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Comparison of Product Data Model between Rapid Prototyping and CNC Milling 3-Axis

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***Abstract*—** Nowadays, there are high demands on products with high accuracy and quality, this is due to the development of new technology on machinery and computer software. This research has been done to compare the product data model by using CNC 3-axis and Rapid Prototyping to produce a model spanner. The format files that use consists of STL, IGES, VRML, VDAFS, STEP AP214, STEP AP203 and PRO E. The main purpose of this study was to find loss of data for each format file was design through Solidwork's software. The format file has been simulating to generate tool path by using MasterCam software before machining process will be done. Using that simulation, be able to compare a quality of machining result from surface finishing aspect and machining time for each format file. As a result, only format file VDAFS a suitable for machining CNC 3-axis because that format file contain less of data loss when compared with other format file from surface roughness aspects and defect. While for RP, format files VRML a suitable for machining than STL, because file VRML does not committed to any data losses from aspects of color. Finally, these views provide a concrete guideline for choosing a suitable format file for machining CNC and RP to produce a product required.

***Keywords*:** Product Data Model, CNC, Rapid Prototyping

I. INTRODUCTION

IN this decade, machining process has grown rapidly and prospectively. Due to the technology development, system technology or information technology also improved parallel to the machining technology.

Information technology in an engineering field is a common database that stored a various kinds of CAD system. However, CAD system can be represented in many ways of format files. Each format files have their own strength compared to others format files.

This paper describes a comparison of product data model between rapid prototyping and CNC milling 3-axis which is to find loss of data for each format file. Spanner's design has been used as a case study and it is produced through CAD software (SolidWorks 2007). The format file that has been focused in this study consists of STL, IGES, VRML, VDAFS, STEP AP214, STEP AP203 and PRO E.

The data acquired by the simulation that has been done at UTHM CNC's lab by using MasterCam software, can be able to compare a quality of machining result from surface finishing aspect and defects for CNC machining process, and color aspect for RP process.

II. CAD FORMAT FILES

Design information such as engineering drawing can be stored in various kinds of CAD systems. However, the CAD systems often represent the data in many ways and in different formats. This is because information technology is developing very quickly.

STEP (Standard for the Exchange of Product model data) is an International Standard for the computer-interpretable representation and exchange of product data. STEP still carries much redundancy information, which is not necessary to RP systems.

The STL (StreoLithography) file is the most common interface between CAD and RP systems. The STL file can be in either ASCII or binary format. The STL file carries a high degree of redundancy because of duplicate vertices and edges.

IGES (Initial Graphics Exchange Specification) is a standard used in the exchange of graphics information between commercial CAD systems. The IGES file can precisely represent CAD models. The IGES file has many advantages as an interface between CAD and RP systems. IGES files provide the entities of points, lines, arcs, curves, curved surfaces and solid primitives to precisely represent CAD models. However, there are two major problems when using IGES file as the input files of RP systems. Firstly, the IGES file includes redundant information. Secondly, the algorithms dealing with an IGES file are more complex than those dealing with the STL format.

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VRML (Virtual Reality Modeling Language) that contain less redundant data when compared with STL files and contains all the features of STL. It is suitable data interface for use in color RP systems and can store the geometric information of the model in a similar way to the industry standard STL.

VDAFS (VDA Surface Data Interface) is a neutral file format for the exchange of surface geometry. The VDAFS was defined to eliminate the deficiencies of the CAD interface IGES in the conversion of complex 3-dimensional geometry. VDAFS offers the technical conditions for the direct exchange of data between the CAD systems of the automotive industry and its suppliers. The emphasis of VDAFS is on the exchange of surface data.

Table 1 shows the software's acceptance for each format files to be simulate. From seven format files, just VRML format file is not accepted by MasterCam software and only two of them are accepted to be run by ZPrinter software which is STL and VRML format files.

Table 1: Format files that can be run by MasterCam and ZPrinter.

