

# Computerized Numerical Control Programming for Lathe Machining

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## ABSTRACT

*This paper presents the use of a computerized numerical control (CNC) machine to get more accurate dimensions when producing products with a lathe machine. CNC machines play vital roles in modern technology, which requires the use of computer software, hardware and firm ware in industries. Developed nations such as Ghana are required to acquire necessary skills through capacity building, and research to help convert conventional lathe machines into semi-automatic control lathe machine.*

*Key Words: Computerized numerical control programming, lathe machine, part zeroing*

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## 1. INTRODUCTION

The lathe machine often described as the mother machine tool is the most versatile machine tool that operates by clamping and rotating the work piece to be machine in its chuck while the stationary cutting tool is advanced toward the rotating work piece to obtain a desired finished product [1]. To obtain a high accuracy and repeatability of machine parts, chucking and tool positioning is very critical. There is a need for reducing chucking induced inaccuracy in the turning of machine parts after the realization of hard turning operations serving as a finishing process [2]. There are many factors that affect the accuracy of the positioning of the work piece. These factors include, the deviation in the shape of clamp transmission components, improper control of jaw boring pressure, redundancy in selecting a locating face and jaw – work piece deformation [3].

The positioning accuracy and repeatability of the part can be improved by the implementation of an appropriate clamping pressure during chucking, to prevent the tapering of the surface on which the jaws are located, or increasing the rigidity of the jaw structure by installing larger jaws if the situation permits [3]. To reduce the errors introduced by geometrical imperfections of the jaws, it is advisable to reduce the contact that makes positioning the work piece repeatable and accurate [4]. The use of computerized numerical control (CNC) machine tools have provided significant improvement in the achievement of high accuracy and repeatability of machine parts on lathe, especially in the control of the cutting tool [3]. According to [5], most books currently available on CNC programming are not only inadequate, but also specific to certain CNC control systems and aimed at the professionals in the industry. Such manuals only have very basic explanations on some codes, without adequate pictures and programs examples. Therefore, they do not help in teaching the fundamentals of CNC programming.

Regional maritime university in its efforts to bridge the gap between education and industry took the initiative to secure industry driven laboratory training equipment and electronic manuals in CNC programming from a world class educational training equipment dealer in Israel called Degem to enrich the knowledge of students and also prepare them to fit into today's dynamic industry [6]. Currently students spend two hours in the Laboratory each week for 10 weeks to acquire knowledge and skills in CNC programming, coordinate systems, G and M codes, setting up the lathe, practical activities in parallel turning, chamfering and grooving. Machining is an important manufacturing process that is used in a wide range of applications from marine applications to the manufacturing of energy systems.

This paper is focused on gaining an improved understanding of the mechanics of machining and the different factors that contribute to part quality. The primary machine shop skills acquired, provides an opportunity to turn, mill and drill a class of components to specified dimensions and tolerances [6]. In a numerically controlled (NC) machine, the tool is controlled by a code system that enables it to be operated with minimal supervision and with a great deal of repeatability. CNC is the same type of operating system, with the exception that a computer monitors the machine tool [7]. Figure 1 shows the typical apparatus used in CNC programming lathe machining laboratory.

