UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BOXY AIRCRAFT COMPONENT CNC LATHE MACHINING- HAAS

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process) (Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) (Hons.). The member of the supervisory committee is as follow:

……

ABSTRAK

Projek ini menerangkan tentang proses reka bentuk semula dan pembuatan bahagian pesawat iaitu “boxy” dengan mengunakan mesin CNC-Haas. Proses pembuatan “boxy” merupakan skop utama projek ini dengan merujuk laman web “STEP Tools, Inc”dan journal. Saiz keseluruhan “boxy” telah ditakrifkan oleh journal adalah 100mm (panjang) × 100mm (lebar) × 100mm (tebal) tetapi had panjang mata pemotong menyebabkan dimensi “boxy” perlu diubah menjadi 60mm (panjang) × 60mm (lebar) × 60mm (tebal). Jenis bahan yang digunakan adalah nilon berwarna biru dalam bentuk pepejal. CATIA telah digunakan dalam kajian ini untuk mereka bentuk “boxy”, simulasi laluan alat pemotong untuk pemesinan dan akhir sekali menjana kod. Proses terlibat dalam pembuatan “boxy” ialah dengan membuat “facing” pada semua permukaan bahan kerja dan akhir sekali pembuatan “boxy”.

ABSTRACT

This project describes the process of redesign and manufacture of aircraft component which is “boxy” by using CNC machine-Haas. The manufacture “boxy” is a main scope of this project by refering the website STEP Tools, Inc. and journals. The overall sizes of boxy have been defined by the journal are 100mm (length) × 100mm(width) × 100mm (thickness) but the limitation of the cutting tool length should be changed to be 60mm (length) × 60mm (width) × 60mm (thickness). The type of material used is blue nylon in solid form. CATIA is used in this study to design a “boxy”, simulated cutting tool paths for machining and finally generate code. The process involved in the manufacture of “boxy” is to make a facing on all surfaces of the workpiece and finally fabrication the “boxy”.

DEDICATION

Special Dedication to ALLAH, my family members,
and my friends.

ACKNOWLEDGEMENT

Thanks to ALLAH s.w.t upon the completion of this report. Not forgetting my parents who always support me not matter what obstacles came through. Also special thanks to my supervisor, Engr. Dr. Mohamad bin Minhat in guiding me along this report writing and project completion.

Last but not least, my family and all friends who never give up on supporting me to the completion of this report. Really appreciate all the help and supports.

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LIST OF ABBREVIATION, SYMBOLS AND NOMENCLATURE

CAD	-	Computer Aided Design
CAM	-	Computer Aided Manufacturing
CATIA V5R19	-	Computer Aided Three-dimensional Interactive Application Version 5 Release 19
CI	-	The chip load per tooth
CNC	-	Computer Numerical Control
DIS	-	Draft International Standard
HSS	-	High Speed Steels
ISO	-	International Organization for Standardization
KTH	-	Royal Institute of Technology
mm	-	Milimeter
NC	-	Numerical Control
NIST	-	National Institute of Standards and Technology
PSM	-	Projek Sarjana Muda
RPM	-	Revolution Per Minute
STEP-NC	-	Standard for Exchange of Product Data – Numerical Control
UTeM	-	Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

This chapter introduces STEP-NC and advantages, problem statement, objectives and scopes of work. It also consists of the structure of the report that explains the whole report.

1.1 Background

The Royal Institute of Technology (KTH) is originally developed the gear box part or “boxy” and the STEP-NC Machine Development Partners had enhanced and fabricated the “boxy”. This project attempts to fabricate “boxy” with the use of three axis CNC machine. CATIA V5R19 is one of the software that used to generate the STEP NC. After drawing and simulation process by CATIA, STEP-NC can be generated and sent to the CNC machine. The machining process will be started when the programming code and machine is ready.

1.2 STEP-NC

Standard for Exchange of Product data is known as STEP, was developed on 1980's had been known formally as ISO 10303 in design for product development. Geometry, topology, dimension, tolerance, feature, material, product configuration and so on are represented in STEP. For a seamless data flow between CAM and CNC, STEP-NC (formalized as ISO 14649) has been newly established as an international standard (S. J. Shin et al., 2007). STEP-NC is provided a feature-based data model (Figure 1.2) that does not same as tool movement for a specific CNC machine as G-code (Figure1.1). The part of program supplies the shopfloor with high-level information. As the result, modifications at the shopfloor can be saved and transferred back to the planning department which enables a better exchange and preservation of experience and knowledge.