No.	Format Files	MasterCam	ZPrinter
1	STL	√	√
2	IGES	√	
3	STEP AP203	√	
4	STEP AP214	√	
5	Pro E	√	
6	VDAFS	√	
7	VRML		√

III. SIMULATION AND COMPARISON FOR EACH FORMAT FILES

Eight different points has been determined to make a comparison for each format files because their design complexities such as fillet, edge, and engrave.

Figure 1 show a completed simulation that has been done by using MasterCam and eight points has been decided to be compared to find data loss, surface roughness and defect for each format files.

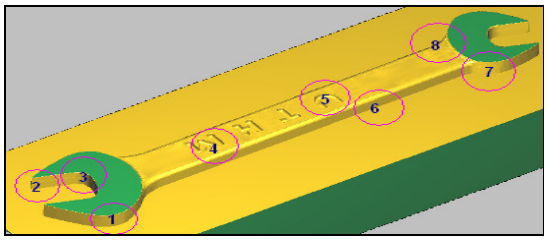

Figure 1: Eight points to be compared for each format files.

MasterCam can accept six format files but only five format files can be generated its tool path for simulation. Tool path for STL format file cannot be generated because it is a wireframe structure. Table 2 shows evidence that each type of format files are influenced towards machining simulation time.

Table 2: Simulation time for each format files.

No.	Format Fail	Simulation time
1.	IGES	2 hour 16 min 1 sec
2.	STEP AP214	2 hour 21 min. 55 sec
3.	STEP AP203	2 hour 28 min. 8 sec
4.	VDAFS	2 hour 12 min. 52 sec
5.	PRO E	1 hour 48 min. 52 sec
6.	STL	___

Comparison in different points for each format files are showed in figures 2 to 9. All results after comparisons for surface roughness and defects are summarized in table 3. From the result, know that VDAFS and STEP AP214 format files have a good surface roughness but for STEP AP214 it is quite difficult to generate a tool path during simulation process.

Hence, a VDAFS format file is the most suitable format file for CNC machining.

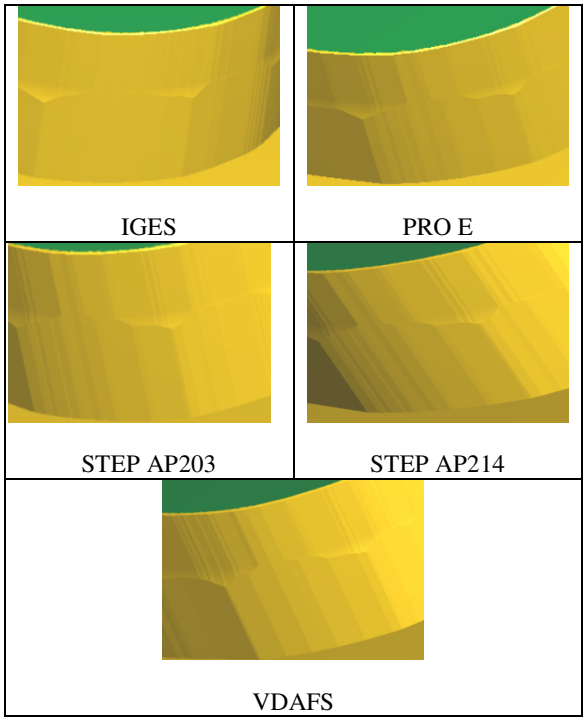

Figure 2: Comparison for point 1.

