ADIC 2011

Aceh Development International Conference
26-28 March 2011, UKM, Bangi – Malaysia

PROCEEDINGS
Volume II

Supported by:

Pemrintah Aceh
Indonesia Embassy
Kuala Lumpur
KELAB ACEH Kuala Lumpur
Universiti Kebangsaan Malaysia
The National University of Malaysia
Aceh Development International Conference 2011
Proceedings Volume II

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ISBN: 978-967-5742-02-6
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DEVELOPMENT OF TOOL DATABASE MANAGEMENT SYSTEM FOR LABORATORY

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Abstract

This paper describes a systematic approach to the design and development of a tool management system for the production laboratory unit of Department of Mechanical Engineering University of Malikussaleh (MEUM) in Aceh, Indonesia. The salient features of the design and development of a centralized database for tools that contains information regarding tooling, tool user, allocation, tool storage and retrieval, etc. are discussed. This system is developed using relational database and modular concept. The tool database management system consists of eight modules. This system will reduce the amount of manual and clerical effort in the laboratory.

Key word: Tools, tool crib, machine tool, tool users

Introduction

Tool management in production, as a group of activities, aimed to ensure appropriate productivity, means on time availability of resources, undertaking limitations connected with the costs (time and material overcapacity). Term tool management considers organization and implementation of a system which includes continuous activity monitoring, which are realized on two levels [1].

- material (tools) flow
- information flow (monitoring of the use of resources)

The laboratory's tools are type and shape varied, so it is needed right management system and qualification compatibility of laboratory's personnel. With the advance of hardware and software technology, it has become chance to development of tool management system computerized base. To increase the efficiency of tool use in a laboratory, it is necessary for the tool database to support information used in the control of tool use. A management system sharing some tools for some students or user to do practical work or research in laboratory, and using them efficiently, can make the best use of tool capacity. For the realization of this system, the tool user needs information to select the tool and to deploy it in the appropriate place just in time, based on tool status and student practical work schedule. Several approaches to tool management systems have been proposed [2-9].

Subrahmanyam et al. has design and development of a tool-management system for the valve production unit [2]. They designed and develop a centralized database for tools that contains information regarding tooling such as tool location, allocation, tool flow, tool storage and retrieval, parts, and machines. With the implementation of the tool-management system, it is expected that 30% of the product manufacturing cycle
time pertaining to the tooling problem can be significantly reduced, based on a trial conducted.

Mitsui et al. dealt with a design method for a tool database to be used in tool use planning [3]. They constructed an activity model of such a system for an flexible manufacturing system (FMS) for clarifying requirements for a tool database. Later, they designed such a tool database for satisfying the requirements with the help of an object-oriented method using software such as EXPRESS, C++, and an object-oriented database system. In FMSs, the initial investment in cutting tools and fixtures may be up to 25% of the total FMS investment. Seven to ten times more money is spent on tools, jigs, fixtures and consumables than on capital equipment during the useful life of the machines.

Veeramani et al. advocate tool requirements planning (TRP) as an information management tool for planning and controlling tool use [4]. They suggest that TRP performs well in a closed-loop manufacturing control system driven by material requirements planning (MRP) and supported by complete shop floor control. The TRP is supported by a database whose files include tool master, tool bills, etc. A comprehensive and effective tool management system is essential in flexible manufacturing systems.

Ranky discussed the design of an FMS turning-tool database and tool-management system and a robot-tool-management system for flexible assembly systems (FAS), both based on common principles, resulting in a generic system architecture. Besides explaining the methodology, based on hierarchical decomposition principles, both turning-tool and robot-tool management system designs, and sample database runs are illustrated to highlight the common and diverse features and to point out the CIM specific design and implementation goals [5].

Garapati and Wang presented a decision support system (DSS) for tool management in FMS [6]. Considering the fact that FMS should be able to accommodate a variety of different parts in random order, tool management at cell level, and tool transportation, tool data management, tooling data collection, tool maintenance, and manual and/or summarize tool assembly at an FMS level, are all very important. Tooling information in FMS is used by several subsystems, including; production planning; preset maintenance; summarize and/or manual tool assembly; stock control and materials storage.

