will provide business interface to every basic business and assemble them. The Resource can manage the business information no matter static or dynamic, which will provide the interface for business object to create, update, remove and query. Fig. 2 show an interface model for plan management of RMES.

Grains of RMES. The technology of SOA is used to information integration of RMES. Based on SOA, RMES can define services for the service function and the receiving or sending data quantity, such as fine-grained service, coarse-grained service or combination-grained service. The grain-service includes two meanings: (1) how to realize the service. (2) how much data or messages are sent or received. The relation between the grain service and information integration of RMES is shown in Fig. 3. The coarse-grained service provides more complicated business function and exchanges more data. The end clients of RMES cannot directly use the fine-grained service, but it can be used for coarse-grained service or combination-grain service. The fine-grained service carries out the least function and exchange for a small amount of data. The application of RMES cannot directly be set up by fine-grained service because it will destroy loose coupling of SOA. Coarse-grained service can use more than one fine-grained service, but it can not provide the security and control of meta service. The combination-grained service can be assembled by fine-grained services and coarse-grained services.

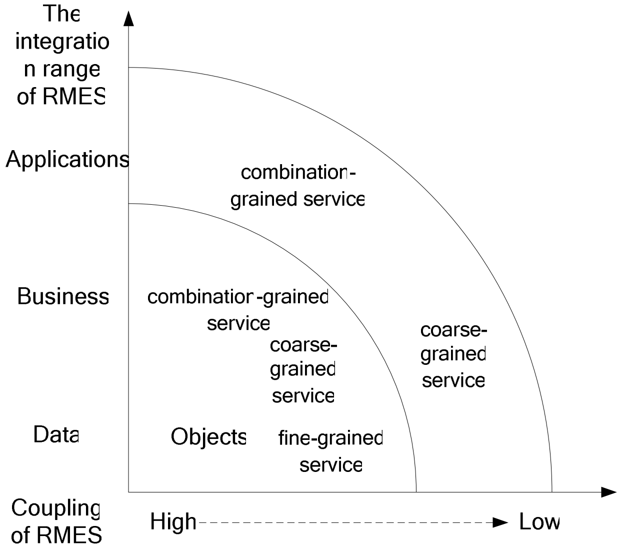

Fig.3 Relation between grains and couple of RMES

System Realization of RMES

System Realization Process of RMES. The steps of the system realization process of RMES include:

(1) System analysis: collect requires of users and confirm the system's boundary and the running environment. First, the case model is used to collect the requirements until the last coincident understanding coming. Second, the data dictionary of RMES is constructed to prepare for Data Sharing. Last, a unanimous interface to end users will be confirmed.

(2) System refine: referring to the application frame of RMES, business model to application system can be constructed by adjusting the frame. Component model come into being by using the CA on business model. Model for component assembly can construct by configuring and assembling the component model. And some component will be encapsulated by Web service to interface for application integration.

(3) System construct: the tool of MDA is used for mapping the model to codes and build a code frame. Later, some proper codes are added into the frame and finish the system development. The test for integration and security is carried through to ensure the system's usability and security. The finished application system comes into being after locale config and adjust.

Accessor Model of RMES. Accessor model of RMES shows the accessor component in the context. This model includes ten components: system manage, ground data, plan manage, tool manage, quality manage, process manage, stock manage, data manage, equipment manage, login on manage.

The representer mainly includes:(1) StartFrame representer not only initialize and startup the system but provide an uniform interface for users. (2) MainFrame representer is the main frame of user interface, which includes: HeaderFrame, ItemFrame and WorkFrame. HeaderFrame mainly show subsystem list and information of system. (3)ItemFrame shows the function list of every subsustem. WorkFrame locate on the right and down includes OperateFrame and ListFrame. The Operateframe mainly provide user's operation. ListFrame mainly shows the user's request.

Realize of RMES

Fig.4 shows the relations between uniform style of interface and representer. This user interface reflects the system representer on client layer and includes six frame. The user interface Main maps to the MainFrame representer which manages the style and layout of the user interface and compose of Heade,Item and Work. Head maps to the HeaderFrame representer which mainly includes the function list of subsystem and can display the name and edition information of the system.Item maps to ItemFrame representer which show the functions of the subsystem in function tree. Item can provide special function according to the user's type. Work maps to WorkFrame representer includes Operate and List which maps to OperateFrame representer and ListFrame repersenter. Operate mainly contain various toolbar and button and user can add, modify, delete, submit and query . All those operations' result put in or executed can display or operate in list.

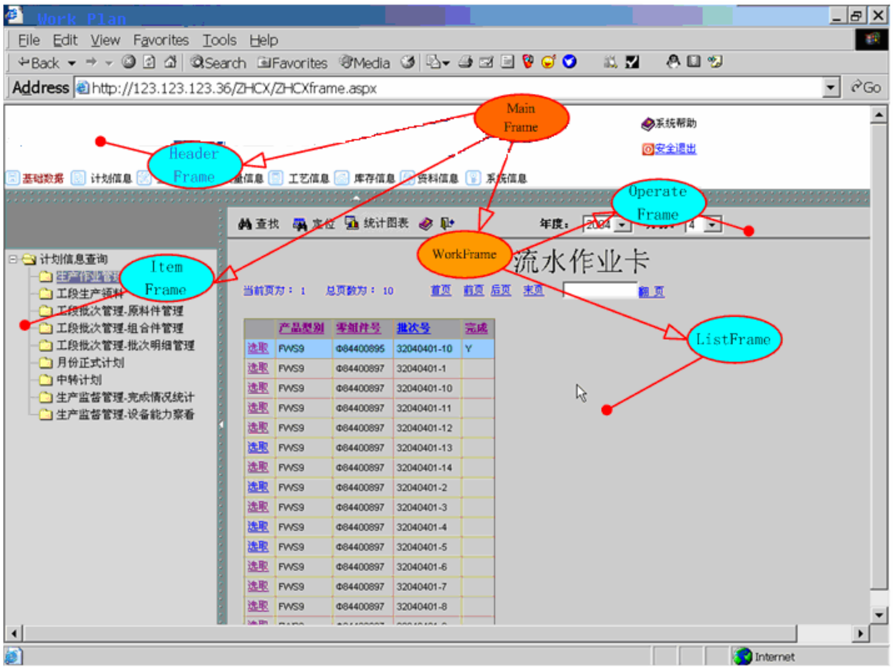

Fig.4 The relation between interface and representer

Summary

The paper analysis the trend of MES and point out that RMES has been an important hot point .by introduce the connotation of RMES, the conclusion comes that RMES will lower the cost of development and maintain. So RMES show an effective approach for the study on MES.

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