

“A Study of CNC Machine Operations and Productivity Improvement at Kinetic Engineering PVT LTD, Ahilyanagar.”

Shivam Dashrath Roman¹, Gaurav Rajendra Shahane², Dr. Ramesh Suryabhan Gadakh³

¹ Student, Department of Mechanical Engineering Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

² Guide, Department of Mechanical Engineering Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

³ Principal Sau Sundarbai Manik Adsul Polytechnic, Chas, Ahilyanagar, India

ABSTRACT

Computer Numerical Control (CNC) machines play an important role in modern manufacturing industries because they provide high accuracy, repeatability, productivity and consistent product quality. This research paper presents a study of CNC machine operations performed in an automotive manufacturing environment with reference to Kinetic Engineering Limited, Ahilyanagar. The study focuses on the activities and responsibilities of a CNC Machine Operator, including machine operation, component loading and unloading, tool monitoring, inspection, production recording and implementation of safety and 5S practices.

The research examines the relationship between CNC machining parameters, machine utilization, production rate, rejection and component quality. Proper machine setting, correct selection of cutting tools, monitoring of machining parameters and regular inspection are important factors for achieving the required dimensional accuracy. The study also identifies common problems such as tool wear, improper clamping, dimensional variation, machine downtime and rejection. Improvement methods including preventive maintenance, operator training, in-process inspection and reduction of setup time are discussed.

The study concludes that the role of the CNC Machine Operator is highly important in maintaining productivity and quality in precision manufacturing. Effective monitoring of machine operations and continuous improvement practices can reduce rejection and downtime while improving overall equipment utilization.

Keywords: CNC Machine, CNC Operator, Machining, Productivity, Quality Control, Automotive Manufacturing, Tool Wear, 5S, Machine Utilization.

1. INTRODUCTION

Manufacturing industries are continuously adopting advanced machines and automation systems to achieve higher productivity and better product quality. In the automotive component industry, precision machining is essential because components must meet specified dimensions, tolerances and surface finish requirements.

Kinetic Engineering Limited has manufacturing capabilities associated with precision machining, including CNC-based operations and VMC/HMC capabilities for processes such as milling, drilling and tapping. The company's manufacturing material also emphasizes accuracy, repeatability, inspection and modern production systems.

A CNC machine operates according to programmed instructions. Compared with conventional machine tools, CNC machines provide improved repeatability and better control over machining operations. However, the performance of a CNC machine depends not only on the machine and program but also on the operator. The CNC Machine Operator is responsible for operating the machine safely, monitoring production and ensuring that the manufactured components meet quality requirements.

This paper studies CNC machine operation from the viewpoint of production, quality and productivity improvement.

2. OBJECTIVES OF THE STUDY

The main objectives of this research are:

1. To study the working of CNC machines used in manufacturing operations.
2. To understand the duties and responsibilities of a CNC Machine Operator.
3. To study the sequence of CNC machining operations.
4. To identify factors affecting production and productivity.
5. To study component inspection and quality

control methods.

6. To identify common causes of rejection in CNC machining.
7. To study the effect of tool condition and machining parameters on component quality.
8. To suggest methods for reducing machine downtime and rejection.
9. To study the importance of safety and 5S in CNC machining operations.

3. ORGANIZATION PROFILE

3.1 Kinetic Engineering Limited

Kinetic Engineering Limited is associated with automotive and precision manufacturing activities. Its manufacturing capabilities include precision machining and operations involving advanced machine tools. Published company information describes VMC and HMC capabilities for operations such as precision milling, drilling and tapping.

In a precision manufacturing environment, the major requirements are:

- Dimensional accuracy
- Repeatability
- Surface finish
- High production rate
- Minimum rejection
- Optimum machine utilization
- Tool life improvement
- Safe working practices
- Proper inspection and documentation

CNC machining supports these requirements by performing programmed and repeatable machining operations.

4. CNC MACHINE

4.1 Definition

CNC stands for **Computer Numerical Control**. A CNC machine is a machine tool controlled by a computer-based numerical program. The movement of the machine axes and machining operations are controlled according to programmed instructions.

