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Designing workshop management system supporting decision making with OODB

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Abstract

In this study, a workshop production management system supporting decision making is designed for use in small and medium-sized machine workshops. Small and medium sized companies' quality, price, and delivery time issues are in a tough competitive environment. Especially such as the orders which cannot be delivered to customers in time, disruptions in production schedules and low production performance seem to be the major problems facing in this type of sector. Through this research it is aimed to design software to keep all the needed information in a suitable database and give the customers fast and accurate information. In order to support future implementation of decision support system, the software is designed such that it will enable the user to easily analyze its production parameters such as efficiency, cost deviation of production from planned cost, cost estimation of new production, etc. Due to the natural structure of this project Object Oriented database is chosen for implementation. These databases can be constructed through object-oriented language and in the scope of this work .NET based db4o is used. For software development, Unified Modelling Language (UML) is used since by using UML the database system is well defined, visualized, generated and specified considering complete project. The user interfaces are designed by using ASP.NET for easy access of the user location independently. It is seen that without using so much coding load, an effective object-oriented database can be designed. It is possible to use the same language for both application and object-oriented databases in contrast to relational databases. The designed database can be used in different machine workshops with small modifications depending on the specifications of workshops.

Keywords: Workshop Management System; Object Oriented Database; UML; Web Based Interface; Decision Support System

1. Introduction

Nowadays small and medium sized companies cover 90% of all firms, and the contribution to our country's economy and labor force is remarkable. But quality, price, and delivery time issues are in a tough competitive environment. Because of the problems such as orders which cannot be delivered to customers in time, disruptions in production schedules and low production; firms face some performance and efficiency issues. So they intend to improve their productivity and competitiveness getting advantages by using the information technology in their work.

In the recent years the trend in manufacturing systems is to change from island of automation to enterprise-wise integration, from physical processing workers to information processing workers, and from management of people/activity to management of information about people/activities \cite{1}. Since information takes the center part of
the new manufacturing management system, databases have vital importance for the system. Some authors point out the increasing interest and use of object-oriented database in manufacturing systems [2-3-4].

It is found suitable to use Unified Modeling Language (UML) before preparing the database system. By using UML; the database system is well defined, visualized, generated and specified considering complete project. UML is the international standard notation for object-oriented analysis and design which is defined by Grady Booch, Ivar Jacobson and James Rumbaugh [5-6-7]. After these declarations it is standardized by Object Management Group. And now this language is one of the most important steps to implement a software. Also the graphical presentation makes it easier to see the whole project.

For this project web-based user interface is chosen for easy access of the user location independently. A Web application is any software application that depends on the Web for its correct execution [8]. It is coded in a browser-supported language and reliant on a common web browser to render the application executable. The ability to update and maintain web applications without distributing and installing software on potentially thousands of client computers is a key reason for their popularity, as is the inherent support for cross-platform compatibility [9].

2. Object Oriented Databases

In the first place databases started to be used from file based systems. But hierarchical, network and relational database models, which focused on record-oriented information and simple data types, dominated the market from 1960’s to 1980’s [10]. Object-oriented database systems began developing in the mid-80’s out of a necessity to meet the requirements of applications beyond the data processing applications, which characterized relational database systems [11]. Like every new technology in industries, OODBMS had no standards when it came out. In order to rapidly promote the growth of the OODBMSs, a number of standards were proposed to define Object-Oriented Data Model. These include the three manifestos, ODMG, OMG, etc [9]. It can shortly be described as database that integrates object orientation with database capabilities [12]. So an OODB model must integrate the model of both object-orientation and database. The OODB model can be summarized as shown in Table 1 [2]:

