Manufacturing Engineering

Year 1

SECTION

6

PRINCIPLES OF MARKING OUT, MEASUREMENT AND GAUGING

MANUFACTURING TOOLS, EQUIPMENT AND PROCESSES

Manufacturing Processes
Safety, Quality and the Environment

Introduction

In this section, we shall learn about the fundamentals of basic bulk deformation forming processes and sheet metal work development, which are essential components of the manufacturing industry, you will be:

- introduced to the principles of deformation forming, the selection of appropriate forming processes and the development of sheet metal work.
- exposed to hands-on activities to help you practice how to understand the processes involved in bulk deformation and sheet metal work, the standard procedures and their applications.
- able to understand and appreciate the importance of maintaining a safe working environment and the standard safety practices in the manufacturing industry.
- exposed to activities that will help you identify potential hazards and apply safety measures in a manufacturing setting.

At the end of the section, you will have a comprehensive understanding of the manufacturing industry, its processes, safety practices and its impact on society.

At the end of this section, you will be able to:

- Discuss rolling, forging and extrusion as bulk deformation processes
- Recognise and identify dies and presses used for sheet metal working operations
- Discuss cutting, bending and drawing as sheet metal working operations
- Identify potential hazards in the workspace
- Describe the social and economic consequences that a manufacturing activity can have or has had on individuals and society
- Explain how the manufacturing industry affects the local and international economy (e.g., with respect to job creation, standards of living, sustainability, and conservation of the environment)

Key Ideas

- Bulk Deformation Forming Processes refers to material forming processes in which the thicknesses or cross-sections are reduced, or shapes are significantly changed.
- These forming processes encompass practices like rolling, extrusion, cold and hot forging, bending, and drawing.

- Safety hazards include fire explosion and electrical hazards, whereas health hazards include excessive noise, flying materials and carcinogenic materials. It is important to act quickly to eliminate any potential hazards and respect safety guidelines in the workplace.
- Among the positive impacts of manufacturing include improvement in the standard of living of individuals via job creation, growth of communities through CSRs, etc.
- On the other hand, manufacturing companies negatively impact the environment via the release of pollutants; add to the global warming case by releasing greenhouse gases, and pose health threats to individual workers from unsafe manufacturing conditions.

ROLLING, FORGING AND EXTRUSION AS BULK DEFORMATION PROCESSES

The key aspect of these processes is the application of appropriate stresses - tension, compression and shear - to shape metal products into desired dimensions. We will consider the appropriate forming processes and the development of sheet metal work in the manufacturing industry.

Bulk Deformation Forming Processes

- Material forming processes in which the thicknesses or cross-sections are reduced, or shapes are significantly changed, are referred to as Bulk Deformation Forming Processes.
- Bulk deformation forming processes are a set of metalworking methods that involve substantial plastic deformation of the material to achieve a specific shape while preserving its mass and chemical composition.
- These techniques are distinguished by their three-dimensional deformation, in contrast to sheet-forming processes, and encompass practices like rolling, extrusion, cold and hot forging, bending, and drawing.
- The key aspect of these processes is the application of appropriate stresses-tension, compression and shear - to shape metal products into desired dimensions.
- The importance of bulk deformation processes in the industry is highlighted by their cost efficiency, superior mechanical properties of the end product, operational flexibility, increased productivity and reduced raw material wastage, resulting in accelerated production rates.

Rolling

- Rolling operations reduce the thickness or cross-section of a material through compressive forces exerted by rolls.
- In the basic rolling process, a metal is passed between two rolls that rotate in opposite directions, with the gap between the rolls being somewhat less than the thickness of the metal being rolled.

- Rolling is used to convert thick materials or metals into blooms, slabs or billets, which are later rolled to produce plates, sheets, strips, rails, wire rods, bars, pipes, etc.
- The process of rolling involves more than just mechanically reducing material thickness., it also includes intricate interactions between the material's microstructure and the applied stresses, resulting in texture evolution and refinement of the microstructure.
- In the case of thread rolling, materials experience significant microstructural changes as they are primarily stretched at the top and bottom of the formed thread parts, improving the performance of these parts.
- The complexity of the rolling process and its influence on material properties highlight its importance in bulk metal forming.
- Rolling not only shapes materials but also boosts their mechanical properties by carefully controlling deformation and microstructural evolution.

Figure 6.1 shows the basic metal rolling process and some products produced by the metal rolling process respectively.

