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# Fault Diagnosis of Non Execution of Linear Interpolation on CNC Turning Machine

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**ABSTRACT:** Today industries are growing rapidly and in today's manufacturing ideologies, the production should be continuing 24x7. Therefore machines should be available all the time with full capacity. In case of machine breakdown, the machine responsible personnel cannot wait much and he want to repair it as soon as possible. Thus the main objective of the work is to diagnose the problem occurred due to non-execution of G code G01 in CNC turning machine. Therefore, in this study, the fault diagnosis procedure is proposed for the non-execution of the geometry code G01. For the completion of the study, the machine was disassembled to check the different parts of the machine. The visual fit method is used to diagnose the fault. The parts of the machine were inspected step by step and the status for the same was noted.

During the work it was noticed that there are some causes due to which the G code G01 is not executed. These causes are software crash, not working of encoder, Damaged CF card, etc. at the end it is found that in this case the encoder was not working. And it was replaced with new encoder (AMO). Afterward machine stated normal functioning.

**Keywords:**Fault Diagnosis, CNC Machinating, CNC Turning, AMO Encoder, Geometry Codes, Fanuc Series 21, Fault Rectification

## I. INTRODUCTION

The manufacturing industries are growing rapidly and want high production levels with high efficiency to increase the profit as much as they can. Therefore, all machine tools should be run efficiently and effectively without failure. CNC machines are advanced machines which are a combination of automation technology, computer technology, high precise machinery, and precise measurement etc.

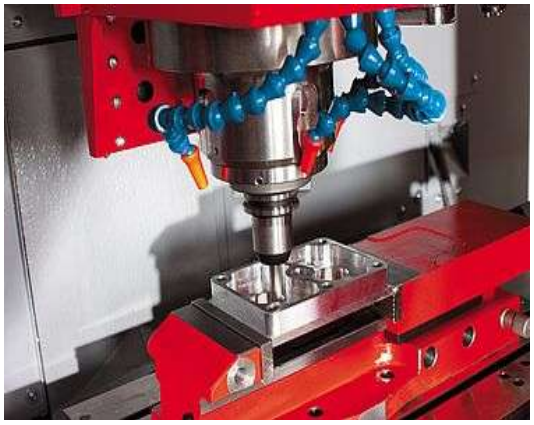

**Figure 1** CNC Milling Machine

Today, every production industry is using CNC machine tools (shown in figure 1) for high production & quality with low production cost. To maintain the consistency of the production, risk analysis which defines the utilization rate and production rate of machines should be done. Machine failure is a kind of risk which can stop the production or decrease the rate of production. There is some common fault which causes machine breakdown.

- Software crash
- Axis misalignment due to heavy accident
- Not working of coder or decoder
- Power supply fault

1. Software crush

Software stops working due to sudden cut of power supply, computer configuration is not as per required, frequently software ON/OFF etc.

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2. Axis Misalignment

Axis misalignment generally comes because of heavy accident. the axes of the machine shift their actual position up or down because of this, the correct dimensions of the workpiece do not achieve during the cutting. The problem is rectifying with the help of dia indicator by align the axis at its right position.

3. Encoder

There are many encoders that are fixed at different places to read the programming codes for decoding and give desired output.

These encoders are

- Absolute measuring encoder
- Angular measuring encoder
- Linear measuring encoder

4. Power supply fault

Due to the power supply cut, many problems come like software crush, short circuits, overheating etc.

1.1 Preparatory code/Geometry code (G-Code)

These are the codes which are responsible for controlling the machine tools. In other words, we can say these codes instruct the machine; where to move, how fast to move and what path to follow. There are some common codes (for Fanuc controllers) used generally for part programming are written in table 1.