<table>
<thead>
<tr>
<th>Object Orientation Capabilities (Data Abstraction)</th>
<th>Database Capabilities (Persistence)</th>
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</thead>
<tbody>
<tr>
<td>Encapsulation (behaviors)</td>
<td>Integrity</td>
</tr>
<tr>
<td>Inheritance (dispatching: overriding, polymorphism)</td>
<td>Concurrency</td>
</tr>
<tr>
<td>Complex objects</td>
<td>Recovery</td>
</tr>
<tr>
<td>Computational Completeness</td>
<td>Transactions (Locking, Deadlock Detection)</td>
</tr>
<tr>
<td></td>
<td>Querying</td>
</tr>
<tr>
<td></td>
<td>Versioning</td>
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<td></td>
<td>Security</td>
</tr>
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<td></td>
<td>Constraints</td>
</tr>
<tr>
<td></td>
<td>Indexing</td>
</tr>
<tr>
<td></td>
<td>Data Access Mechanism</td>
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<td></td>
<td>Persistence</td>
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</table>

OODBs enable programmers represent the real world entities easily because of the hierarchical structure, less programming efforts and object-oriented programming properties like inheritance, re-use and extensibility of code and etc (see Table 2). Also they provide rich type system that they can define almost any type which program permits. Especially advanced database applications like CAD, CAM, GIS focus on the OODBMSs because of the ability of managing complex and highly interrelated information. Already RDBMSs’ deficiencies on this kind of applications accelerated the evolution of OODBSs. Each object in the database is indicated by an object identifier (OID) which is generated by the system. These OIDs provide to traverse the queries and give the results in a fast and accurate way. But they are not visible neither programmer nor user of the program. Moreover it is sufficient to work
with the objects in the programming language to work with the database. Since the objects in the databases are produced by the exact programming language, the members of programming language like classes, attributes etc. are the members of databases as well.

Table 2. Advantages and Disadvantages of OODBs

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
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<tbody>
<tr>
<td>rich type system</td>
<td>lack of agreed upon standard,</td>
</tr>
<tr>
<td>less programming effort</td>
<td>lack of universal query language</td>
</tr>
<tr>
<td>better at modeling complex objects &amp; relations</td>
<td>lack of Ad-Hoc query</td>
</tr>
<tr>
<td>better performance on certain data structures</td>
<td>lack of a universal data model</td>
</tr>
<tr>
<td>no impedance mismatch</td>
<td>lack of mathematical foundation</td>
</tr>
<tr>
<td>no primary keys</td>
<td>language dependence</td>
</tr>
<tr>
<td>easiness of representations of the real world entities</td>
<td></td>
</tr>
<tr>
<td>class hierarchy</td>
<td></td>
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</tbody>
</table>

However the lack of agreed upon standard, lack of universal query language, lack of Ad-Hoc query, lack of a universal data model and lack of mathematical foundation are the main deficiencies. Moreover OODBs have language dependence and they have to be tied to a specific language.

Relational databases are still the most prevalent products. There are some main reasons for that. First of all most programmers use RDBMS and they are not familiar with OODBs. So it is easier to use what you know. Also most of the people do not hear of OODBs or their vendors. Because OODB vendors are not as big companies as the RDBMS are. Other reason is that they do not know about the technology which OODBs use. So these factors prevent programmers or firms from using OODBs. Nevertheless there are lots of large companies which aware of the importance and usage of OODBs also they encourage us to use the OODBS [13].

db4o –which is used in our study- is an object-oriented database management system developed by db4objects, Inc. Unlike most other DBMS, db4o is not built as a server system but as a library. This allows for some important features of db4o, like a very small memory footprint [14]. The distribution system of db4o is open-source, having the advantage that flaws in the code are quickly detectable and correctable. The product website offers support in the form of forums, downloads, and subscription to a newsletter. [15].

3. Workshop Management System

To overcome the problems faced by the mid-size workshop companies, it is intended to develop a workshop management system. In the centre of the system design, a well structured database which stores all the needed information and gives the customers fast and accurate feedback is introduced. On the other hand in order to support future implementation of decision support system, the software is designed such that it will enable the user to easily analyze its production parameters such as efficiency, cost deviation of production from planned cost, cost estimation of new production, etc. In order to develop an effective system, the basic idea is considered as follows:

- All information which is related to cost is to be defined and stored in the database.
- Each project which will be stored in the database should be analyzed in different levels in terms of cost.
- Database has to enable user to compare the planned and applied values.
- Database has to have a parametric base which can be customized for items requiring changes.
- For real life application, user needs to access and re-evaluate the project in any location.