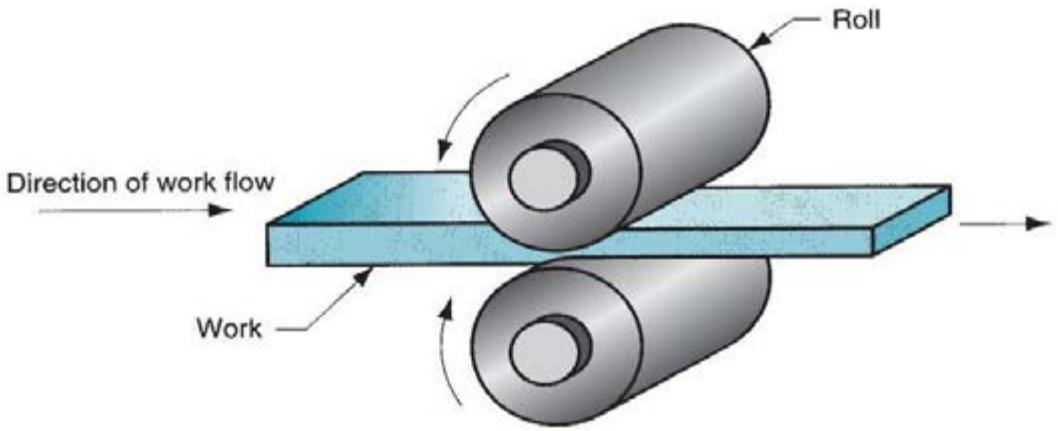

Fig. 6.1: The basic metal rolling process

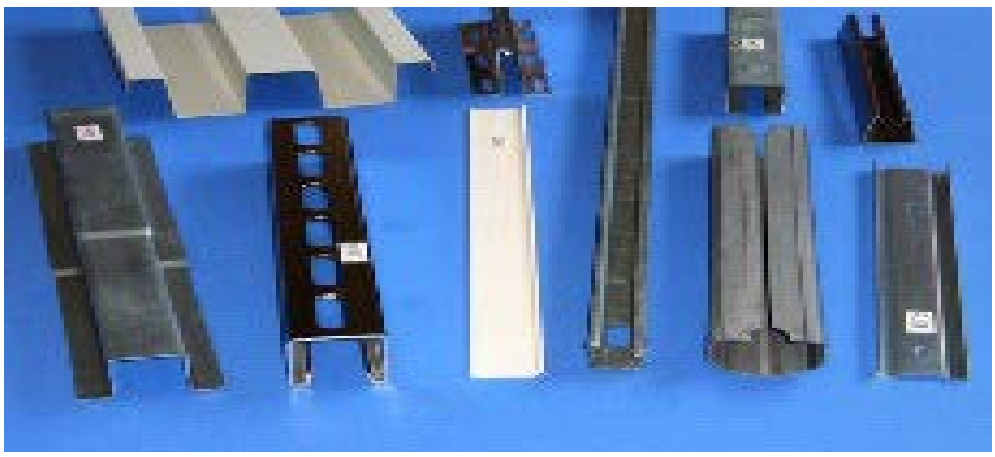

Fig. 6.2: Some products produced by the metal rolling process

Forging

Forging is a term applied to a family of processes that induce plastic deformation through localised compressive forces applied through dies.

- The forging equipment can take the form of hammers, presses or special forging machines. Forging is the oldest known metal-working process.
- Common forging processes include open–die drop-hammer forging, impression-die drop-hammer forging, automatic hot forging and roll forging, etc. This method falls under the category of bulk deformation, encompassing techniques that convert material of basic shapes into specific forms without changing its mass or chemical composition through three-dimensional deformation.
- Forging methods consist of procedures like closed-die forging, where multiple dies compress a billet into a more intricate shape, often resulting in excess material called flash that needs to be removed, indicating material wastage and additional processing stages.
- The forging procedure can be complex, involving significant plastic deformation at high temperatures to achieve the desired shape and size.
- Forging plays a vital role in diverse sectors, such as automotive, military and aerospace, due to its capacity to manufacture consistent, high-quality parts at affordable prices and with high reproducibility.
- The process entails intricate die designs and demands a thorough comprehension of material flow, die filling and the effects of forging on microstructure and mechanical properties.

Figure 6.3 presents an image of open-die and closed-die forging processes.

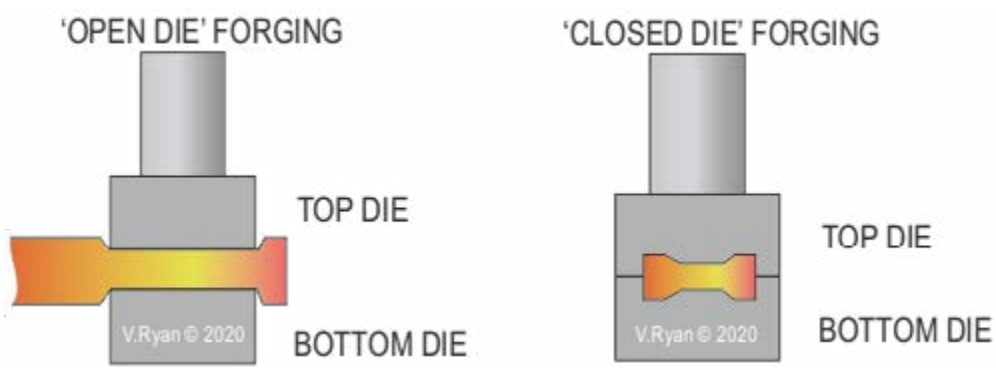

Fig. 6.3: Open die forging vs Closed die forging processes

Extrusion

In the extrusion process, the metal is compressed and forced to flow through a suitably shaped die to form a product with a reduced but constant cross-section. Extrusion may be carried out directly or indirectly.

In **direct extrusion**, a solid ram drives an entire billet to and through a stationary die and must provide additional power to overcome the friction between the surface of the moving billet and the confining chamber.

In **indirect extrusion**, a hollow ram pushes the die back through a stationary, confined billet.

- Extrusion is a versatile method extensively employed in the manufacturing of various long, semi-finished components like bars, tubes, wires and strips, either performed at ambient temperature or elevated temperatures.
- This technique entails the alteration of materials through the implementation of severe plastic deformation (SPD) methods, which play a pivotal role in the creation of bulk materials with refined microstructures and improved mechanical characteristics.
- The process of extrusion can be categorised into different approaches, each presenting distinct advantages, drawbacks, and applications, spanning from the fabrication of intricate shapes to the enhancement of material attributes.
- A notable variation of extrusion is friction extrusion, which leverages heat generated by friction and shear strain to process metallic materials, providing a distinctive means of enhancing material properties by handling powders, chips and bulk materials.

Figure 6.4 shows a schematic of a direct extrusion process.