**Table 1** Geometry Codes/Preparing codes

| S.N | G-Code | Description | S.N | G-Code | Description |
|---|---|---|---|---|---|
| 1 | G00 | Rapid traverse | 10 | G42 | Tool nose radius compensation right |
| 2 | G01 | Linear interpolation | 11 | G72 | Finishing cycle |
| 3 | G02 | Circular interpolation CW | 12 | G73 | Turning cycle |
| 4 | G03 | Circular interpolation CCW | 13 | G74 | Facing cycle |
| 5 | G04 | Dwell | 14 | G77 | Grooving cycle |
| 6 | G18 | Input in mm | 15 | G78 | Threading cycle |
| 7 | G28 | Return to reference position | 16 | G92 | Coordinate system setting or max. spindle speed setting |
| 8 | G40 | Tool nose radius compensation cancel | 17 | G95 | Feed Per Revolution |
| 9 | G41 | Tool nose radius compensation left | 18 | G97 | Constant spindle speed(RPM) |

1.2 Problem Statement

During the work in the Bhartiya skill development university, Jaipur, a CNC machine had a breakdown due the non-execution of geometry code G01.

While execution of the program, the block having G01 command did not execute. In fact, the machine hung there and did not move to the next block as well as the coordinates of 'distance to go' not appeared.

1.3 Objective of Study

To diagnose the problem due to the machine having breakdown and rectify the same.

To prepare a proper standard operating procedure for rectifying the problem so that next time it would be diagnosed easily with the help of it.

## II. RESEARCH METHODOLOGY

Research methodology is defined as a systematic approach or the specific procedures or techniques to identify, select, and analyze information about the topic.

There are four types of diagnosis methods for identifying the fault which causes machine failure. These are

- Visual fit method
- Self-diagnosis
- Parameters a-a-a method
- Principle analysis methods

The terms which are most essential to get better understanding the CNC turning machine and its fault diagnosis system (FDS). In this paper the "Visual Fit Method" is used to diagnose the problem.

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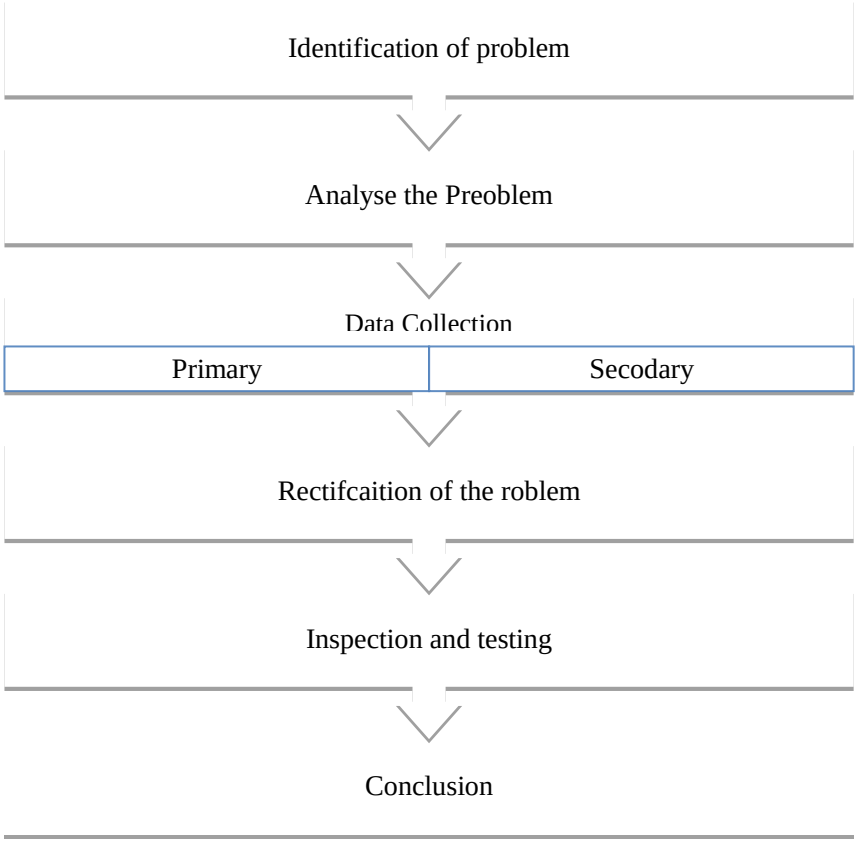
2.1 Flow Chart

The flow chart figure 2 of the research methodology which is followed in the study is illustrated below. The chart gives a clarification to understand the basic stages of the study.