Common CNC operations include:

- CNC Turning
- CNC Milling
- Drilling
- Boring
- Tapping
- Facing
- Threading
- Grooving
- Contouring

4.2 Basic Parts of a CNC Machine

The important parts of a CNC machine are:

1. CNC Control Unit

It receives and processes the programmed

instructions.

2. Spindle

It provides rotational motion to the cutting tool or workpiece.

3. Tool Turret or Tool Magazine

It holds the required cutting tools.

4. Chuck or Fixture

It holds the workpiece securely during machining.

5. Feed Drive System

It controls the movement of machine axes.

6. Coolant System

It removes heat and helps improve tool life and surface finish.

7. Hydraulic/Pneumatic System

It performs auxiliary operations such as clamping and other machine functions.

5. ROLE OF CNC MACHINE OPERATOR

The CNC Machine Operator performs an important role in the production process. The main responsibilities include:

5.1 Before Starting the Machine

- Checking machine condition.
- Checking lubrication and coolant level.
- Checking air and hydraulic pressure where applicable.
- Verifying the CNC program.
- Checking cutting tools and inserts.
- Ensuring proper work holding.
- Checking safety guards and machine interlocks.
- Reviewing the production schedule.

5.2 During Machine Operation

- Loading the raw component.
- Ensuring correct clamping.
- Starting the machining cycle.
- Monitoring machine operation.
- Observing abnormal sound or vibration.
- Monitoring coolant flow.
- Checking tool wear.
- Measuring the first component.
- Conducting periodic inspection.
- Recording production quantity.

5.3 After Completion of Operation

- Removing the finished component.
- Checking the component visually.
- Performing required measurements.
- Separating accepted and rejected components.
- Recording production details.
- Cleaning the machine and workplace.
- Following 5S procedures.

6. CNC MACHINING PROCESS FLOW

The general process flow of CNC machining is shown below:

Raw Material/Component



Component Identification



Loading and Clamping



Program Selection



Tool Offset Verification



First Piece Machining



First Piece Inspection



Production Machining



In-Process Inspection



Final Inspection



Accepted Component

- Vernier caliper
- Outside micrometer
- Bore gauge
- Height gauge
- Dial indicator
- Thread gauge
- Plug gauge
- Ring gauge
- Surface roughness tester

The operator should ensure that the component dimensions are within specified tolerance limits.

First Piece Inspection

The first machined component is inspected before regular production begins. This helps identify problems related to:

- Wrong program
- Incorrect tool offset
- Improper tool selection
- Incorrect dimensions
- Improper clamping

Early detection prevents the production of a large quantity of rejected components.

7. IMPORTANT MACHINING PARAMETERS

The quality and productivity of CNC machining are affected by several machining parameters.

7.1 Spindle Speed

The spindle speed is the rotational speed of the spindle.

For machining operations:

$$N = (1000 \times V) / (\pi \times D)$$

Where:

N = Spindle speed in rpm

V = Cutting speed in m/min

D = Diameter of workpiece or cutting tool in mm

Incorrect spindle speed may cause poor surface finish and excessive tool wear.

7.2 Feed Rate

Feed is the distance travelled by the tool during machining.

Higher feed may increase production rate but can also affect surface finish and tool life.

7.3 Depth of Cut

Depth of cut is the thickness of material removed during one machining pass.

Excessive depth of cut can result in:

- High cutting force
- Vibration
- Tool damage
- Poor dimensional accuracy

8. QUALITY CONTROL IN CNC MACHINING

Quality control is essential in precision component manufacturing.

Common inspection instruments include:

9. COMMON PROBLEMS IN CNC MACHINING

Sr. No.	Problem	Possible Cause	Effect
1	Dimensional variation	Incorrect offset	Rejection
2	Poor surface finish	Tool wear	Quality problem
3	Tool breakage	Excessive feed/depth	Machine downtime
4	Vibration	Improper clamping	Poor accuracy
5	Component damage	Incorrect loading	Rejection
6	Machine stoppage	Mechanical/electrical fault	Production loss
7	Excessive burr	Tool condition	Additional rework
8	Wrong machining	Incorrect program selection	Rejection

10. PRODUCTIVITY IMPROVEMENT

Productivity can be improved by reducing non-productive activities and increasing machine utilization.