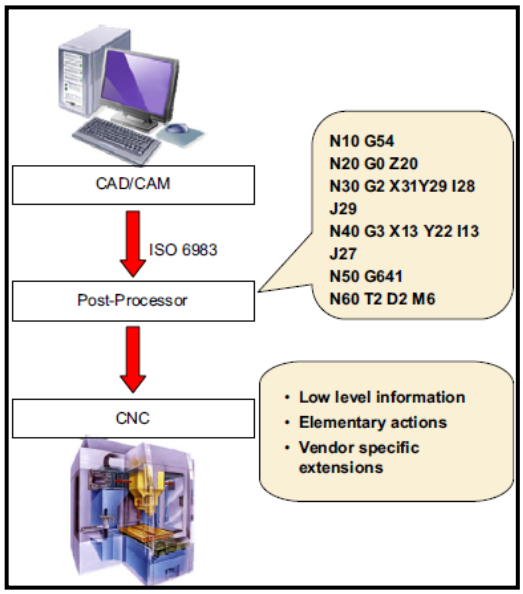

Figure 1.1: Current G-code (Matthieu Rauch et al., 2012)

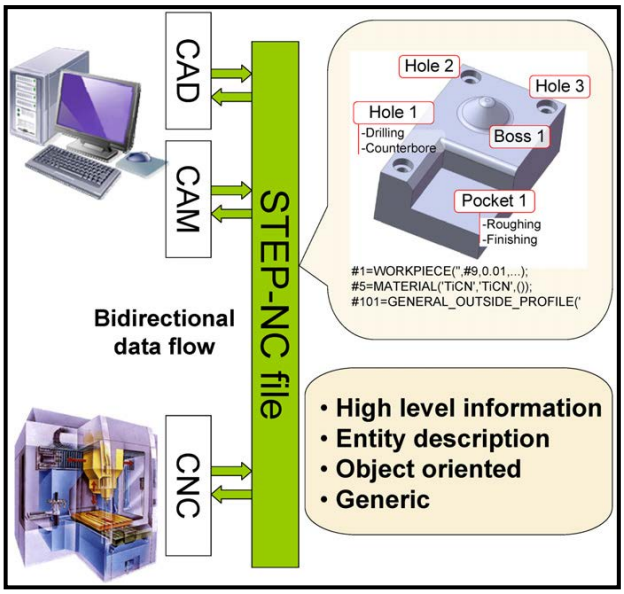

Figure 1.2: New STEP-NC high level programming (Matthieu Rauch et al.,2012)

1.3 Advantages of STEP-NC

STEP-NC have more advantages after improving the G/ M Code (ISO 6983). The importance STEP-NC had to provided a complete and structured data model that linked with geometrical and technology information so that no information is lost between the different stages of the product development process (Xu et al., 2006). The extendable to further technologies and scalable to match the abilities of a specific CAM, shopfloor programming or NC is known as data model. The interface that does not require machine specific information will be eliminated by postprocessor mechanism. Modification of the shopfloor can be saved and feedback to the planning department which enables a better exchange and preservation of experience and knowledge (Xu et al., 2006).

1.4 Problem Statement

"Boxy" is a standard part of aircraft originally developed by Royal Institute of Technology (KTH) and STEP-NC Machine Development Partners was enhanced and manufactured the boxy. The purpose of this study is to explore fabrication of "boxy". In actual machining practice, "boxy" is machine by an advance CNC Turn/Mill machine. Due to the availability, the "boxy" will be machined by using CNC Milling and CNC Turning separately.

1.5 Objectives

The main objective is to replicate the design "boxy" and fabricate it. The other objectives of the "boxy" aircraft component CNC Lathe machining-Haas are:

- To study on how to machine the "boxy" aircraft component by using the CNC Lathe Machine-Haas.
- To design the "boxy".
- To determine the right process plan before the actual machining process running.

1.6 Scope of Work

Based on the objectives, the scopes of this project is including study of "boxy" fabrication process or gear box aircraft. The fabricating of "boxy" theoretically is referred from the website of STEP TOOLS, Inc. All manufacturing process involve to fabricate the "boxy" are redesigning the "boxy", simulation, generate the STEP-NC and machining "boxy". The design process is using CATIA software to develop "boxy".

1.7 Structure of Report Dissertation

Chapter 1 is the introduction of the final year project which gives details of the background, problem statement, objectives and scope the project. The introduction about the STEP-NC and advantage STEP-NC are also included in this chapter.

Chapter 2 is discussing the literature review which reviews the STEP-NC technology, comparison between G-code and STEP-NC, design of data model, machine, cutting tools and analysis the journal about STEP-NC from 2005 until 2012.

Chapter 3 is explaining the research task and flow. The research tools also included in this chapter. The research tools are software CATIA V5R19, CNC lathe and milling, cutting tools and material.

Chapter 4 describes the result and discussion of this project from the manufacturing process that have been implemented.