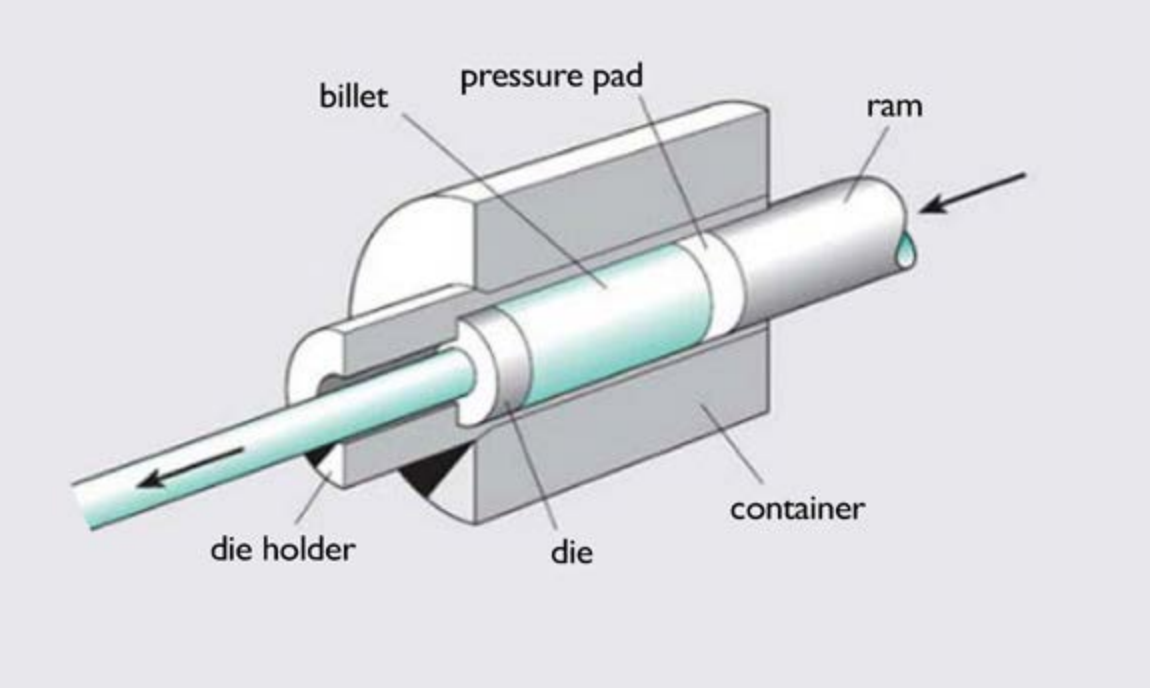

Fig. 6.4: A schematic of a direct extrusion process

Activity 6.1

Make a search on the internet, watch the video or read from the textbook on the following rolling, forging and extrusion processes using the links below and the book provided.

- https://www.youtube.com/watch?v=pkJxrZPeP_0
- https://www.youtube.com/watch?v=5EeuYai8Ax8
- https://www.youtube.com/watch?v=ix8BDa_nMaU
- https://www.iitg.ac.in/engfac/ganu/public_html/Metal%20forming%20processes_full.pdf

Prepare a PowerPoint presentation to be presented to your class highlighting the principles, advantages, disadvantages and applications of each process.

Activity 6.2

Visit a nearby metal workshop, for a more practical demonstration on how to perform metal rolling, forging and extrusion processes. Under supervision of the workshop craft master, perform these three operations at the workshop.

a. Rolling
b. Forging
c. Extrusion processes.

Take a video or picture of yourself during the operations.

Activity 6.3

Choose one of these forming processes as a project work to produce (design and construct) a prototype of your choice to solve a real-life problem in your community.

Follow the procedures and steps below to complete your prototype. Ensure that you accurately report your observation.

1. Plate Rolling

Plate rolling is the process of forming flat metal plates into curved or cylindrical shapes using specialised machinery called plate rollers or plate bending machines. This process can be used to create pipes, tanks, cylindrical shells for pressure vessels, wind turbine towers, and structural components in construction

Setup: Positioned the rollers in a in a triangular configuration. place a flat metal plate is between three or more rollers

First Rolling: Ensure that the plate passes through the rollers and is rotated by them. Adjust the gap between the rollers to control the degree of curvature.

Bending: The rollers apply pressure to the plate, bending it as it passes through. Multiple passes are typically required, gradually increasing the pressure to achieve the desired curvature.

Final Shape: Readjusting the positions of the rollers and the pressure applied, the plate can be formed into cylindrical, conical, or other curved shapes.

Hope you have been able to produce your desired prototype

2. Closed-Die Forging (Impression-Die Forging)

Closed-die forging, also known as impression-die forging, is a process where the metal workpiece is placed between two dies that contain the shape of the desired final product. Unlike open-die forging, the metal is mostly confined, allowing for the creation of more complex and precise shapes. The process involves high pressure to force the material into the cavity of the dies.

Steps:

- **Heating the Workpiece:** Heat the metal to a high temperature usually below the melting point to make it malleable. This is typically done in a furnace. The temperature depends on the material for steel, it can range between 1000°C and 1250°C (hot forging).
- **Placing the workpiece in the die:** Place the heated workpiece in the lower die, which contains the negative impression (cavity) of the final product.
- **Applying Force:** Apply great force on the upper die containing part of the shape of the product, by the use of hydraulic presses or mechanical hammers. The metal is squeezed between the upper and lower dies, and the material is forced to flow into all the cavities of the dies, taking the shape of the final product.
- **Flash Formation:** Excess material, known as flash, often forms around the edges where the die halves meet. The flash cools faster than the rest of the workpiece due to its thinness, and this helps in confining the rest of the material within the die cavity.

USES OF DIES AND PRESSES IN BASIC SHEET METAL WORKING OPERATIONS

This lesson looks at cutting, bending and drawing as sheet metal working operations.

Components of a Stamping Die

The working components of a stamping die are the punch and the die. These are attached to the upper and lower portions of the die set, respectively called the punch holder (or upper shoe) and die holder (or lower shoe). The die set also includes guide pins and bushings to ensure proper alignment between the die and the punch during the stamping operation. Figure 6.5 shows a schematic of a simple stamping die.

Types of Stamping Dies

- Dies (or stamping dies) are classified based on the following criteria: Number of separate operations to be performed in each press actuation: A simple die performs a single blanking operation with each stroke of the press; a compound die performs two separate operations at a single station; a combination die performs two operations at two different stations in the die.
- How the die operations are accomplished: A progressive die performs two or more operations on a sheet-metal coil at two or more stations with each press stroke, thus the part is fabricated progressively.