10.1 Reduction of Setup Time

Setup time can be reduced by:

- Standard operating procedures.
- Proper fixture arrangement.
- Tool presetting.
- Standard tool location.
- Quick verification of programs.

10.2 Tool Management

Proper tool management includes:

- Monitoring tool life.
- Replacing worn inserts.
- Maintaining tool records.
- Using correct cutting parameters.
- Avoiding unexpected tool breakage.

10.3 Reduction of Machine Downtime

Downtime can be reduced through:

- Preventive maintenance.
- Regular lubrication.
- Daily machine inspection.
- Timely reporting of abnormalities.
- Availability of spare parts.

11. 5S IMPLEMENTATION IN CNC SECTION

The 5S system improves workplace organization and efficiency.

Seiri – Sort

Remove unnecessary items.

Seiton – Set in Order

Arrange tools and materials properly.

Seiso – Shine

Keep the machine and workplace clean.

Seiketsu – Standardize

Maintain standard procedures.

Shitsuke – Sustain

Follow the system continuously.

Benefits of 5S include:

- Improved safety
- Reduced search time
- Better workplace organization
- Improved productivity
- Better machine maintenance

12. SAFETY PRECAUTIONS

The following safety precautions should be followed:

1. Wear appropriate personal protective equipment.
2. Do not operate the machine without proper training.
3. Ensure that the workpiece is clamped correctly.
4. Keep machine guards closed during operation.
5. Do not touch rotating components.
6. Remove chips using proper tools.
7. Stop the machine before measuring components where required.
8. Report abnormal machine conditions immediately.
9. Keep the workplace clean.
10. Follow standard operating procedures.

13. RESULTS AND DISCUSSION

The study indicates that CNC machining performance depends on the combined effect of the machine, operator, cutting tools, work holding system, machining parameters and inspection practices.

The following factors have a major influence on productivity:

- Machine availability
- Tool condition
- Proper CNC program
- Correct tool offsets
- Reduced setup time
- Proper component loading
- Regular in-process inspection
- Preventive maintenance

Quality problems can be reduced through first-piece inspection and regular measurement of critical dimensions. Monitoring tool wear can prevent sudden dimensional variation and improve consistency.

The CNC Machine Operator therefore has an important role in maintaining both production quantity and component quality.

14. CONCLUSION

The study of CNC machine operations at Kinetic Engineering Limited, Ahilyanagar demonstrates the importance of CNC technology in precision manufacturing. CNC machines provide high accuracy, repeatability and productivity, but effective operation depends on proper machine monitoring and operator skills.

A CNC Machine Operator contributes to the manufacturing process through correct component loading, program selection, machine monitoring, tool inspection and dimensional checking. Proper implementation of first-piece inspection, in-process quality control, tool management, preventive maintenance and 5S can help reduce rejection and machine downtime.

It is concluded that continuous improvement in CNC machining operations can improve machine utilization, product quality and overall manufacturing productivity.

15. FUTURE SCOPE

Future improvements in CNC machining may include:

1. Industry 4.0-based machine monitoring.
2. Real-time production data collection.
3. Predictive maintenance of CNC machines.
4. Automatic tool wear monitoring.
5. Digital quality inspection systems.
6. Automated component handling.
7. CNC process optimization for reduced cycle time.

8. Energy-efficient machining practices.

16. REFERENCES

1. Kinetic Engineering Limited, *Company Manufacturing and Precision Machining Information*.
2. Kinetic Engineering Limited, *Engineering and Manufacturing Capabilities*.
3. S. Kalpakjian and S. R. Schmid, *Manufacturing Engineering and Technology*.
4. P. N. Rao, *CAD/CAM: Principles and Applications*.
5. M. P. Groover, *Automation, Production Systems and Computer-Integrated Manufacturing*.
6. Y. Altintas, *Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations and CNC Design*.