

Industrial Exposure to Sheet Metal Fabrication, CNC Machining, Press Working and Welding Processes Under Industrial Training.

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Abstract:

Industrial training plays an important role in bridging the gap between theoretical knowledge acquired in an academic institution and practical applications used in manufacturing industries. This paper presents an industrial exposure study carried out at **Inspire Metal Engineering, MIDC Ahilyanagar**, with particular emphasis on sheet metal fabrication, CNC machining, press working, and welding processes. The study focuses on understanding the sequence of manufacturing operations, machine utilization, tooling, material handling, dimensional inspection, quality control, workplace safety, and process planning followed in an industrial environment.

1. INTRODUCTION:

Manufacturing industries are an essential part of modern engineering and economic development. Mechanical engineering professionals are required to understand not only the theoretical principles of manufacturing but also their practical implementation in industrial environments. Industrial training provides students with an opportunity to observe actual manufacturing processes, machines, tools, inspection methods, safety practices, and production systems.

The present study was carried out during industrial training at Inspire Metal Engineering, MIDC Ahilyanagar. The main objective of the study was to understand the practical implementation of manufacturing processes, particularly sheet metal fabrication, CNC machining, press working, and welding.

Sheet metal components are extensively used in industrial equipment, automotive components, electrical enclosures, machine structures, brackets, panels, cabinets, and various fabricated assemblies. Their manufacturing generally involves operations such as shearing, cutting, bending, punching, forming, drilling, and joining.

CNC machining is an important modern manufacturing technology that enables accurate and repeatable production of components according to programmed instructions. CNC machines are widely used when dimensional accuracy, productivity, repeatability, and complex machining operations are required.

Press working is another important manufacturing technique in which sheet metal is subjected to operations such as

blanking, piercing, bending, drawing, and forming using a press and suitable tooling. Welding provides an efficient method for joining metallic components permanently and is widely used in fabrication industries.

2. OBJECTIVES OF THE STUDY:

The major objectives of the industrial exposure were:

1. To study the overall manufacturing activities carried out in the industry.
2. To understand various sheet metal fabrication processes.
3. To study the working principles and applications of CNC machining.
4. To understand press working operations and associated tooling.
5. To study different welding operations used in fabrication.
6. To understand the sequence of manufacturing operations from raw material to finished product.
7. To study the importance of dimensional inspection and quality control.
8. To observe material handling and workplace organization.
9. To understand industrial safety practices.

3. INDUSTRY PROFILE:

Inspire Metal Engineering, MIDC Ahilyanagar was considered as the industrial learning environment for this study. The industrial training provided exposure to manufacturing and fabrication-related activities involving metallic components.

The training focused mainly on understanding the practical aspects of:

Sheet metal fabrication
CNC machining
Press working
Welding
Component inspection

Material handling
Production planning
Quality control
Industrial safety
Maintenance practices

4. METHODOLOGY:

The study was carried out using direct industrial observation and interaction during the industrial training period.

The methodology consisted of the following stages:

4.1 Industrial Visit and Orientation:

An initial orientation was carried out to understand the industrial layout, departments, manufacturing activities, safety requirements, and workflow.

4.2 Process Observation:

Manufacturing processes were observed systematically, beginning with raw material preparation and continuing through machining, fabrication, joining, inspection, and finishing.

4.3 Interaction with Industrial Personnel:

Discussions with operators, supervisors, technicians, and other industrial personnel helped in understanding machine operation, tooling, process parameters, quality requirements, and safety precautions.

4.4 Study of Machines and Tools:

The machines and tools used for sheet metal fabrication, CNC machining, press working, and welding were studied with respect to their applications and operating principles.

4.5 Quality Inspection:

The importance of dimensional measurement, visual inspection, and quality control at different stages of production was studied.

5. SHEET METAL FABRICATION:

Sheet metal fabrication involves converting metal sheets into useful components through cutting, bending, forming, punching, drilling, and joining operations.

The general sequence can be represented as:

Raw Material → Marking/Cutting → Punching/Drilling → Bending/Forming → Welding/Joining → Inspection → Finishing → Final Component

5.1 Raw Material Selection:

The selection of sheet material depends on the required mechanical properties, thickness, corrosion resistance, manufacturability, and application.

Common sheet materials used in industries include:

- Mild steel
- Stainless steel
- Aluminium
- Galvanized steel
- Other engineering alloys

The material is selected according to component requirements and production specifications.

5.2 Sheet Cutting:

Cutting is generally the first major operation in sheet metal fabrication. The sheet is cut according to the required dimensions.

Cutting may be carried out using suitable mechanical or CNC-based cutting equipment depending on component geometry and production requirements.

Important factors include:

- Sheet thickness
- Cutting accuracy
- Required dimensions
- Cutting speed
- Edge quality
- Material utilization

5.3 Bending:

Bending is used to produce angular or curved shapes in sheet metal components.

A press brake or similar equipment may be used for bending operations. Correct positioning of the sheet and selection of suitable tooling are important for obtaining accurate bends.

Factors affecting bending include:

- Material type
- Sheet thickness
- Bend angle

Bend radius

Tool geometry

Springback

5.4 Drilling and Punching

Holes may be produced using drilling or punching operations. Punching is particularly useful for repetitive sheet metal components.

The location and size of holes are important because dimensional errors may affect subsequent assembly.

5.5 Sheet Metal Assembly

Fabricated sheet metal parts may be joined using:

Welding

Fasteners

Riveting

Bolted joints

Other joining methods

The selection of joining method depends upon component design and functional requirements.

6. CNC MACHINING:

Computer Numerical Control (CNC) machining is a modern manufacturing method in which machine-tool movements are controlled by programmed instructions.

