AUTOLISP/IGES/CDF AND SDF
MULTILATERAL COMMUNICATION LANGUAGE BETWEEN
AUTOCAD AND CAE ACTIVITIES

Great benefits have been obtained from the full integration between CAD systems with the other Computer-Aided Engineering CAE activities. NC programming for both milling and turning had been successfully demonstrated in previous work. These programs generate automatically the NC part program required for any specific product through the geometry data from the DXF file extracted from AUTOCAD. The work in hand focuses the possibility of retrieving CAD Drawing Data Base (DDB) through specific procedure, starting from Autolisp program, IGES format and ending with both CDF and SDF files for managing the Manufacturing Data Base (MDB). Excellent results and benefits have been demonstrated.
1 INTRODUCTION

The integration of Computer-Aided Design (CAD) systems with manufacturing activities provide industry with larger economic and commercial benefits. Current practice has been to provide such integration by means of specific application programs [1]. Often these run on a CAD system and simulate the relevant manufacturing process and once the results of this simulation are satisfactory, executable instructions for the real manufacturing system are generated and issued from the CAD system. Many programs written in this way require the user to retrieve the MDB from CAD system. The MDB includes all the data on the product generated during design such as: geometry data, bill of materials, and parts list, material specifications, etc. as well as additional data required for manufacturing much of which is based on the product design.

In a previous work [2 & 3] we had described how the user can use the geometry data from the DXF file, extracted from AutoCAD, to generate automatically the NC part program required to manufacture the part drawing for milling and turning operations. In this paper we look at the possibility of retrieving CAD drawing data base (MDB) by different ways. First an Autolisp program has been described, to extract MDB in a specified format then the IGES file format has been illustrated. Finally both CDF and files have been described using for managing the MDB.

2 MACRO AUTOLISP PROGRAM

Autolisp is a form of Lisp programming language embedded within AutoCAD [4]. Autolisp allows to write macro programs and functions that is well suited to graphics applications. The current program is to retrieve the drawing entities from the data base and return a list containing its definition data. Objects in the resulting list are coded with AutoCAD's DXF group codes [5] for each part of the entity data and list the results in a text Ascii file. The output format can be changed to suit a specific application. Figure 1 illustrates the suggested program. Figure 2 illustrates the output of the drawing data base for the part drawing shown in Fig. 3. As shown in Fig. 2, the output of the first arc includes its center (35.0, 13.0), the radius which equal to 5.0 and both the start and end angles which equal to 3.14159 and 4.71239 respectively. The second entity "Line" represented by two points (35.0, 30.0) and (25.0, 30.0) respectively. The last entity "Circle" represented by the center (35.0, 45.0) and its radius (10.0).

3 IGES

IGES is another method to transfer data from a CAD system. IGES was originally published by the National Institute of Standards and Technology (NIST) [6]. An example of an IGES file is shown in Fig. 4, for the part drawing shown in Fig. 3. The commands used to generate IGES file is IGESUNIT. The IGES representation is an Ascii text file composed of five major sections:
(define c (λ (t) (setq x (+ x t))
(setq y (+ y t))
(let (d (distance a b))
(setq t 0 (setq d t)))
(while (< t n)
(setq a (car (assoc 0 (getkey (assoc d t)))))
(setq b (car (assoc 10 (getkey (assoc d t)))))
(setq c (car (assoc 20 (getkey (assoc d t)))))
(setq d (car (assoc 50 (getkey (assoc d t)))))
(print (list 6 a))
(print (list 7 c))
(print (list 8 d))
(print (list 9 b))
(print (list 10 b))
(print (list 11 b))
(setq t (+ t 1))
(close t)
)

Fig. 1 Macro Automap Program.