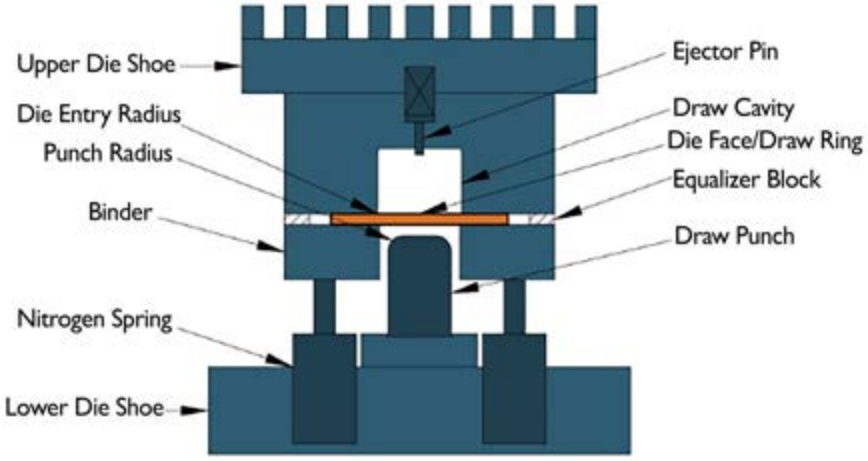

Fig. 6.5: A schematic of a simple stamping die.

Presses for Sheet Metal Forming

A press used for sheet metal forming is a machine tool with a stationary bed and a powered ram (or slide) that can be driven towards and away from the bed to perform various cutting and forming operations. It has a frame, which establishes the relative positions of the bed and the ram, with the ram being driven by mechanical or hydraulic power. The frame may be of the gap frame type, the solid gap frame type, the adjustable bed frame type, the straight-sided frame type, etc.

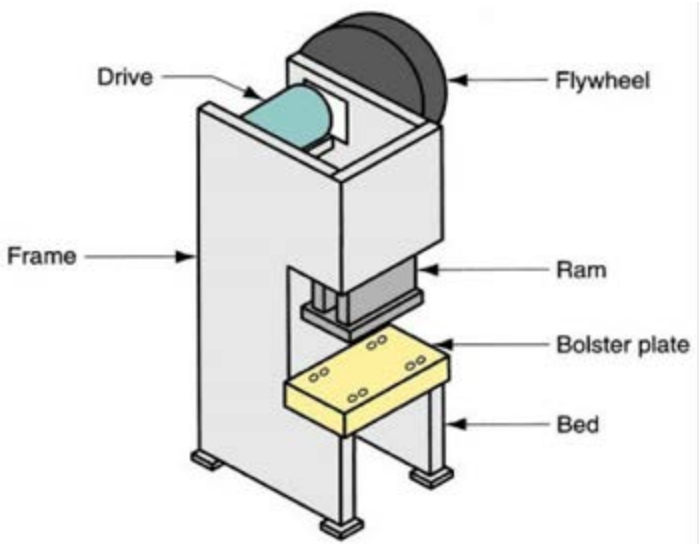

Fig. 6.6: A schematic of a general gap frame press

PRINCIPLES OF CUTTING, BENDING AND DRAWING IN SHEET METAL WORKING OPERATIONS

Cutting in Sheet Metal Working

The cutting of sheet metal is achieved by the shearing action of two sharp cutting edges. The upper cutting edge (the punch) sweeps down past the stationary lower cutting edge (the die). As the punch begins to push into the sheet metal, plastic deformation occurs in the sheet metal surface, and as the punch moves downward, penetration occurs, in which the punch compresses the sheet and cuts into the metal due to the occurrence of fracture in the sheet

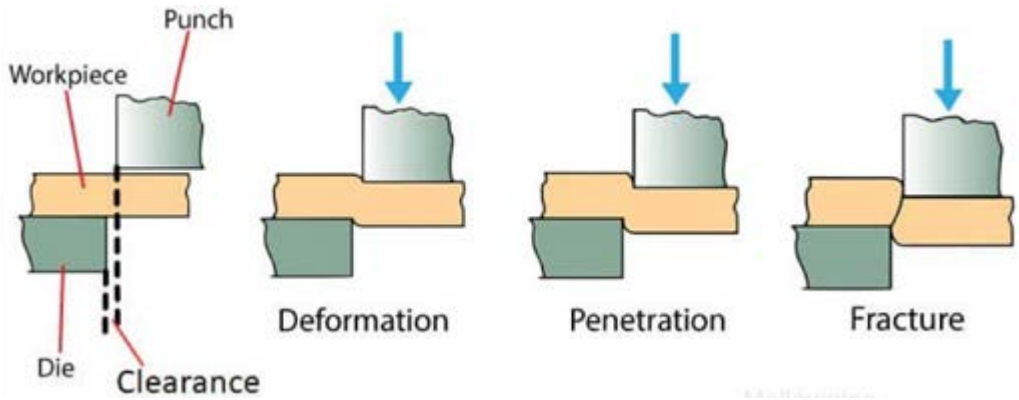

Fig. 6.7: A schematic of the cutting operation in a sheet metal working.

Bending in Sheet Metal Works

Bending in the context of sheet metal operations refers to the straining of the metal around a straight axis. During this operation, the metal on the inside of a neutral plane is compressed while the metal on the outside of the neutral plane is stretched. Bending operations are performed using punch and die tools. V-bending and edge-bending as shown below:

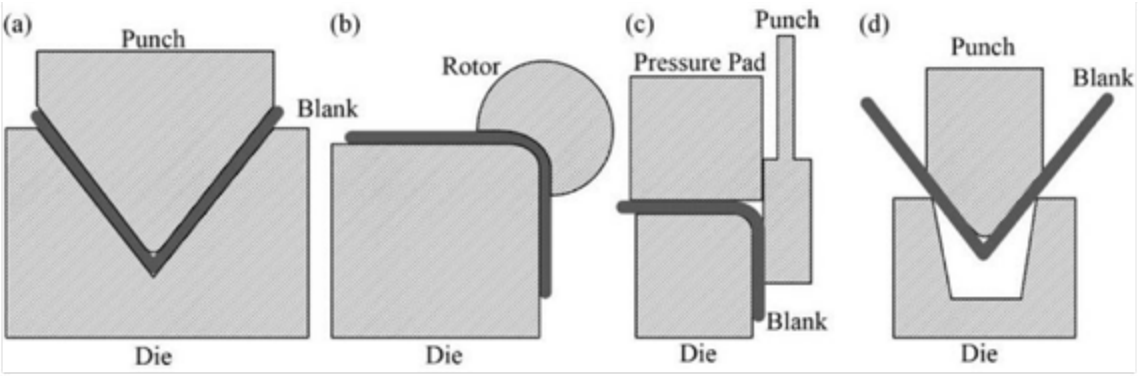

Fig. 6.8: Schematics of (a) a V-bend and (b) an Edge-bend

Drawing in Metal Sheet Operations

Drawing refers to forming a flat metal sheet into a hollow or a concave shape, by stretching the metal. A blank holder is used to hold down the blank while the punch pushes into the sheet metal.

