
Ain Shams University

Faculty of Engineering

# Advanced techniques in CNC programming

A Thesis

By

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Of M.Sc.in Mechanical Engineering

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# Statement

This thesis is submitted in the partial fulfillment of master degree in Mechanical Engineering to Ain Shams University.

The author carried out the work included in the thesis, and no part of this thesis has been submitted for a degree or qualification at any other university.

Signature

Amr Ahmed Sayed Shaaban

# Acknowledgment

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# Advanced techniques in CNC programming


## Abstract

As STEP-NC grows as the new technique for programming CNC machine tools, the traditional interface so called M & G code (ISO 6983) commonly used for CNC since 1950s is about to be obsolete. Establishing, developing and implementing STEP-compliant CAD/CAM/CNC system based on the new data model is drawing worldwide attention. This research focuses in two points. Firstly, a comparison between the two programming methods of CNC machine tools, namely, the G and M codes and the new technique of programming CNC machine tools known as STEP-NC which is a new interface for the CAD-CAM-CNC chain formalized in (ISO 14649 and ISO 10303 AP238). Secondly, a conversion system between Step-NC and G-code. By this automatic conversion the problem of legacy code -preserved by companies when STEP-CNC becomes widely available- has been overcome.


## Thesis Structure

The thesis consists of six chapters:

## Chapter 1:

Introduction

## Chapter 2:

A comparison between the current technique and the new one is discussed together with a case study to show the shortcomings of the G-code, and then a literature review is made about the new data model.

## Chapter 3:

A theoretical background of the new technique is discussed with a detailed description of the ISO10303, the ISO 14649, the STEP-NC file structure, and finally, the design considerations, functional architecture, and implementation architecture of a STEP-compliant CNC software are discussed together with an application that show in details the steps of producing a part program based on the new technique.

## Chapter 4:

The design considerations and the functional architecture of the recommended conversion system between the current technique and the new one are discussed. This chapter focuses on the conversion from G-code to STEP-NC. The information that can be extracted from a G-code part program is clarified with the information necessary to form a STEP-NC part program. The procedures of conversion are illustrated supported with a case study.

## Chapter 5:

This chapter focuses on the conversion from STEP-NC to G-code. The procedures of conversion are illustrated supported with a case study

## Chapter 6:

The main conclusion of the research is presented, and the recommendations for future work are discussed.

# Summary of the M.Sc. Thesis

# "Advanced techniques in CNC programming"

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STEP-NC has recently raised a lot of interest in the research due to its evolution as a new data model replacing the old technique (G-code). Researchers studied STEP-NC from different aspects. Some researchers studied the architecture and implementation of a shop-floor programming system based on STEP-NC for both turning and milling applications. Other researchers were interested in retrofitting an existing CNC machine tool to develop a STEP-compliant CNC one. Others made a development of ISO 14649-based conversational programming system for multi-channel complex machine tools. Others were interested in how to use the intelligent functions of STEP-NC like on-line inspection in support of closed-loop machining.

Limited research studied the conversion process between G-code and STEP-NC to overcome the problem of legacy code preserved by companies when STEP-CNC becomes widely available. However, these researches suffer from some shortages and didn't give a complete study as the standard was not yet complete at the time when these researches made. On the other hand these researches only studied the conversion from G-code to STEP-NC only.

In this thesis, the basic considerations, the functional architecture and the implementation procedures of a system that can generate a STEP-NC code are discussed supported with a case study. On the other hand, the thesis studied the functional architecture of the auto-conversion system (reincarnation system), which is one of the main modules in the recommended STEP-NC system that can convert either from G-code to STEP-NC and from STEP-NC to G-code.

The study recommends that the STEP-NC code generation process can be done by a system that contains 6 modules: (1) Interpreter module, (2) Feature recognition module, (3) working steps generation module, (4) ISO14649 part

program generation module, (5) Cutter location path simulation module, and (6) Reincarnation module. Each of the mentioned modules is discussed in details showing the entity-index map which is the structure of any STEP-NC file, and the standard entities that represent the machining operations, machining features, machining strategies, and machining technology.

On the other hand, the study recommends that the reincarnation system can convert G-code to STEP-NC using the following functions: (1) Working steps generation function, (2) Machine tool generation function, (3) Technology generation function, (4) Machine function generation function, (5) Machining operation generation function, (6) Feature recognition function, (7) Machining strategy generation function, (8) STEP-NC part program generation function and finally, (9) Part program verification function. Each of the mentioned functions was discussed followed with a casestudy.

Finally, this thesis introduced a study about the conversion process from STEP-NC to G-code. The study recommends that the reincarnation process can be achieved by using the following functions: axis movement generation function (which is the main function that select the appropriate G-code format), machining technology generation function, machine tool generation function, and finally part program verification function. Each of the mentioned functions was discussed supported with a casestudy.

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