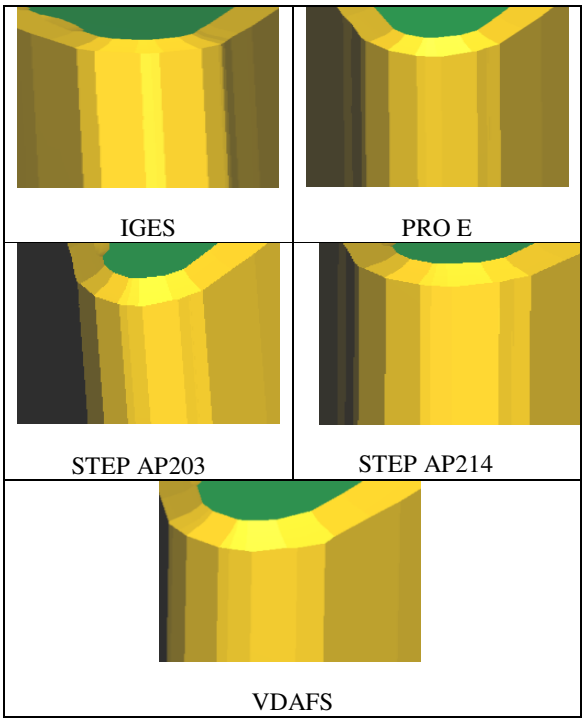

Figure 3: Comparison for point 2.

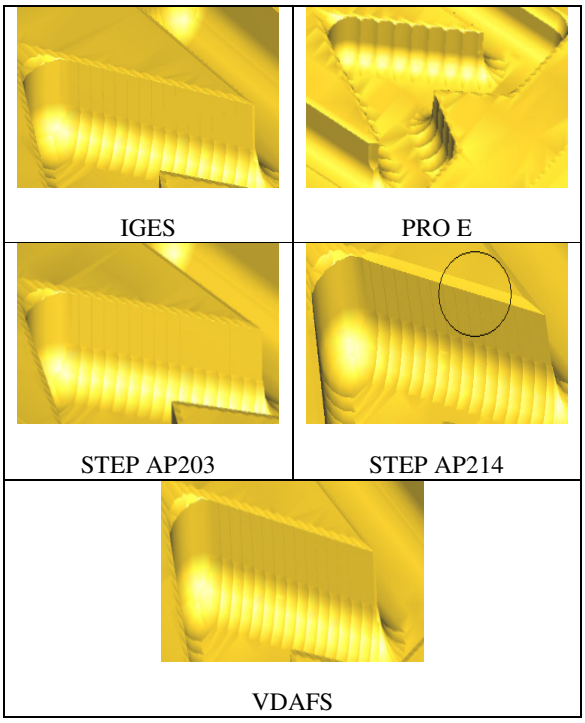

Figure 5: Comparison for point 4.

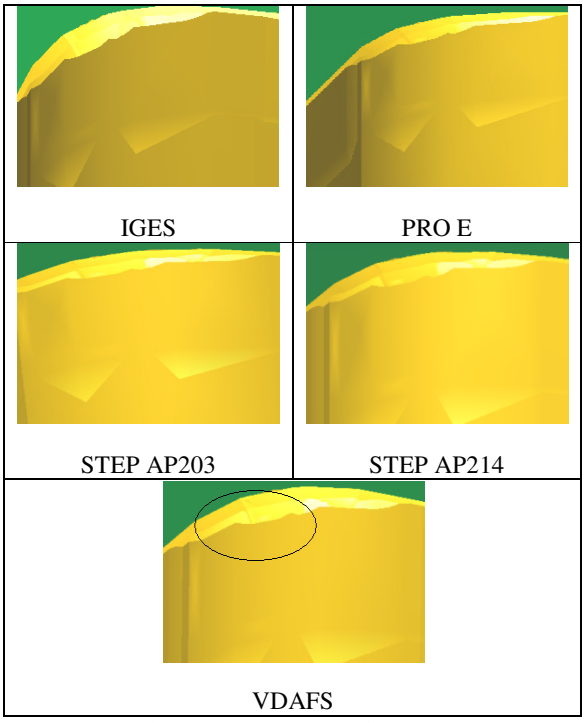

Figure 4: Comparison for point 3.

