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An interface integrating design and mfg in small size companies

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Abstract

Design tasks attempt to ensure that products meet market demands. Many programs have been developed to assist in the design task. Rarely do these programs permit to exchange of information with other departments without restrictions. This work deals with the development of an interface to extract information (e.g. the bills of materials), in a CAD (Computer Aided Design) environment. In addition, the materials are organised through MRP (Materials Requirements Planning) system.

Keywords

CAD/CAM system, interfaces (computer), materials management, process manufacturing, CIM systems

1 INTRODUCTION

Manufacturing automation allows high quality and low costs products, through the use of CAD, CAM (Computer Aided Manufacturing) and computer network. Product development in CAD environment works over all manufacturing variables (CAM environment). Therefore, some problems are brought forward to early production specification. Other important feature

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is the opportunity of obtaining a efficient production and breaking paradigms with the jobs made sequentially. In this environment, the jobs are made in parallel process.

The main objective of this work is to integrate CAD/CAM systems and reduce manual input of data. Therefore, the input of data will be quicker without errors. This work includes design (CAD) and manufacturing (CAM) technologies, essential to small sized companies which are competing in global market. This paper presents an interface development written in AutoLISP (Autodesk AutoCAD™). The interface extracts a bill of materials directly from the CAD environment. The materials are classified in standard, produced by another company, or internally manufactured. This classification is related to the competitive power of company. In addition, the materials are organised through MRP system developed using Microsoft Excel ™.

2 COMPUTER AIDED TECHNOLOGIES

Computer Aided Design (CAD)

CAD systems are used to help in creation, change, analysis, or optimisation of a project. Product quality and costs are determined by project decisions and performance planning. Little change in design phase is most precious to save resources that great change during the performance. Approximately 90% of product cost is defined during project phase so that, the planning activity is important to decrease errors (Berliner and Brimson, 1992).

Computer Aided Process Planning (CAPP)

Process Planning is the activity that determines the appropriate procedure to transform raw material (usually in some prespecified form) into a final product (Sluga et al., 1988).

The make-or-buy decisions are very important today, because the customers require high quality product and efficient delivery performance (Just-In-Time strategies). These decisions are strategic, because they allow fulfil market needs and have quick reaction in face to environmental, social and technological changes.

The historical development of CAPP was concentrated mainly in CAD, NC (Numerical Control) and other systems. In the past CAPP was known as the weak point in information integrated flow (Alting and Zhang, 1989; Tönshoff and Anders, 1990).

Software development to planning different process and different functions do not consider the hierarquical structure of process planning, operation planning and programming. Therefore, the efforts to develop independent systems produce the following problems (Eversheim et al. 1987, 1989):

- Different data structure;
- Storage of unnecessary data;
- Inconsistent database;
- Inadequate statement of technological data;
- Different understanding of features in CAD, CAPP and NC. In addition, the current efforts show protocols and standards to data interchange in definition phase.

The greatest challenge to CAD/CAPP integration is the translation of CAD language to CAPP language. As a consequence, a system which recognises the part features is necessary. This

process is expensive and error prone (Madurai and Lin, 1992). Therefore, the CAD system do not perform well technological information inherent to the project because CAD is geometric. The use of new concepts, like features, reduce these difficulties.

Quality process planning is very dependent of planners (Emerson and Ham, 1982; Shunk, 1985). In many companies the process planning are multipliable because of the lack of information retrieving system and comparison techniques (e.g. two planners make different plans of a component) (Wolfe, 1985).

Computer Aided Manufacturing (CAM)

CAM is the activity that planning, management and control the manufacturing operations.

Materials Requirements Planning (MRP)

Materials Requirements Planning is usually made in a spreadsheet (MRP system) that defines materials quantities and materials delivery time to manufacturing. The spreadsheet can be made manually (in case of small quantities of materials). In case of large quantities of materials the spreadsheet should be made in computational systems. Some MRP systems have special features. The planning in MRP is based in Master Production Scheduling (MPS).

Small size agile manufacturing

Gillies, Nelder and Fan (1996) present four steps to small size companies getting agile manufacturing. Firstly, such companies must be helped to recognise the strategic value of their reactive ability and how to learn from their experience of changes. Secondly, the value of networking must be promoted and the networking skills of partner selection, trust, risk evaluation and relationship management must be understood and systematised. Then, Information Technology applications can be introduced to speed-up network transactions and to extend the boundaries and possibilities of the network. Finally, extended enterprise concepts can be applied leading to fully agile manufacturing in small size companies

3 CADSYSP INTERFACE DEVELOPMENT

Objective of the work

The principal aim of this work is develop an interface called CADSYSP (an interface between CAD environment and planning systems) to data extract. The project was made in AutoCAD program (release 13 for Windows).

The MRP spreadsheet, made in Excel program, only shows the data utilisation after the interface extraction. The objective was not to share software development in the market, but only to demonstrate the feasibility of the idea.