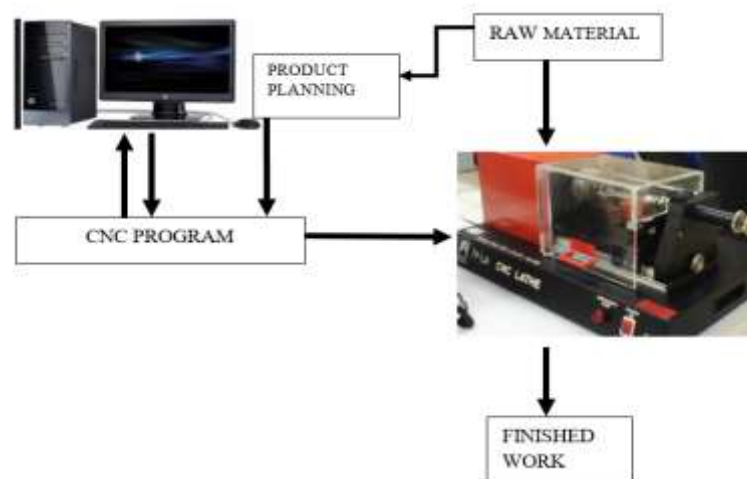


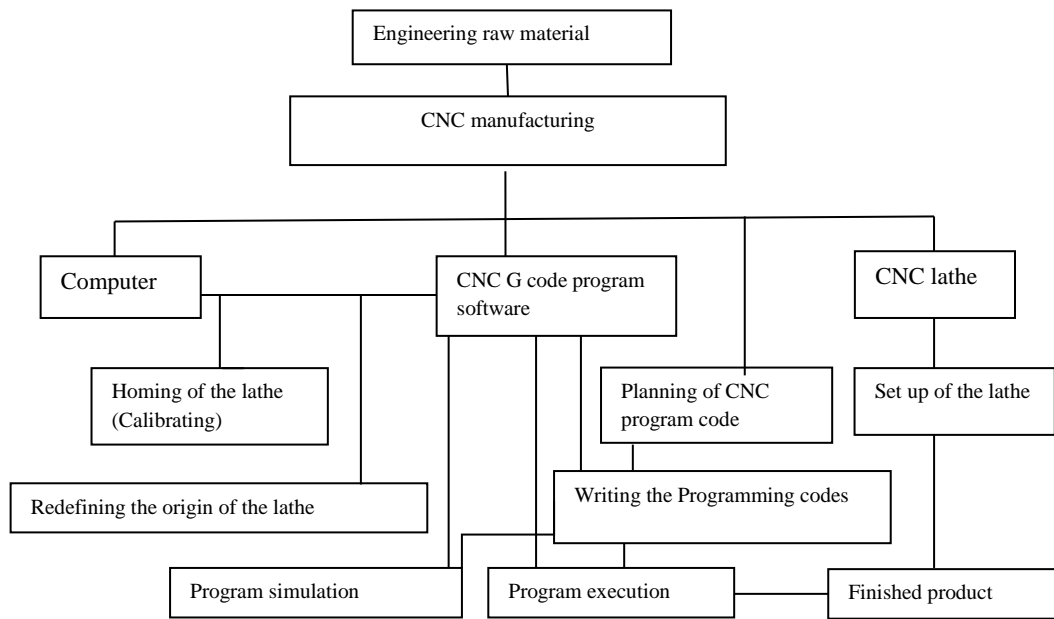
Figure 1: Apparatus used in CNC programming

The same principles used in operating a manual machine are used in programming an NC or CNC Machine. The main difference is that instead of cranking handles to position a slide to a certain point, the dimension is stored in the memory of the machine control once [6]. The control will then move the machine to these positions each time the program is run. In order for the machine to carry out a given task, it gives instructions on where to move to, how fast to move and to what part to move. The most common situation is that, within a machine tool, a cutting tool is moved according to these instructions through a tool path, cutting away excess material leaving only the finished working product [8]. The apparatus used in this paper are, 20 mm x 100 mm perspex work piece, CNC lathe machine, vernier caliper, and CNC software.

## 2. PROGRAMMING FRAMEWORK

### 2.1 Set Up

To establish the coordinates required to bring the tip of the cutting tool of the lathe machine into contact with the work piece, there is the need to prepare the CNC lathe machine for a new machining operation. A cylindrical perspex work piece with dimension 100 mm x 20 mm diameter having a kerner on one end is required [9]. There is the need to keep records of this dimension, after measuring the work piece with a venier caliper and the length of the work tool. During the setting up process, the work piece is secured in between the chuck and the tail stock properly and the lathe guard or door is closed. A typical CNC programming framework is presented in Figure2.