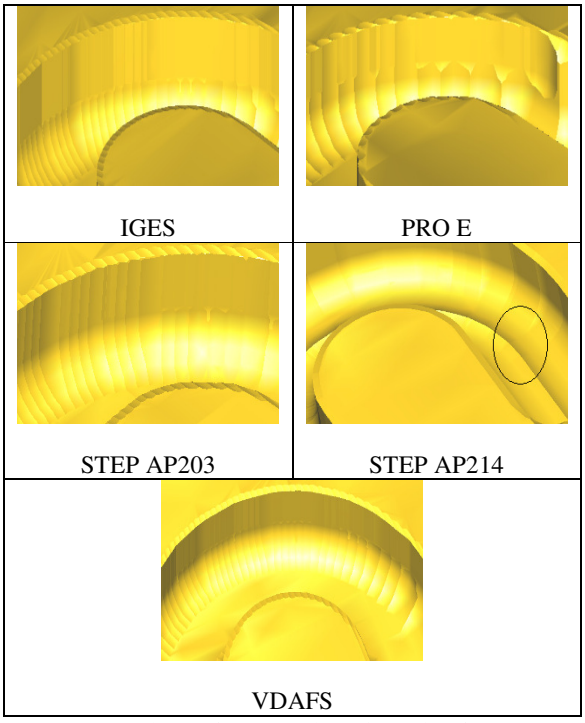

Figure 6: Comparison for point 5.

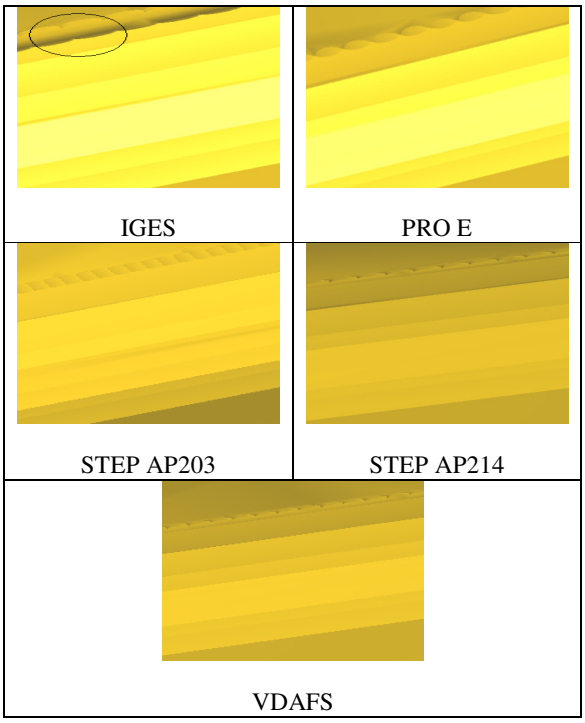

Figure 7: Comparison for point 6.

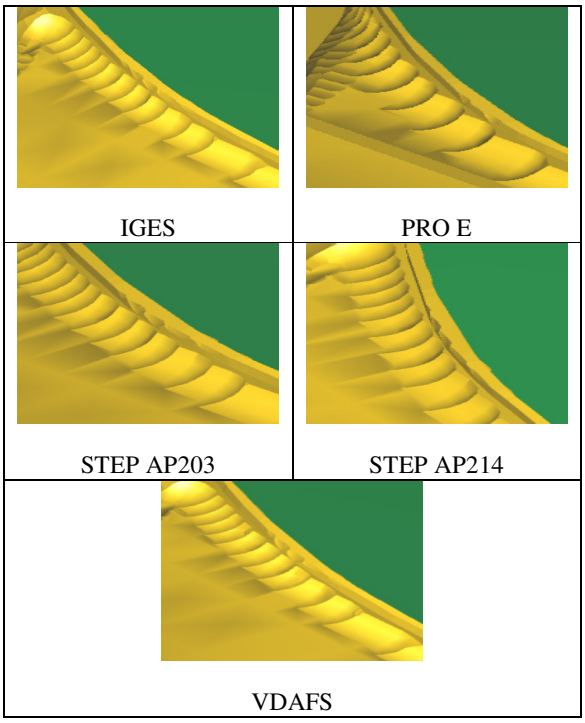

Figure 9: Comparison for point 8.