Ranky summarized the major tasks to be solved when developing tool-management systems for FMS, as well as giving a solution for describing the data structure of a tool database integrated with a generic tool description method, and showed an example of the way the FMS real-time control system can access and use this database [7].

Tool management is very critical for effective and uninterrupted operation of computer-integrated manufacturing systems (CIMS) and is especially important for high productivity and flexibility in FMS. Shanker and Gopinath dealt with the tool planning and control (TPC) aspect of the tool management, and described a computer-aided procedure for the integration of functions of assigning the tools to various operations, procurement and replacement of tools, and scheduling the sharpening of tools. The need for automated tooling in flexible machining, assembly, and sheet fabrication systems should be addressed [8]. ElMaraghy discussed the various methods of implementing these systems, their benefits and drawbacks [9]. The author also described the basic modules of automated tool transfer, storage,
loading/unloading and management, together with the appropriate level of automation for each module.

This paper describes a systematic approach to the design and development of a tool management system for the production laboratory unit of department Mechanical Engineering University of Malikussaleh (MEUM). The production laboratory unit is a tool crib unit, a machines tool unit and a grinding cutting tool area. The tools management centralized on tool crib unit. With the increasing tools and students activities handled in the above production laboratory unit, there is a need to devise a computer-aided tool-management system and personnel who have appropriate qualifications. The objective of this work is to design and develop a centralized database for tools that contains information regarding tooling such as tool location, allocation, tool flow, tool storage and retrieval, users/students. The proposed system will minimize the duplication of tools purchased and facilitate the forecast of tool requirements based on tool consumption and lead time, besides ensuring a substantial reduction of tool inventory.

**Information System**

In a large organization such as department of MEUM, the database system is typically part of a much larger information system that is used to manage the information resources of the organization. An information system includes all resources within the organization that are involved in the collection, management, use, and dissemination of information. In a computerized environment, these resources include the data itself, the database management systems software, the computer system hardware and storage medium, the personnel who manage the data, the application software that accesses and updates the data, and the application programmer who develops these applications. Hence, the database system is only a part of a much larger organizational information system.

**Tool flow model.** The tools flow information modeling on the production laboratory unit designed a generic. The production laboratory there is a tool crib unit, a machine tool unit and the grinding cutting tool area. The tools management centralized on tool crib unit. The tool crib unit there is registration section, tools storage section and tools preparation section. Each new tools entry to the tool crib registered in the registration section for identification and codification process, and then the tools are stored in the storage section. The task of the tools preparation section is grinding of blunt cutting tools and insertion of cutting tool on the holder (assembling & presetting). The tools flow information in the production laboratory as shown in Fig. 1.

**Data model.** When data is added to a database, it becomes a “model” of that part of reality to which the data refers. As there is an increased need for up-to-date information, an automated tool database management system (TDMS) was developed based on groups of formalized data modeling rules called data models. A TDMS is a central controller of tool data. All applications must request data from the TDMS. The TDMS permits direct access to the data. Fig. 2 shows the structure of the TDMS centralized data.
Figure 1. The tools flow information in the production laboratory

Figure 2. The structure of the TDMS centralized data

Tool Coding
The tools used in the production laboratory unit of MEUM were classified into four different groups, namely, machining tools, hand tools, measuring tools and maintenance tools. The coding system designed following the name of work process (Milling, Turning, Drilling, Measuring, etc), tool name and tool material. The following three groups of characters coding system has been designed to address the various tools used in the production laboratory unit of MEUM. Fig. 3 shows the groups of characters coding system. A sample entity-attribute data requirement list for a machining tool has shows in Table 1. Similar data requirement lists were developed for hand tools, measuring tools and maintenance tools.
TABLE 1. List of sample data requirement

<table>
<thead>
<tr>
<th>ENTITIES</th>
<th>ATTRIBUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machining Tool</td>
<td>Tool code, tool name, specification, tool material, register date, quantity, storage number, etc.</td>
</tr>
</tbody>
</table>

Development of Tool Database Software

Basically, the software of TDMS that is a tool developed to record and keep information of tools data in the laboratory. The software system is a database object-oriented developed in the windows using C++ Builder. The TDMS have coverage of data has shows in Table 2.