"ARC" 1.5708
35.0 "LINE"
75.0 75.0
60.0 60.0
35.0 35.0
60.0 60.0
3.14159 nil
4.71239 nil
"LINE" nil
75.0 "ARC"
35.0 35.0
55.0 55.0
nil nil
5.0 nil
"ARC" 1.5708
35.0 "LINE"
75.0 75.0
55.0 55.0
5.0 35.0
4.71239 nil
0.0 nil
"LINE" nil
80.0 nil
35.0 55.0
40.0 45.0
55.0 nil
10.0 nil
"ARC" nil
75.0 nil
55.0 nil
5.0 nil

Fig. 2 Output of the Suggested Automap Program.
Fig. 3 The Part Drawing.

Fig. 4 Sample of an IGES File.
a-The start section, containing a human-readable header.
b-The global section, containing information about the CAD system where the drawing originated.
c-The directory entry section, which lists all entities (such as lines, circles, arcs and dimensions) and relationships that exist among them.
d-The parameter data section, which gives specific information about entities such as the starting and ending point of a line.

For example, the first line at this section display as:
100,0.0,35.0,35.0,30.0,34.0,35.0,30.0, represent an arc its center point coordinate is (35.0,30.0) and start point coordinate is(30.0,35.0) and end point coordinate is (35.0,30.0).
The next line display as:
110, 35.0, 0.0, 0.0, 35.0, 30.0, 0.0, represent a line from point (35.0,30.0) to point (75.0,30.0). The last line display as:
120, 55.0, 45.0, 65.0, 65.0, 45.0, 65.0, 45.0, represent a circle with center point coordinate (55.0,45.0) and a point (65.0,45.0) on its circumference.
e-The terminate section, containing a count of all lines that should be in each preceding section but data integrity purpose.

4 ATTRIBUTE EXTRACTION

Attribute extraction is a method to extract information entities from AutoCAD drawing and write them to a disk file for analysis by another program or for transfer to a database. These data may include all the manufacturing data generated during design with material type, part name, number O/D, required, the part name, code, the weight, material specifications, etc., and any other data used in management.

4-1 CDF and SDF Extract

The CDF and SDF format extraction processes are very similar [5]. Each entity. Attributes information in a text file in a format that can be read easily by DBASE package.

CDF:Comma delimited format. It produces a file containing at most one record for each block reference in the drawing. The fields of each record are separated by a delimiter and character fields are enclosed in quotes.

SDF: At most one record is written for each block reference in the drawing. The fields of each record are of a fixed width, no fields separators on character string definitions are employed.

As an example of CDF and SDF format, Fig. 5 illustrates the assembly drawing for a Worm Gear Box and its manufactured list defined as attribute including description (desc) of the parts, type of material (Mat), the number of required (Num), the code name (Code) and weight for each part may be added. The prompt sequence for Attribute definition and CDF/SDF extracts as follows:
Fig. 5 The Assembly Drawing of Worm Gear Box.

<table>
<thead>
<tr>
<th>DESC</th>
<th>NUM</th>
<th>MAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>BODY</td>
<td>1</td>
<td>GG.20</td>
</tr>
<tr>
<td>MORN</td>
<td>1</td>
<td>ST.60</td>
</tr>
<tr>
<td>COVER</td>
<td>2</td>
<td>GG.20</td>
</tr>
<tr>
<td>FEATHER</td>
<td>1</td>
<td>ST.50</td>
</tr>
<tr>
<td>DISTANCE WASHER</td>
<td>2</td>
<td>ST.37</td>
</tr>
<tr>
<td>SHAFT</td>
<td>1</td>
<td>ST.60</td>
</tr>
<tr>
<td>BALL BEARING</td>
<td>2(15-4204)</td>
<td></td>
</tr>
<tr>
<td>SCREW M5x14</td>
<td>4</td>
<td>ST.40</td>
</tr>
<tr>
<td>WORM GEAR</td>
<td>1</td>
<td>ST.37</td>
</tr>
<tr>
<td>PLUG</td>
<td>1</td>
<td>BRASS</td>
</tr>
<tr>
<td>BALL BEARING</td>
<td>2(12-4204)</td>
<td></td>
</tr>
<tr>
<td>PACKING</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>WASHER</td>
<td>1</td>
<td>CU</td>
</tr>
<tr>
<td>PLUG</td>
<td>1</td>
<td>ST.37</td>
</tr>
</tbody>
</table>
Fig. 6 The Template File. Explain the Structure of the Extracted Files. Include Code and Weight if it added to the DBI.