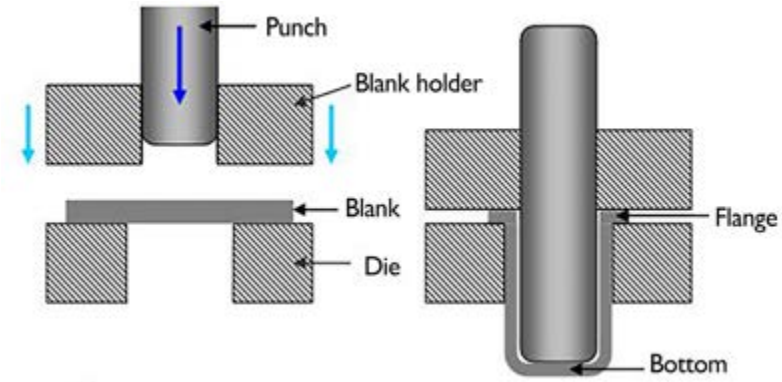

Fig. 6.9: A schematic of a deep drawing technique.

Activity 6.4

Search on the internet, or watch the videos linked below, or reading from the textbook on dies and presses used in casting operations.

- https://www.youtube.com/watch?v=xbynUVj3hAE
- https://technologystudent.com/despro2/forging21.html

Make a neat sketch of dies and presses showing all the parts for presentation in your class. During these presentations discuss the operational principles of dies and presses.

Activity 6.5

Visit a nearby metal workshop, for more practical on sheet metal formation operation processes. Under supervision of the workshop craft master, perform these three operations at the workshop.

a. Vee bending
b. Deep drawing
c. Edge-bending

Take a video or picture of yourself during the practical session.

Activity 6.6

Choose one of these forming processes as a project work to produce a prototype of your choice. (metal brackets, hinges, flanges, latches, clips, cover plates)

Follow the procedures and steps below to complete your prototype. Ensure that you accurately report your observation.

Metal brackets

To make metal brackets in a bench fitting workshop, the process is more manual and relies on hand tools and basic machinery.

1. **Marking out processes:** Choose a suitable metal sheet based on the size and strength required. With the help of scribes, calipers, steel rules, and engineer's squares, carefully mark out the shape and dimensions of the bracket on the metal. Use a centre punch to mark points where holes will be drilled.
2. **Cutting processes:** Use a hacksaw to cut along the marked lines. For larger or thicker pieces, you might use the power hacksaw machine. File to size and remove any burrs.
3. **Forming processes:** Place the metal plate in a bench vice or use a bending jig to bend the plate to the required angles,
4. **Drilling processes:** Hold the plate firmly in drill vice and drill through to create circular holes where required. Start with a small drill bit and work your way up to the desired size. Deburr all sharp edges.
5. **Assembling Processes** (If Necessary): Join parts together by means of rivets or bolts and nuts

6. **Finishing processes:** Use a hand file to remove any remaining rough edges or burrs. Apply advanced coating finishes, such as anti-corrosion oil or paint the metal using brushes or spray paint for basic protection.

Check the dimensions using a caliper or steel rule and ensure that the bracket meets the required specifications.

NOTE: Follow the same steps/ processes to fabricating the following items

- hinges
- flanges
- cover plates

Now, think about any product you may want to design and fabricate to help your class or community.

POTENTIAL HAZARDS IN THE WORKSPACE

Recognising and understanding hazards is critical to maintaining a safe and efficient work environment. Staying alert to potential risks can significantly reduce the likelihood of accidents and injuries, ensuring the well-being of you and your colleagues.

This knowledge is vital not only for your personal safety but also for compliance with health and safety regulations designed to protect everyone in the workplace.

Introduction to workplace hazards.

A workplace hazard can be defined as the possibility of harm or danger occurring at the workplace, and it encompasses all aspects of technology and activities that have a certain degree of likelihood of negatively affecting the health and safety of workers at the workplace.

A workplace hazard can cause damage to property, injury, or death in extreme cases.

Hazards in the workplace can arise from various origins, such as being in contact with harmful substances, using risky tools and machinery, or engaging in activities requiring repetitive motions, strenuous lifting, or exposure to severe environmental conditions.

The spectrum of hazards present in work settings extends beyond chemical risks to encompass kinetic and potential energy dangers, electrical hazards, geological and meteorological threats, as well as health risks.

Categories of Workplace Hazards

Hazards at the workplace can be placed into two (2) broad categories according to the OSHA (Occupational Safety and Health Administration) in the USA.

Safety Hazards and Health Hazards.

- **Safety Hazards**: Safety hazards are situations that can cause immediate injury to or death of a worker. These include machinery (Unguarded and moving machinery parts that a worker can accidentally touch), flying materials, anything that can cause spills or trips, such as cords running across the floor or ice, anything that can cause falls, such as working from heights, including ladders, scaffolds, roofs, or any elevated work area, fire and explosion hazards, and electrical hazards (such as frayed cords, missing ground pins, and improper wiring).
- **Health Hazards:** These are hazards associated with long-term exposure to certain situations or substances. These hazards can produce acute (immediate) or chronic (long-term) effects. Health hazards include excessive noise, wood dust (carcinogenic), chemicals, improperly adjusted workstations and chairs, frequent lifting, poor posture and vibration from machine operation.