Structure of the program

The AutoCAD is a popular CAD system developed by Autodesk. The CADSYSP interface was developed in AutoCAD R.13 (for Windows environment). AutoLISP is a subset of LISP language. Autodesk maintains, eliminates, or adds commands in AutoLISP. AutoLISP is a specific AutoCAD language (Head, 1989).

Competitivity is the ability to get (and sustain) velocity, performance and flexibility in the company system. In a global market, a company needs to offer projects and products to the customers quickly. Competitivity arises in all parts of the organisation such as R&D, purchasing, supplier, and other areas that use CAD information, and not by the use of some AutoLISP routines.

Microsoft Excel 5.0 (for Windows) is a computer spreadsheet to save, calculate and analyse data. A MRP system was developed in Microsoft Excel. The objective of this system is only to carry out research.

The CADSYSP Interface

Figure 1 shows the connection between CAD and materials management across the CADSYSP interface.

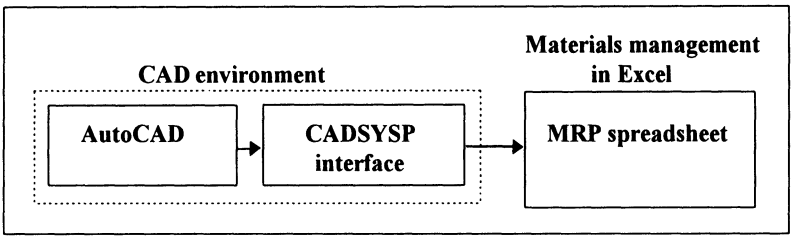

Figure 1 Connection between CAD and materials management across the CADSYSP interface.

The CADSYSP interface was written in AutoLISP. This interface extracts data concerning materials used in project. Both material and project are in the AutoCAD environment while the exported data are in ASCII standard. Therefore, the data should be used by a computer spreadsheet like Excel.

The AutoCAD program executes AutoLISP routines in CAD environment. The bill of materials is made in CAD environment. CADSYSP interface extracts data information, which contains materials data such as description, quantities and so on.

Figure 2 shows the cycle between project and planning since the company may buy any materials, these products, need to have high quality, low costs, and reliable delivery time.

The download of CADSYSP interface can be seen in figure 3. In this stage, the CADSYSP is transformed into a AutoCAD command. The mouse buttons select the information to copy to a ASCII file. This file is imported by Excel program. The source and the lead time are specified for each material. After this, the materials report was indexed, as the 'source' (see 'SC' in Table 1).

Table 1 shows the classified materials report. Materials classified as standardised or produced by other companies are sent to purchasing function. On the other hand, materials classified as internally manufactured are sent to Production Planning and Control (PPC) function.

As the MRP system was developed in an Excel spreadsheet, the cells were programmed by the user. The introduction of new products needs new spreadsheet program as well as design changes need spreadsheet changes.

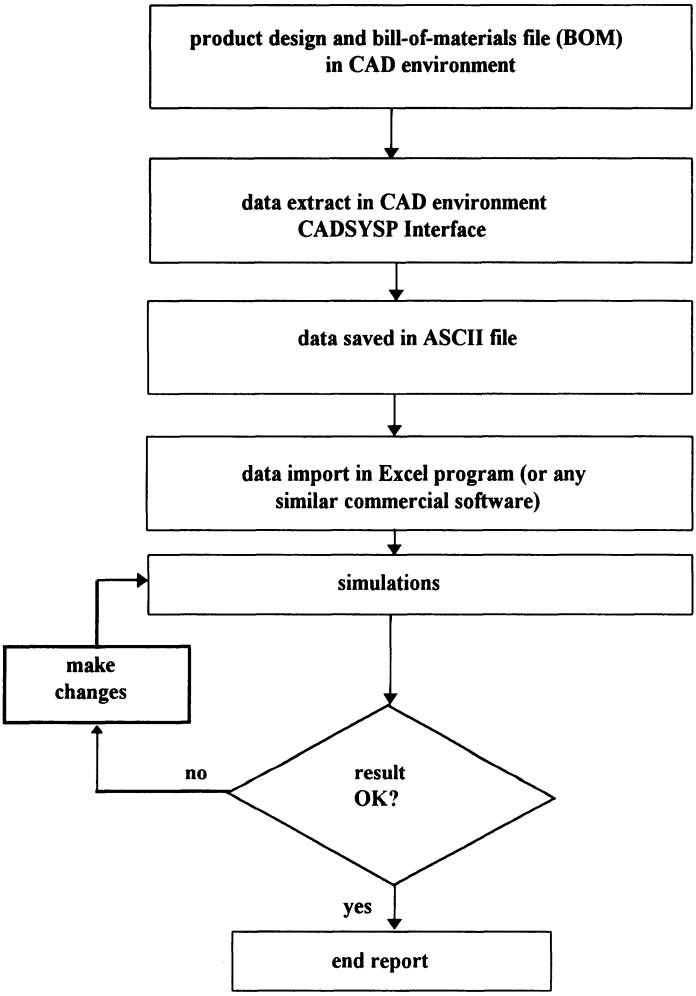

Figure 2 Cycle between project and planning.