## III. EXPERIMENTAL WORK

3.1 Description of Used CNC Turning Machine

The machine is one of the machines that can be used in a flexible production unit (flexible manufacturing). It is called a CNC Turning machine (CNC: Computer Numeric Control). The specification of the machine is given table 2 below:

**Table 2** Machines Description-CNC turning

| S.N | Specification | Description |
|---|---|---|
| | Machine Name | EMCO Concept Turn 250<br>(PC- Controlled 2 axis CNC turning machine for chuck and bar machining. |
| 1 | Travel in X/Z | 100/300 mm |
| 2 | Tool magazine | 12 tools (6 driven tool) |
| 3 | C axis | Yes (high precision C axis) |
| 4 | Bar diameter | 250 mm |
| 5 | Maximum turning diameter | 85 mm |
| 6 | Max. part length with tailstock | 255 mm |

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| | | |
|---|---|---|
| 7 | Swing over bed | 250 mm |
| 8 | Max speed | 6300 RPM |
| 9 | Machine weight | 1100 kg |
| 10 | Quill stroke | 120 mm |

3.2 Fault Diagnosis Procedure
Steps followed for diagnosing the fault:

**Step 1**

At the very first stage, it is noticed that this problem is formed due to the virus in the programming software. Therefore, the software was installed in the controller and restarted it but the problem remained the same.
In the same stage, the software was scanned through the anti-virus but all was in vain.

**Steps 2**

Compact flash card: While working on the machine, it was observed that the same problems (not execution of G01 Code) comes because of the CF card. To confirm the same, The CF card was replaced with the new one CF card. Then the program was executed again but it was still not resolved. The pictures for the same are attached below in the figure 2 for future reference.

**Step 3**

As per the operating manual of the machine, it is found that the same problems come due the difference between the Actual speed and the programmed speed. The actual speed in the Fanuc software is not displaced. Therefore, to see the difference in the both speeds, the Controlled Fanuc series 21 was replaced with the Siemens Controller.

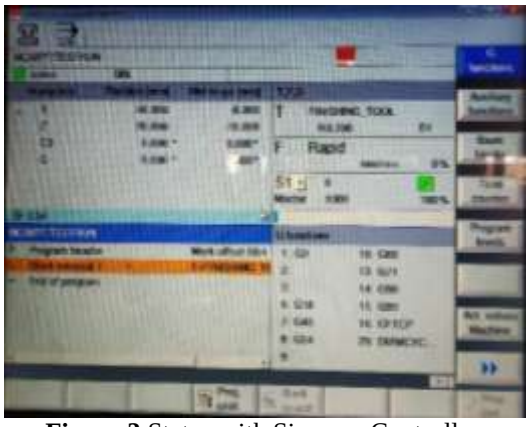

**Figure 3** Status with Siemens Controller

It is cleared figure the above figure 3 as a result, we found that
Actual speed=0
Program Speed= The speed given the program
Whereas it should be equal or having very less difference between the both speeds. The AMO encoder is responsible for the actual speed.

**Steps 4**

To check the AMO encoder shown in figure 4, first of all, the voltage was checked at the position of pins 3-4 and the pins 6-7. For that a wire was soldered at the same pins.


**Figure 4** AMO Encoder

The voltage level was measured with the help of Voltmeter (unit Millimeter) and it was found that it was not okay because the voltage was zero while as per the machine manual, it is recommended that the voltage should be between 270 mV to 420 mV.

## IV. RESULT AND DISCUSSION

It is clear from the above mentioned step 4 that the linear measuring encoder is not working therefore it is replaced with the new AMO endercoder. Thus finally the problem was resolved and the machine started functioning normally.

## V. CONCLUSION

The main purpose of the research work is to diagnose the fault non execution of geometry

code G001 (linear interpolation) and rectify it with possible and feasible solution. The research is followed by 'visual fit method'. The complete step by step solution is given and the possible reason for the non-execution of the g-code G001 also mentioned above.

The fault was found in the encoder which read the geometry code for linear movement. The old AMO encoder was replaced with new encoder. After that machine start functioning well and production was resumed.

## VI. ACKNOWLEDGEMENTS

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