Chapter 5 summaries the conclusion which is based on the planning and the process involved to fabricate “boxy”.

1.8 Summary

This chapter has completely discussed about the background, STEP-NC, and advantages STEP-NC. The Royal Institute of Technology (KTH) is originally developed the “boxy” or another name gearbox. Later, the STEP-NC Machine Development Partners is enhanced and manufacture the boxy. Furthermore, this chapter also covered on problem statement, objective, scope of work and finally on structure of the project. The next chapter would explain the literature review.

CHAPTER II

LITERATURE REVIEW

This chapter describes the review of STEP-NC technology and comparisons between G code and STEP-NC by referring from journals. In addition, design of data model also described in this chapter. Besides that, the machine, cutting tools, analysis journals and summary were also explained.

2.1 Reviews of STEP-NC

Before the revolution of the industry, the activities of engineering were defined by physical model of the product to be manufactured. CAD tools have opened new opportunities, such as the possibilities of obtaining fabricating instruction directly from drawing. However, with increasing of engineering demands, there was a proliferation of design and manufacturing tools, also increasing of the number format and means to capture and store data (Kemmerer 1999). Besides, the major problem for the industry is the needs of product data sharing among their supply chain.

Improvement by used CNC machines had been seen to play as an important role. The rapid advances in information technology were leading their capabilities improvement. High speed machining, high precision machining and multi-axis machining had improved productivity and quality of manufacturing systems (Suh et al. 2006). However, the language that these machines use is still same as language

that was used for more than fifty years (example G-code, ISO 6983), which present many major drawbacks (Xu and He 2004).

In 1997, STEP-NC was introduced to an ISO Working Group. The STEP-NC in 1997 as a draft International Standard (DIS) called ISO 14649 by technical Committee.

Since 2000, there are nineteen industry demonstrate STEP-NC in USA.Before that, the usage of G and M codes was popularly known as ISO 6983. The numerical control and tool motion is G codes while an instruction is M codes. The M and G code was used since 1950s. The G and M codes of machine programming have a weakness. The reason the G and M codes has a weakness is the result in loss of production information along the manufacturing process chain. To optimize the manufacturing effort, the tool paths and switching instructions specific to an individual are generated. STEP-NC was produces as an alternative because features and part geometry was maintained throughout the manufacturing process and changes on the shop floor are immediately reflected in the CAD/CAM models.

2.2 Comparison G code and STEP-NC

Xu et al. (2006) describes STEP-NC as “what-to-make,” whereas the G-codes can be described “how-to-make”. G/M-codes are a low level language while the STEP-NC is a high level language. The reason is G/M-codes was defined by just using numerical codes such as G, T, M, F, S is indicating the movement of the machine and an axis to the controller (S.J. Shin et al., 2007). STEP-NC describes tasks such as predrilling, drilling, roughing and finishing that are based on the machining features. Figure 2.1 shows the different between G code and STEP-NC.

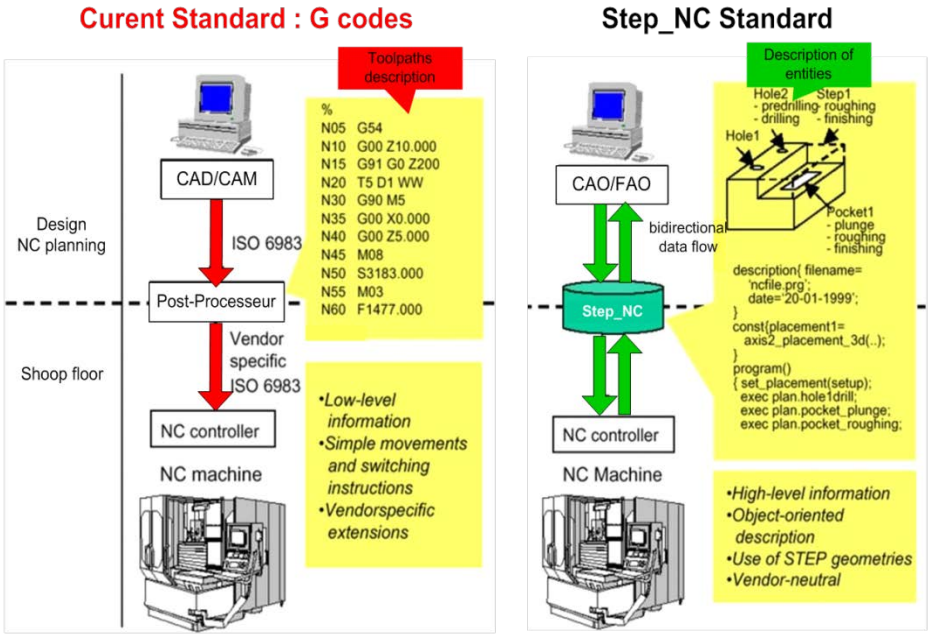

Figure 2.1: The Comparison G code and STEP-NC

(Source < zaipul.wikispaces.com/file/view/06+Step+NC.ppt> 23/11/2012)