Identifying/Recognising Potential Hazards in a Work-place

Identifying any form of potential hazard in the manufacturing environment can be much easier to carry out by trying to find answers to the following basic questions at any point in the workplace:

- **What work is being done?** Understanding the kind of work being done is an important step to being able to identify the potential hazards associated with the work.
- **What kind of possible injury, damage or danger can occur?** List all the potential hazards that can occur depending on the nature of the work being done.
- **What can or has to be done to avoid the potential hazard?** After listing all the possible hazards that can occur, write down all the precautions that can be taken to avoid such hazards or to reduce risk if the hazard should occur.

Fig. 6.10: A workplace with several hazardous situations: what are the various hazards in this picture?

KNOWING THE GENERAL SAFETY PRACTICES IN THE MANUFACTURING ENVIRONMENT AND THE IMPORTANCE OF FOLLOWING THEM

Safety

Safety is simply a state of being at little or no risk of injury or any form of danger. It is the process of protecting employees from work-related illness and injury. In the manufacturing environment, a wide range of safety practices are implemented to safeguard workers and ensure the production of safe goods.

These practices, including compliance with Good Manufacturing Practices (GMP), play a fundamental role in the creation of safe food and healthcare items by coordinating all aspects of the facility to guarantee safety throughout the production process, from sourcing raw materials to distribution. It is imperative to provide training and education to employees to enhance the safety culture and behaviour, ultimately fostering a secure environment in the workplace.

The manufacturing industry is prone to various hazards such as machine-related risks, musculoskeletal disorders, occupational illnesses stemming from noise and chemical exposure, and incidents of workplace violence, all of which require thorough safety protocols to be put in place.

Who is Responsible for Workplace Safety?

It is very important to understand that safety is a culture and a habit everyone needs to have irrespective of who/where you find yourself. In the manufacturing environment/ workplace:

- Safety is everyone's responsibility.
- Management (employer) is responsible for the safety of workers.
- Workers need to be trained to work safely.
- All injuries are preventable.
- Mistakes that lead to accidents can be always prevented.
- Safety guidelines specific to every site in the workplace must be available all the time, and workers must be obliged to follow them.

Some General Safety Practices at a Manufacturing Workplace:

- Wear Personal Protective Equipment (PPE).
- Use equipment and tools properly.
- Keep work areas and emergency exits clear.
- Eliminate fire hazards.
- Take work breaks from time to time (avoid overworking).
- Prevent objects from falling by keeping them in appropriate places.
- Prevent slips and trips by making sure that spills are cleaned and that aisles are clear.

Identifying Safety Signs and Symbols at the Workplace

Safety signs are essential tools for communicating safety conditions at the workplace. Safety signs serve as visual indicators of potential hazardous situations in the workplace and required precautionary measures to be taken to avoid any accident or harm to employees and visitors.

The following are some of the important safety signs to watch out for at the manufacturing workplace:

Exit Sign

This safety sign is used to indicate the location of an exit or escape route from a building in an emergency.

Fig. 6.11: Exit Sign

Slips, Trips and Falls

This sign in the workplace alerts employees and visitors to the potential dangers of slipping, tripping, or falling in a specific area. They are placed in areas where there is a higher risk of falling.

Fig. 6.12: Slip, Trip and Fall Sign

Authorised Personnel Only Sign

This sign is used to restrict access to specific areas or rooms that contain sensitive information, hazardous materials, or equipment that could pose a risk to personnel.

Fig. 6.13: Authorised Personnel Only Sign

Personal Protective Equipment (PPE)

The PPE sign indicates areas where PPE is required. It is placed in areas where there is a risk of physical harm.

Fig. 6.14: Personal Protective Equipment (PPE)

Danger Flammable Sign

This is a safety sign used to warn workers and visitors of flammable substances. They are placed in areas where there is a risk of fire explosion.

Fig. 6.15: Danger Flammable Sign

Prohibition Signs

Prohibition signs are universal symbols used to identify actions or behaviours that are not permitted in a specific area. The circular design is immediately recognisable, usually with a red border and a diagonal line slashing through it.

Fig. 6.16: Prohibition Sign

Warning Signs

Warning signs inform people about possible risks or dangers and serve as a precautionary warning. They can be identified by specific images or text that describe the nature of the danger. They are characterised by their yellow or amber triangular shape with a bold exclamation mark in the middle. For example, to warn people about possible falling objects, a warning sign outside a construction site could show an image of a falling brick.

Fig. 6.17: Prohibition Sign

Activity 6.7

1. Watch and observe the activities in the following videos:
   a. https://www.youtube.com/shorts/X3Zqxus7hj8
   b. https://www.youtube.com/shorts/gSMWeA5PchM?feature=share
   c. https://www.youtube.com/shorts/R2lbWpIudSM?feature=share
   d. https://www.youtube.com/shorts/QARI1uURASo?feature=share
   e. https://www.youtube.com/watch?v=_F__Mxklpw8
2. Identify potential hazards in the videos provided and note them down.
3. Form small groups with your colleagues and discuss your findings.
4. Prepare a presentation to share your findings with the rest of the class. This could be a slide presentation, a poster, an oral presentation or even a short video or role-play.

Activity 6.8

1. Visit your school's workshop or a local manufacturing workshop.
2. During the visit, observe and list potential hazards you noticed.
3. Identify and note the various safety practices followed at different locations within the workshop.
4. Form small groups with your colleagues and discuss your findings and categorise potential hazards into safety and health hazards
5. Prepare a presentation to share your findings with the rest of the class. This could be a slide presentation, a poster, an oral presentation or even a short video or role-play.

Activity 6.9

1. In groups, study the safety signs in the charts provided.

Fig. 6.18: Safety sign chart A

Fig. 6.19: Safety sign chart B

2. Start a discussion about the safety signs in the charts provided. The discussion should focus on the identification and explanation of the safety signs and where they are used.
3. Initiate another discussion about the current safety situation in the classroom, map out potential hazards and suggest safety improvements.
4. Create safety charts or maps based on your observations and the provided visuals.
5. Prepare a presentation to share your findings with the rest of the class. This could be a slide presentation, a poster, an oral presentation or even a short video or role-play.