The project may change in AutoCAD environment to attend market needs such as high quality, low cost and reliable delivery. Therefore, the company have an external material source to attend reliable delivery. The company may produce in house some materials that contain important know-how. This work does not considered product costs.

The project changes in CAD environment may decrease costs. At least 90% of products costs are defined in project phase.

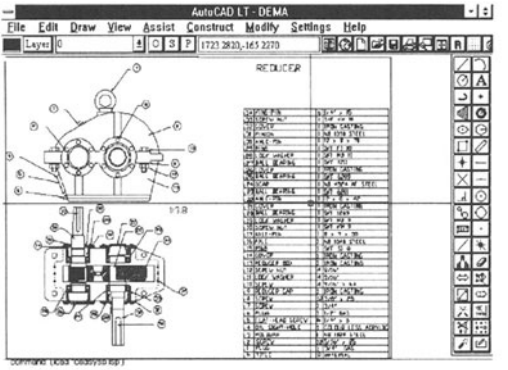

Figure 3 Download of CADSYSP interface - A typical assembly draft.

Table 1 Classified materials report

SQ	*title*	*QT*	*material*	*SC*	*LT*
1	plug	1	3/4" gas	1	0
4	oil sight-hole	1	colour less acrylic	1	0
5	flat-head screw	6	1/4" x 6	1	0
6	plug	1	1/2" gas	1	0
8	screw	12	3/8" x 25	1	0
10	screw	4	9/16" x 64	1	0
19	lock washer	1	SKF mb 9	1	0
20	ball bearing	1	SKF 1209	1	0
25	ball bearing	1	SKF 6209	1	0
33	screw nut	1	SKF km 10	1	0
9	reducer cap	1	iron casting	2	0
13	reducer box	1	iron casting	2	0
14	cover	1	iron casting	2	0
21	cover	1	iron casting	2	0
26	cover	1	iron casting	2	0
32	cover	1	iron casting	2	0
16	axle	1	SAE 1040 steel	3	8
22	axle-pin	1	12 x 8 x 42	3	8
24	gear	1	SAE 4524 af steel	3	8
31	pinion	1	SAE 1030 steel	3	8
34	king-pin	6	1/4" x 15	3	8

Source (SC): 1 = standard;
2 = produced by an other company;
3 = internally manufactured.

LT = Lead Time; SQ = Sequence; QT = Quantities

Note: Security inventory = 0; Minimum order = 1

Companies which have great product mix may execute MRP system only to high cost materials and low use (e.g. axle bed). Other materials (low cost and high use) like screws are controlled by replacement point. Data analysis should be executed in other programs like dBASE, Lotus 123, ACCESS and so forth.

Companies that use other CAD programs (except AutoCAD) need to change files to IGES (Initial Graphics Exchange Specification) standard to data extraction. The IGES file is imported by AutoCAD. The CADSYSP interface send materials data to MRP system. However, this work do not consider IGES standard to data extraction because AutoCAD has leadership in CAD program market. The principal advantage of AutoCAD is that it requires minimum hardware configuration in small sized companies.

5 CONCLUSIONS AND FUTURE RESEARCH

Manufacturing systems need to provide a wide range of products. Additionally, the life cycle of products has been drastically reduced. Companies need to integrated all functions through computational resources. Consequently, the interface development becomes an important element of computer integration.

This paper presented an interface development between CAD and materials management function. The main contribution of this work is the material database that may be used by other company's functions, or suppliers (e.g. materials standard or sourced by other companies). The interface extract data information. The output is an ASCII file. This file could be used by is DOS, Windows and Mainframe. Some commercial systems (like dBASE, Lotus 123, Excel, COPICS, and others) could use this file. Future research in this field will include cost analysis (e.g. ABC - Activity Based Cost) and sourcing strategies definition.

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7 BIOGRAPHY

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He joined the IBM Corporation in 1986 where he was a trainee in quality engineering. From 1987 to 1990, he was a process engineer at Texas Instruments Ltda. From 1991 to 1993, he was a product engineer at Robert Bosch Ltda. His current research interests include concurrent engineering, reengineering, and strategy development.

Dr. Geraldo Nonato Telles graduated in mechanical engineering at the State University of Campinas (UNICAMP), Brazil, in 1971. He then worked as a research engineer at the Technology Centre at UNICAMP (1972-1979), then at Nardini Machine Tools Company (1979-1982), and at the Centre for Computing Science of the Ministry of Science and Technology. Dr Telles obtained his PhD in 1990 and became a senior lecturer in the Mechanical Engineering Institute at UNICAMP. At present he is Associate Professor and his research activities involve CAD/CAM systems (interface development), CNC machines (simulators and automatic programming), industrial robots, FMS and CAPP (features strategies).