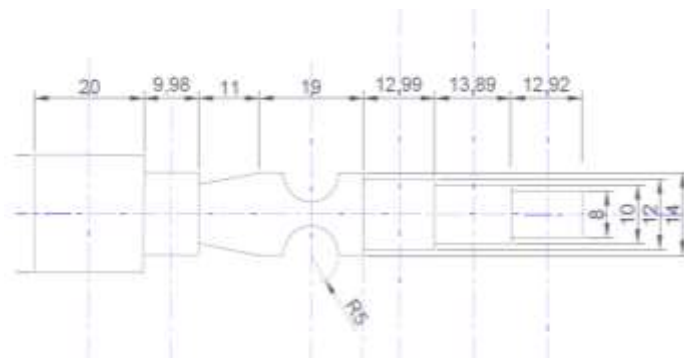
**Figure 2: CNC programming framework**

**2.2 Homing the Lathe Machine**

After the preparatory stage of CNC manufacturing which involves the recording of measurements, correct placement of the work piece and the work tool in the working area of the lathe, there is another stage involving the use of the CNC software installed on a computer to control the movement of the tool post by moving it to its default position upon a click of a button in the software; under the machine menu it is required the programmer present the dimensions of the work tool and the work area. This will help the software to present a graphical representation of the work within the lathe for simulation on the monitor [10]. The work specification is presented in Figure 3 showing the dimensions used for the finished product.

**2.3 Part Zeroing**

To change the default position of the tool post to suit the coordinate within a CNC control program, there is the need to control the tool post manually from the machine menu to a point on the work piece where machining would commence; by the click of arrows at a speed of between 30 -50mm/min [11]. The option of offsetting the cutting tool after making contact with the work piece gives the programmer the room to move the cutting tool back to a chosen distance. This operation is also done within the machine menu of the software [11]. In the case of executing this computerized manufacturing project the coordinate used is X6 Z6 with a speed set at 50mm/min. Closing the offset menu and pressing the zero coordinate makes the new position of the cutting tool the origin [6].



**Figure 3: Work specification**

## 2.4 Planning a Program Code

Considering the drawing of the finished product, an appropriate CNC blocks of programs is required to produce the finished product. Though it may take weeks, months or even a year to plan these block of programs for a particular finished product, it is common practice to start by producing the drawings of the finished product within the raw material [11]. This approach makes it easier for the programmer to identify the various procedures and turning processes involved in producing the finished product. The amount of material to remove and the cutting speed of the work tool are considered in the design of the block of CNC program [9]. Figure 4 presents the raw material for the CNC lathe machine programming.

## 2.5 Writing the Program

The entire written program is in three part. The startup part of the program makes it possible for the software to understand the coordinate system used, the units of the numbers within the block and finally turns on the spindle [11]. The second part of the program involves the use of the words with the CNC block of program to perform material removal operations. The starting position of the cutting tool must conform to the first block of program within this part of the program [8]. In the case of this project it is G00 X-6 Z-6.



Figure 4: Raw material

## 2.6 Programming and Simulation

The CNC software provides the programmer an edit window where the planned written blocks of the program can be typed [9]. The software provides a simulation window where the typed program can be run, taking into account the software's ability to recognize the dimensions of the raw material and the work tool [12]. This helps promotes the effectiveness and efficiency of the type of program to manufacture a finished product to the exact specification.

## 2.7 Program Execution & Results

Executing the program means switching from simulation to real mode and running the lathe to produce successful results. The simulation results are presented in Figure 5 & Table 1 and the corresponding finished product. The lathe door is opened and finished product released from the tail stock and chuck, once the spindle has stop rotating [12].