CNC technology provides:

High dimensional accuracy

Repeatability

Improved productivity

Reduced manual intervention
Consistent component quality
Capability to manufacture complex profiles

6.1 Basic CNC Machining Sequence:

The general sequence is:

Component Drawing → Process Planning → CAD Model/Program → Tool Selection → Work Holding → CNC Setup → Machining → Inspection

6.2 CNC Machine Setup:

A CNC setup generally involves:

Selection of suitable workpiece.
Proper work holding.
Selection of cutting tools.
Tool offset setting.
Work coordinate setting.
Program loading or preparation.
Trial operation.
Machining of the component.
Dimensional inspection.

6.3 CNC Programming:

CNC programs contain instructions that control machine movements and machining operations. Depending on the machine and controller, programming commonly uses standardized numerical control commands.

Important programming considerations include:

Tool movement
Cutting depth
Feed rate
Spindle speed
Tool selection
Coordinate system
Work zero
Coolant requirements

6.4 Cutting Parameters:

The major machining parameters include:

Cutting Speed

Cutting speed is the relative velocity between the cutting tool and workpiece at the cutting zone.

Feed

Feed represents the distance moved by the cutting tool relative to the workpiece during machining.

Depth of Cut

Depth of cut represents the thickness of material removed in a machining operation.

Correct selection of these parameters affects tool life, surface finish, productivity, power consumption, and dimensional accuracy.

7. PRESS WORKING:

Press working is a manufacturing process used primarily for producing components from sheet metal using a press and a suitable die.

The basic principle involves applying force through a punch and die arrangement to perform the required operation.

7.1 Major Press Working Operations:

7.1.1 Blanking:

Blanking is an operation in which the required shape is cut from the sheet and the blank becomes the useful product.

7.1.2 Punching:

Punching produces holes in sheet metal. The removed material generally acts as scrap.

7.1.3 Bending:

Bending changes the angular shape of the sheet without significantly changing its thickness.

7.1.4 Forming:

Forming produces a required three-dimensional shape in the sheet.

7.1.5 Drawing:

Drawing is used to produce cup-shaped or deep components by forcing sheet metal into a die.

8. OBSERVATIONS DURING INDUSTRIAL TRAINING:

The major observations from the industrial exposure can be summarized as follows:

Manufacturing requires systematic process planning.

Proper raw-material selection affects final component quality.

Sheet metal fabrication requires accurate cutting and bending.

CNC machining provides repeatability and dimensional control.

Correct work holding is essential for accurate machining.

Tool selection has a significant effect on machining performance.

Press tools require proper alignment and maintenance.

Welding parameters influence joint quality.

Dimensional inspection is required at various production stages.

Operator skill has an important role in manufacturing quality.

Machine maintenance contributes to productivity and reliability.

Workplace safety is essential during every manufacturing operation.

Proper material handling reduces damage and production losses.

Production quality depends on coordination among design, production, inspection, and maintenance activities.

9. SKILL DEVELOPMENT THROUGH INDUSTRIAL TRAINING

Technical Skills:

- Understanding of manufacturing processes
- Basic CNC machining knowledge
- Understanding of press working
- Sheet metal fabrication knowledge
- Welding process awareness
- Engineering drawing interpretation
- Dimensional measurement

- Quality inspection
- Machine and tool identification
- Production process understanding

Professional Skills:

- Industrial discipline
- Communication
- Teamwork
- Time management
- Problem-solving
- Workplace safety awareness
- Observation and technical reporting

10. RESULTS AND DISCUSSION:

- The industrial exposure provided practical understanding of the relationship between manufacturing theory and industrial practice.
- The study showed that sheet metal fabrication involves a combination of cutting, forming, bending, and joining operations. CNC machining provides accurate and repeatable production when suitable tooling, programming, work holding, and machining parameters are selected.
- Press working provides an efficient method for producing repetitive sheet metal components, particularly when appropriate press tools and dies are available. Welding plays an important role in joining fabricated components and requires proper joint preparation, process parameters, and inspection.
- The overall manufacturing process demonstrates that product quality does not depend on a single operation. Instead, it is the result of coordinated activities involving material selection, process planning, machine operation, tooling, inspection, maintenance, and skilled manpower.
- The training also highlighted the importance of safety and disciplined working practices in an industrial environment.

11. CONCLUSIONS:

- The industrial training at Inspire Metal Engineering, MIDC Ahilyanagar provided valuable practical exposure to important manufacturing processes, particularly sheet metal fabrication, CNC machining, press working, and welding.
- The study helped in understanding the complete manufacturing sequence from raw-material handling to finished-component inspection. Sheet metal fabrication demonstrated the practical importance of cutting, bending, forming, and joining operations. CNC machining provided an understanding of computer-controlled manufacturing, tool selection, work holding, programming, and dimensional accuracy. Press working demonstrated the

application of punches, dies, and presses for producing sheet metal components. Welding provided practical understanding of permanent joining, joint preparation, welding parameters, and inspection.

- The industrial exposure also demonstrated the importance of quality control, preventive maintenance, material handling, workplace organization, operator skills, and safety practices.
- The knowledge gained during the training can be directly related to subjects taught in the mechanical engineering curriculum. Such industrial exposure helps students develop practical skills, understand current manufacturing practices, and prepare themselves for employment and further professional development in the manufacturing sector.

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Industrial training observations and technical discussions carried out at Inspire Metal Engineering, MIDC Ahilyanagar.

Mechanical Engineering curriculum and laboratory/practical manuals related to manufacturing processes, CNC machining, welding, metrology, and production engineering.