An exhaustive C++ database comprising eight modules for capturing real-time tool information was developed as listed below:

Module 1: to registering of each new tool that entry to tool crib unit.
Module 2: as data record of tool users or students.
Module 3: to highlight the updated list of tools issued.
Module 4: to consolidate data resume of issue and return of tools.
Four modules, as catalog of tool pertaining to a particular group of tool (i.e. machining tools, hand tools, measuring tools and maintenance tools).

The data created pertaining to one of tool (i.e. machining tool) is given in Table 3.

TABLE 2. The data record of TDMS

<table>
<thead>
<tr>
<th>Tools data</th>
<th>Users/students data</th>
<th>Resume of tool issue and return</th>
</tr>
</thead>
<tbody>
<tr>
<td>- tool code</td>
<td>- user/student ID</td>
<td>- user/student ID</td>
</tr>
<tr>
<td>- tool name</td>
<td>- name</td>
<td>- tool code</td>
</tr>
<tr>
<td>- specification</td>
<td>- place of birth</td>
<td>- date of issue</td>
</tr>
<tr>
<td>- tool picture</td>
<td>- date of birth</td>
<td>- date of last return</td>
</tr>
<tr>
<td>- work process</td>
<td>- address</td>
<td>- date of return</td>
</tr>
<tr>
<td>- store location</td>
<td>- telephone number</td>
<td></td>
</tr>
<tr>
<td>- tool condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- quantity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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TABLE 3. Machining Tool data created in Borland C++ Builder

<table>
<thead>
<tr>
<th>Tool_Code</th>
<th>Alphabet (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool_Name</td>
<td>Alphabet (25)</td>
</tr>
<tr>
<td>Specification</td>
<td>AlphaNum (20)</td>
</tr>
<tr>
<td>Tool_Material</td>
<td>Alphabet (3)</td>
</tr>
<tr>
<td>Work_Process</td>
<td>Alphabet (10)</td>
</tr>
<tr>
<td>Tool_PICTURE</td>
<td>Graph (1)</td>
</tr>
<tr>
<td>Storage_No</td>
<td>Number (2)</td>
</tr>
<tr>
<td>Rack_No</td>
<td>Number (2)</td>
</tr>
<tr>
<td>Cell_No</td>
<td>Number (3)</td>
</tr>
<tr>
<td>Quantity</td>
<td>Number (3)</td>
</tr>
</tbody>
</table>

The main TDMS interface is shown in the Fig. 4. The modules that are created are the tool registration module, supplier data module, tool catalog module, user/student data tool and tool issue/return module. By clicking the menu buttons, the users can navigate to the respective modules. The system use relational database and can be accessed using interface or dialog box developed using C++ Builder. The modules that have been developed for various transactions such as tools registration, tool issue/return record, etc. The interface some of the modules created is shown in the Fig. 5 to 8.
Figure 6. The tool user/student data interface

Figure 7. The record of tool issue/return interface

Figure 8. Four modules of tools catalog interface (i.e. machining tools, hand tools, measuring tools and maintenance tools).
Conclusion

A tool database management system has been designed and developed using C++ Builder to control, store and retrieve associated data. A form-based interface has been created to access the database. A menu interface has been developed that can call items like menu file, tool management, tool catalog, etc., to carry out the data processing requirements. The major useful data that can be derived from the tool management system are status of tool, such as available tools, issued tools, or out of use tools. With the implementation tool database management system, it is expected that the tooling problem in the laboratory can be reduced. Thus student practical work and research in the laboratory can be implemented smoothly. The tool database management system can also be integrated with other available database in the laboratory for future modification.

References


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