'BODY', 1, 'GG.20'
'MORK', 1, 'ST.60'
'COVER', 2, 'GG.20'
'FEATHER', 1, 'ST.50'
'DISTANCE WASHER', 2, 'ST.37'
'SHAFT', 1, 'ST.60'
'BALL BEARING', 2, '(15-4204)'
'SCREW M5x14', 4, 'ST.40'
'WORM GEAR', 1, 'ST.37'
'PLUG', 1, 'BRASS'
'BALL BEARING', 2, '(12-4204)'
'PACKING', 1, 3
'WASHER', 1, 'CH'
'PLUG', 1, 'ST.37'

Fig. 7 The Extracted CDF File.

BODY 1GG.20
MORK 1ST.60
COVER 2GG.20
FEATHER 1ST.50
DISTANCE WASHER 2ST.37
SHAFT 1ST.60
BALL BEARING 2(15-4204)
SCREW M5x14 4ST.40
WORM GEAR 1ST.37
PLUG 1BRASS
BALL BEARING 2(12-4204)
PACKING 13
WASHER 1CH
PLUG 1ST.37

Fig. 8 The Extracted SDF File.
Command: ATTEXT

Attribute mode: ... Invisible: Y verify: Y present: Y
Enter (ICUP) to change. Return when done: (Press Return)
The next prompt is:
Attribute tag: (Desc)
Attribute prompt: (Desc)
Default attribute value: ()

Repeat a series of Attributes in the same way as text strings.
For (Mat, Num, etc.). The second or subsequent Attributes in a
series, simply enter a space or return when AutoCAD asks for the
starting point. AutoCAD aligns each new Attribute Definition
below the previous Attribute Definition. Use Block Command to
transer the last attribute to a block and use Insert Command to
reference a block when you need to add data to the manufacturing
drawing.

To extract Attributes entity:
Command: ATTEXT
CDF, SDF or DXF Attribute extract (in Entities)? (C) (S or Return)

For CDF and SDF format extract, the next prompt is:
Template file (default: list (will be explained): Extract file name (giving name): File Name.
The extract file type is "txt" for CDF or SDF format.

The template file tells AutoCAD how to structure the extract
file; it specifies which Attributes are to be extracted. What
information is to be included in each block having these
Attributes, and how that information is to appear.

It created by using a text editor. Each line of the template file
specifies one field to be written in the extract file, including
the name of the field, its width in characters, and its numerical
precision, if applicable.

Each record starts with the file name. Field name may be of any
length. The next must be "C" or "N" denoting a character or
numeric field. The next three digits are the field width in
characters. The last three are number of decimal places for a
numeric field.

Figure 6 illustrates the template file (list.txt) used in the
current example. Figures 7 and 8 illustrate both the CDF and
SDF extracted.

5 Using ExTRACTED FILES WITH DATABASE PACKAGES

To import the .txt files or .sdb files to database packages, first a
data base file must be created with the same field characteristics
of the extracted files. Then the operation "Append from... .txt
defimited" for the .txt files and "Append from... .sdb"
CONCLUSION

A method of multilateral communication between different CAD/CAM drawing database has been developed for the progress of CAD/CAM practice. A common language incorporated with the concept of a common model has been introduced for the multilateral translation process. It has been shown that semantic analysis using the preliminary concept of set and relational theory is very useful. For this analysis, the essential common structure of CAD/CAM drawing has been extracted and a sophisticated language to communicate between different CAD/CAM models has been integrated.

REFERENCES


4-AutoLisp User Reference.

5-AutoCAD User Reference.