2.3 Design OF Boxy

First step is to fabricate the gearbox part “boxy” as Royal Institute of Technology (KTH). After that, the gearbox part “boxy” was enhanced and fabricated by the STEP-NC Machines Development Partners during the Renton testing round in October 2010. NIST and Bath also test to produce gear box part “boxy”. The size of the gearbox part “boxy” by referring Benavente et al. (2012) is 100mm × 100mm × 100mm and the illustrate the gearbox part “boxy” is on Figure 2.2.

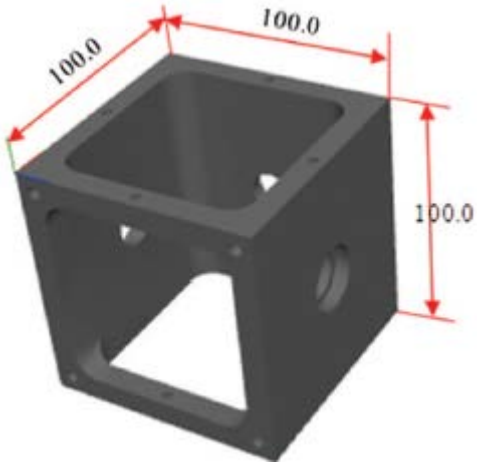

Figure 2.2: The Size of “boxy” (Benaventa et al., 2012)

2.4 Machine

CNC is a computer-assisted process to control general-purpose machines from instructions generated by a processor and stored in a memory a system or storage media for present use as well as future use (James Madison, 1996). There are several types CNC such as CNC Milling Centers, Turning Centers, Boring Machines and Grinding Machines but for this project CNC lather and CNC milling was used. Figure 2.3 shows the advantages of CNC. The explanations of the advantages are:

a. Lower Tooling Cost: Steve F. Krar et al. (2011) classified CNC machines generally use simple holding fixtures, which reduce cost of tooling by as much as 70%. Standard turning and milling tools eliminate needs for special form tools.
b. Increased Productivity: All the machine function was controlled by the CNC systems that cause parts tp produce faster and reduce lead time.
c. Reduction of Scrap: The accuracy of CNC systems causes the scrap to reduce.
d. Reduced Lead Time for Production: The short time for setup the computer numerical control machine and preparation of program can affect the lead time of production.
e. Fewer Chances for Human Error: The CNC machine eliminates the error from human such as operator take trial cut the material, make trial measurements, make positioning movement, or change tools.

f. Complex Machining Operations: Complex operation can be performed quickly and accurately with CNC and electronic measuring equipment.

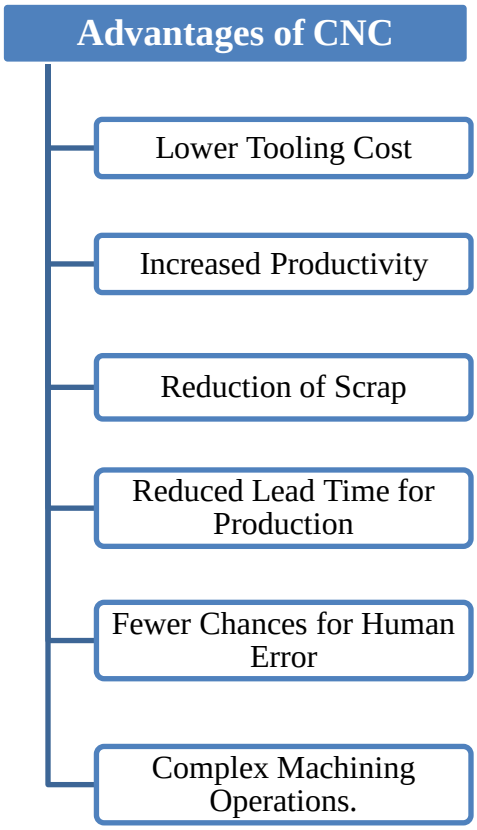

Figure 2.3: The Advantages of CNC (Steve F. Krar et al., 2011)

2.4.1 CNC Milling Machine

CNC Milling machine is a machine tool that able to perform versatile process such as shaping, planning and broaching of the metal and other solid material. Classification of the CNC Milling machine can be referred by number of axis that can be possessed. The axis is referred to the motion machine either the horizontal or vertical movement. X and Y axis usually for horizontal movement while Z axis for vertical movement. The command program for CNC Milling machine is G-codes which is same with CNC Lathe.