Activity 6.10

1. Using the resources listed below, research on general workplace safety procedures;
   a. Videos on workplace safety practices
   b. Textbooks and journal articles
   c. Posters and charts
   d. Internet resources on workplace hazards
2. Identify and note the various safety practices followed at different locations within a typical manufacturing facility.
3. Create safety charts or maps based on your research.
4. Form small groups with your colleagues and discuss your findings.
5. Prepare a presentation to share your findings with the rest of the class. This could be a slide presentation, a poster, an oral presentation or even a short video or role-play.

SOCIAL AND ECONOMIC CONSEQUENCES OF MANUFACTURING ACTIVITIES ON INDIVIDUALS AND SOCIETY

Manufacturing activities are an essential part of economic development and social progress. However, they entail a range of social and economic consequences that can have a significant impact on individuals and communities.

Understanding these consequences is critical to developing sustainable manufacturing practices that balance economic benefits with social well-being.

It must also be noted that the manufacturing industry plays a crucial role in shaping the local and international economy. Understanding these impacts is critical to promoting a balanced manufacturing approach that supports economic growth while ensuring social and environmental responsibility. This knowledge is crucial for promoting sustainable development and global economic cooperation.

Let's explore how we can mitigate the negative impacts while maximising the positive outcomes of manufacturing activities. We shall examine both the negative and positive impacts of manufacturing on the individual and society in the economic and social dimensions.

Positive Social and Economic Impacts on the Individual and Society

- Manufacturing activities have improved the standards of living and financial well-being of individuals and homes through the provision of employment for both skilled and unskilled labour.
- Manufacturing industries promote the development of communities through their corporate social responsibilities (CSRs).
- Manufacturing activities have contributed to the growth of populations and communities due to the surge of migration to industrialised communities.
- Manufacturing activities have enhanced the growth of agricultural communities as agricultural products are the basic raw materials for many manufacturing industries.
- The manufacturing sector contributes greatly to the surge in technological advancement of society, which in turn promotes productivity in other industries. For example, the manufacturing of vehicles, computers and other machinery has led to the growth of transportation networks, digital infrastructure, and automation technologies, all of which have revolutionised how goods and services are delivered, information is accessed, and tasks are performed across various sectors.

Negative Social and Economic Impacts of Manufacturing Activities on Individuals and Society

- Deaths of individual employees from accidents such as explosions and fire accidents.
- Increase in atmospheric temperature (Global Warming) leading to Climate Change due to an increase in emission of greenhouse gases.
- Destruction of water bodies and viable lands due to improper disposal of wastes from manufacturing activities.
- Release of air pollutants, leading to the contraction of respiratory diseases and skin infections etc.
- Increased/intensified social problems such as access to housing (because of urbanisation) etc.

Fig. 6.20: Emission of harmful gases into the atmosphere by manufacturing industries

Fig. 6.21: Deforestation by manufacturing industries

Fig. 6.22: Discharge of industrial sewage into a water body

EFFECTS OF MANUFACTURING ACTIVITIES ON LOCAL AND GLOBAL ECONOMIES WITH RESPECT TO JOB CREATION, STANDARDS OF LIVING, SUSTAINABILITY, ENVIRONMENTAL CONSERVATION

Job Creation/Employment

The manufacturing industry creates more jobs/employment (for both skilled and unskilled labour) and enhances the economic growth of the local and global economies as it adds more value to the primary sector outputs, increasing the national GDP (Gross Domestic Product).

Standards of living

In addition to job creation, people have access to cheap and varied goods. People also have better access to education, health services, etc., due to urbanisation. Households have more income to boost their standards of living.

Sustainability

Most traditional/conventional manufacturing processes are economically and environmentally unsound as they usually result in the depletion of natural resources, hence, demoting both economic and environmental sustainability. Most manufacturing companies are now adopting economically and environmentally-sound processes to promote sustainable manufacturing.

Conservation of Environment

Generally, manufacturing activities are the major cause of depletion of natural resources and the deterioration of the environment. To protect the environment, and guard the fundamental natural resources from exhaustion, manufacturing companies need to be conservation conscious; the forest, water bodies and wildlife has to be strictly protected.

Activity 6.11

Using the internet, watch these videos, or read from the textbook on the positive and negative social and economic impacts of manufacturing companies' activities on individuals and society using the links below and the book provided.

- https://www.youtube.com/watch?v=CuJ4E1UMk3c
- https://www.youtube.com/watch?v=sx81vcCliFA
- https://www.youtube.com/watch?v=LxKiAnT1zDw
- https://www.youtube.com/watch?v=sg22hhnfN2Y

Prepare a report based on the headings below and present your findings to your class or peers

a. Introduction
b. Positive effect of manufacturing industries
c. Negative effect of manufacturing industries
d. Conclusion
e. Recommendations

Activity 6.12

Generate ideas on the role of manufacturing companies in local communities putting into consideration the social and economic impact.

Follow the guidelines below to generate ideas. Introduce the discussion by listing some manufacturing companies in your area

Prompt questions:

a. What products do these companies produce?
b. What raw materials do they use?

c. What do these companies do that you think are good and they must continue?
d. What do they do that you think are not good and must be stopped immediately?
e. What are the various solid, liquid and gaseous pollutants produced by these companies?
f. How have these manufacturing companies influenced and affected the social structure of your community? Consider aspects like employment opportunities, community health, social services, infrastructures such as roads, school and hospital buildings, donations, etc.

Write a report to the chief of your community on the role of manufacturing companies in local communities, putting into consideration the social and economic impact.

Review Questions

1. Prepare a presentation explaining the principles, advantages, disadvantages, and applications of rolling, forging, and extrusion processes.
2. Given a scenario where a metal needs to be shaped into a long, thin product, which process would be more suitable: rolling or extrusion? Justify your answer
3. Explain the positive impact of the manufacturing industry on the local and international economies.
4. Explain the negative impacts of the manufacturing industry on local and international economies.
5. How can the manufacturing industry improve upon the lifestyle of the local community?
6. How does adherence to workplace safety practices generally enhance the manufacturing process?
7. Write an essay on the importance of safety practices in a manufacturing environment.