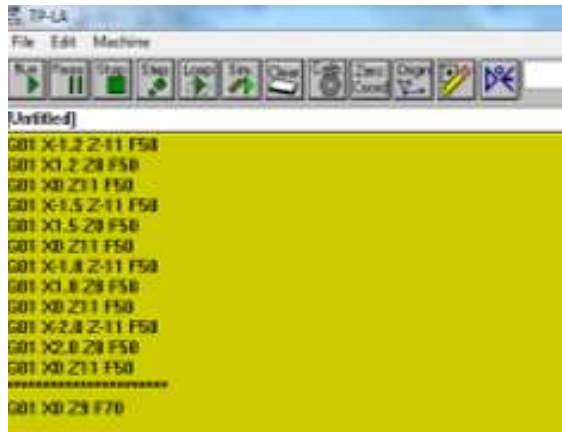


Figure 5: Simulation result

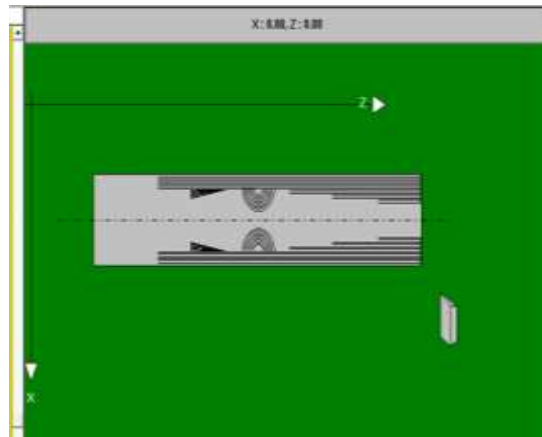


Figure 6: Finished product

Table 1: Simulation result

G91	G01 X3 Z0 F50	G01 X0 Z9 F70	G90
G21	G01 X0 Z-59 F50	G02 X0 Z1 I0 K0.5 F40	G00 X0 Z0
M03	G01 X-0.3 Z-11 F50	G01 X0 Z0.5 F70	M05
G00 X-6 Z-6	G01 X0.3 Z0 F50	G03 X0 Z-2 I0 K-1	M30
G01 X-0.5 Z0 F50	G01 X0 Z11 F50	G01 X0 Z-0.5 F70	*****
G01 X0 Z-80 F50	G01 X-0.6 Z-11 F50	G02 X0 Z3 I0 K1.5 F40	
G01 X0 Z80 F50	G01 X0.6 Z0 F50	G01 X0 Z0.5 F70	
G01 X-0.5 Z0 F50	G01 X0 Z11 F50	G03 X0 Z-4 I0 K-2 F40	
G01 X0 Z-80 F50	G01 X-0.9 Z-11 F50	G01 X0 Z-0.5 F70	
G01 X0 Z80 F50	G01 X0.9 Z0 F50	G02 X0 Z5 I0 K2.5 F60	
G01 X-0.5 Z0 F50	G01 X0 Z11 F50	G01 X0 Z0.5 F50	
G01 X0 Z-80 F50	G01 X-1.2 Z-11 F50	G03 X0 Z-6 I0 K-3 F60	
G01 X0 Z80 F50	G01 X1.2 Z0 F50	G01 X0 Z-0.5 F60	
G01 X-0.5 Z0 F50	G01 X0 Z11 F50	G02 X0 Z7 I0 K3.5 F50	
G01 X0 Z-80 F50	G01 X-1.5 Z-11 F50	G01 X0 Z0.5 F60	
G01 X0 Z80 F50	G01 X1.5 Z0 F50	G03 X0 Z-8 I0 K-4 F50	
G01 X-0.5 Z0 F50	G01 X0 Z11 F50	G01 X0 Z-0.5 F60	
G01 X0 Z-80 F50	G01 X-1.8 Z-11 F50	G02 X0 Z9 I0 K4.5 F60	
G01 X0 Z80 F50	G01 X1.8 Z0 F50	G01 X0 Z0.5 F60	
G01 X-0.5 Z0 F50	G01 X0 Z11 F50	G03 X0 Z-10 I0 K-5 F60	
G01 X0 Z-80 F50	G01 X-2.0 Z-11 F50	*****	
G01 X0 Z80 F50	G01 X2.0 Z0 F50		
G01 X-0.5 Z0 F50	G01 X0 Z11 F50		
G01 X0 Z-40 F50	*****		
G01 X0 Z40 F50			
G01 X-0.5 Z0 F50			
*****			

### 3. CONCLUSION

With the current economic conditions in Ghana machining and manufacturing contracts are continually being awarded to overseas companies. There is an extreme need for talented and knowledgeable individuals to join the manufacturing industry. With the advances in technology and advanced processes, the idea of Ghana becoming the production and manufacturing powerhouse of Africa becomes more of a realization than an idea. This paper was a combination of research efforts into lathe machining framework and how to minimize negative effects on production while trying to personally ascertain skills that will help the manufacturing industry.

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