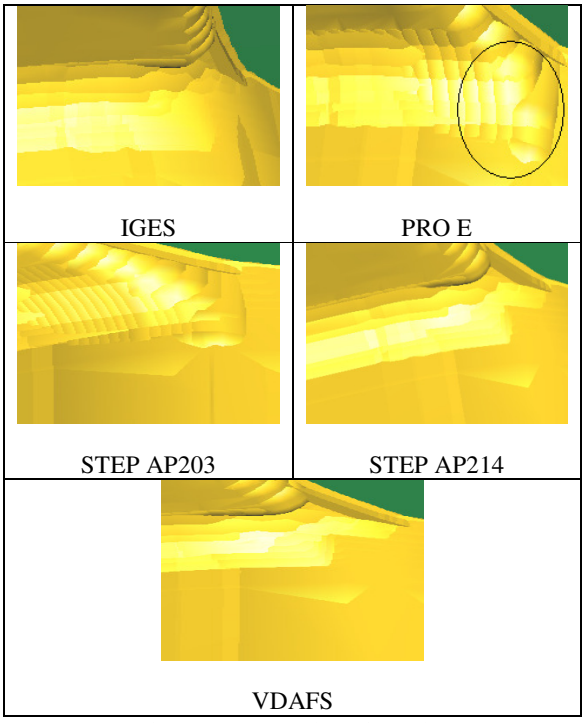

Figure 8: Comparison for point 7.

Table 3: Comparison for surface roughness for each format files.

Part	Format File (good in surface roughness)				
	IGES	VDAFS	PRO E	STEP AP203	STEP AP214
1.	√	√	√	√	√
2.					√
3.		√			
4.					√
5.		√			
6.				√	
7.		√			√
8.		√			√

IV. COMPARISON RESULT FOR RAPID PROTOTYPING MACHINING

Production time to produce a products are differs for each format files. It is also depends on layer thickness during process of prototyping. For rapid prototyping machining process, just two types of format files can be used which is VRML and STL format files as presented in table 4. Machining times for VRML and STL format files are acquired from ZPrinter software. From that table shows that, machining process for VRML format file takes almost 68% longer than STL format files.

Table 4: Machining times for each format files.

No.	Format Files	Machining Time
1.	VRML	20min 15sec
2.	STL	12min 02sec

For this comparison, STL format file is not suitable for rapid prototyping because there is a lack or defect in color aspect. While VRML format file can produce a product while maintaining its actual color and brightness. Figures 10 to 12 shows a differentiation in aspect of color for each format files.

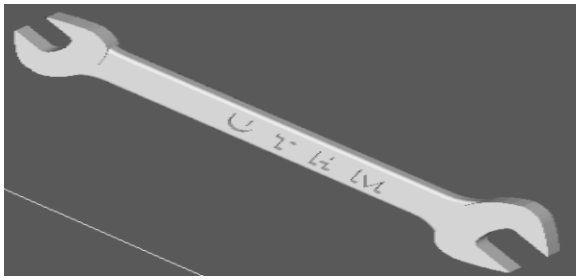

Figure 10: STL format file

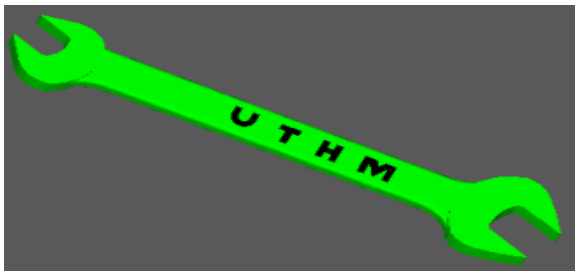

Figure 11: VRML format file

Figure 12: Prototype that has been developed by using STL and VRML format files.

V. CONCLUSION

Through the results, types of format file play the important roles towards surface roughness and data transmission. Only solid or surface structure format files can be used to generate toll path for the simulation process by MasterCam software.

VDAFS format file is the most suitable format file for CNC machining and VRML for the RP process. From this result achieved, it provides a guideline in choosing suitable type of format file following the product compatibility for the required surface roughness.

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