Considering these concerns and according to our study, in this work following subjects will be examined for the workshop management system:
- Object Oriented Database System,
- Unified Modeling Language (UML) Diagrams,
- Web-based Interface
4. Design Methodology

In the programming it is important to make a good architecture for a specific work. Also the whole work should be analyzed in detail for a good design. Because programs written incrementally possess more complex structure and it gets harder to make a good code organization without modeling the whole work. Also a good modeling in the phase of analysis and design can prevent the further problems and enable to develop good infrastructure which can be easily changed whenever needed. According to these basic principles, having the deep idea in the working logic of workshop management system comes into prominence. On the other hand, making a good design as a result from the learned information is as important as learning the system itself. In that case UML class diagrams are chosen to represent the entire work. Class diagrams show the objects in classes as classified in the real world.

A class in UML shows the state and behaviors that are common among objects. In our project the objects which have similar characteristic and behavior are represented with a class. Properties of OOPL like inheritance, associations, and aggregations are showed in the diagram via using an UML tool. In Fig 1, a sample of aggregated classes and the relationship between objects can be seen.

Project consists of two main phases. For the future decision support implementation of this study, project is stored two times - first for the planning part and second for the real values of implemented project. In the planning part, estimated values of the project are stored and after the project is put into practice the real costs and quantities are saved with a different name. So that user is able to see and compare the estimated cost and the real one. It is thought that the decision support module will calculate the costs and give the correct results.

Project is formed of hierarchical structure. From inside to outside parts constitute equipments and equipments constitute projects, as a result, this hierarchy provides us to calculate the cost of whole project easily. Because of this hierarchy is more suitable to object oriented structure, OODB is chosen for this project. In our work, db4o is used as OODBS. Db4o has some distinguish features which directed us to use this program. It is reliable that it supports all of the ACID characteristics. Unlike any other database system, it is unnecessary to create schema definitions for mapping objects to relational database tables. Application’s class hierarchy and object relationships themselves define the database schema. It has an easy implementation so object oriented programming language is enough to build an application.

Db4o does not use SQL for querying. Instead it has several different querying systems, Query by Example (QBE), LINQ, Native Queries (NQ) and the SODA Query API (SODA). Even LINQ is the recommended db4o querying interface for .NET platforms. Also db4o has Object Manager Enterprise module which allows users to build query using drag & drop functionality via interface and browse the results of the query execution on that window. So these features are used for query in our work.

The role of web user interface design has been increasing recently. The success of a web user interface is best achieved through the application of simple and efficient user interface design or commonly referred to as user-centric designs. So according to the project definition and our work, an appropriate user interface is designed by ASP.NET environment.
5. Results and Conclusions

In this work a flexible workshop management system which enables cost analyze and project based consideration is designed. This kind of system will bring several advantages to the user since all the results are derived from the information gathered from shop level to engineering phase. In development stage Object-Oriented Database is utilized by constructing the Unified Modeling Language. At the end of the work advantages and disadvantages of using OODBs are seen practically. First of all using UML made easier to develop our study in the programming language.

The project nature is well suited for arrangement according to specific criteria into successive layers. Hence, object oriented structure helped us to achieve that goal. Using OODBs allowed us develop the application faster comparing to RDBMS. We did not have to prepare or map a separate model for the database. All the classes and relations are generated in the C# programming language and due to that our real world entities are represented in the database as well. This property allowed us use less coding and impedance mismatches. Also it was not necessary to apply some process on data like “normalization”.

OODBs are not commonly used and not widespread as RDBSs. Even though OODB vendors provide good tutorials or forum assistance, sometimes it cannot be easy to find the necessary information and that makes our job harder. But with the advance and more usage of these databases, this kind of problems will be overcome easily.

Since the database efficiency is related to data size inserted into and the queries for that amount of data, it is aimed to use this system in a workshop as real time project to gather real values. For future work, once sufficient amount of data is gathered, decision support system will be considered to analyze the cost in every level. Furthermore introducing the similar project based on the previous projects data will be considered.

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