Answers to Review Questions

1. **Presentation Framework:** Rolling, Forging, and Extrusion Processes

   Slide 1: Introduction
   - Brief introduction to rolling, forging, and extrusion

   Slide 2: Principles of Rolling
   - Definition of rolling
   - Types of rolling (hot vs. cold rolling)
   - Basic mechanics of the rolling process
   - Common materials used

   Slide 3: Advantages of Rolling
   - Produces large quantities of uniform thickness
   - Enhanced mechanical properties due to strain hardening
   - Cost-effective for high-volume production
   - Ability to create complex shapes

   Slide 4: Disadvantages of Rolling
   - Limitations in the thickness range
   - Initial setup costs for equipment
   - Possible surface defects
   - Equipment maintenance requirements

   Slide 5: Applications of Rolling
   - Production of sheets, plates, and strips
   - Use in automotive and aerospace industries
   - Manufacturing of structural components
   - Creation of metal foils

   Slide 6: Principles of Forging
   - Definition of forging
   - Types of forging (open-die, closed-die, and impression-die)
   - Mechanism of deformation through compressive forces

   Slide 7: Advantages of Forging
   - Superior strength and toughness of forged parts
   - Minimal waste of material
   - Ability to produce intricate shapes
   - Enhanced reliability and performance

Slide 8: Disadvantages of Forging

- Higher costs for low-volume production
- Limited complexity compared with other methods
- Requires significant energy input
- Tooling and die costs

Slide 9: Applications of Forging

- Production of critical components (e.g., crankshafts, gears)
- Aerospace and defence applications
- High-performance automotive parts
- Construction hardware

Slide 10: Principles of Extrusion

- Definition of extrusion
- Types of extrusion (hot, cold, and warm)
- Overview of the extrusion process (direct vs. indirect)

Slide 11: Advantages of Extrusion

- Ability to produce complex cross-sectional shapes
- High production efficiency and low waste
- Good surface finish and dimensional accuracy
- Versatile material compatibility

Slide 12: Disadvantages of Extrusion

- Limited to specific materials
- High initial tooling costs
- Potential for defects like sagging or cracking
- Difficulty in producing very large sections

Slide 13: Applications of Extrusion

- Manufacturing of pipes, tubes, and profiles
- Use in construction (window frames, railings)
- Electrical and electronic components
- Packaging materials

Slide 14: Summary

- Quick comparison of principles, advantages, and disadvantages
- Situational recommendations for choosing a process

2. Scenario Consideration

- Need for a long, thin metal product (e.g., wire, tubes, or profiles)

Advantages of Extrusion

- Complex Shapes: Extrusion can create intricate cross-sectional profiles, ideal for long, thin products.

- Uniform Thickness: Ensures consistent wall thickness throughout the length of the product.
- Efficiency: High production rates for continuous lengths make extrusion suitable for long items.
- Versatility: Works well with a variety of materials, including aluminium and plastics.

Advantages of Rolling

- Thickness Limitations: While rolling can produce long sheets or strips, it may not achieve the same level of detail in shape as extrusion.
- Material Properties: Rolling can enhance strength through strain hardening, but this is less critical for thin profiles.

Justification for Extrusion

- Design Flexibility: Extrusion allows for greater design flexibility in producing specialised shapes.
- Production Method: Continuous process makes it ideal for long products, reducing waste.
- Surface Finish: Typically provides better surface quality, which can be important for aesthetic or functional applications.

Conclusion

- Recommendation: For shaping a long, thin product, extrusion is the more suitable process due to its ability to create complex shapes, ensure uniformity, and optimise production efficiency.

3. Local Economic Impact

- Job Creation: Manufacturing generates a significant number of jobs, often providing higher wages and benefits compared with other sectors.
- Skills Development: Offers training and skills development opportunities, enhancing the local workforce's capabilities.
- Supporting Local Businesses: Manufacturing companies often rely on local suppliers and service providers, boosting other sectors.
- Community Investment: Manufacturers often contribute to community development through infrastructure improvements and local initiatives.

International Economic Impact

- Global Trade: Manufacturing drives exports, contributing to a favourable trade balance and increasing foreign exchange earnings.
- Innovation and Technology Transfer: Promotes technological advancements and innovation, often leading to improved productivity and competitiveness.
- Supply Chain Development: Strengthens global supply chains, connecting producers and consumers across countries and fostering international collaboration.
- Economic Growth: Manufacturing is a key driver of GDP growth in many countries, stimulating investment and economic development.

Broader Economic Benefits

- Increased Tax Revenues: Manufacturing contributes to local, state, and national tax revenues, which can fund public services and infrastructure.
- Enhanced Quality of Life: Improved availability of manufactured goods enhances living standards and consumer choices.
- Sustainability Initiatives: Many manufacturers are adopting sustainable practices, contributing to environmental stewardship and long-term economic viability.

4. Negative Impacts of the Manufacturing Industry on Local and International Economies

Local Economic Impact

- Job Displacement: Automation and technological advancements can lead to job losses, displacing workers in traditional manufacturing roles.
- Environmental Degradation: Manufacturing processes may contribute to pollution, resource depletion, and environmental damage, affecting local ecosystems.
- Health Risks: Exposure to hazardous materials and emissions can lead to health problems for workers and nearby residents.
- Boom-Bust Cycles: Manufacturing industries can be susceptible to economic fluctuations, leading to unstable employment and local economies reliant on single industries.

International Economic Impact

- Globalisation Concerns: Outsourcing manufacturing jobs to lower-cost countries can lead to job losses and wage stagnation in higher-cost countries.
- Trade Imbalances: Heavy reliance on imports can create trade deficits, affecting national economies and currency stability.
- Economic Dependency: Countries that focus heavily on a single manufacturing sector may become vulnerable to global market shifts or trade policies.
- Resource Exploitation: International manufacturing may lead to over-exploitation of natural resources in developing countries, impacting long-term sustainability.

Broader Economic Challenges

- Inequality: Economic benefits of manufacturing may not be evenly distributed, exacerbating income inequality within communities.
- Infrastructure Strain: Increased manufacturing activity can strain local infrastructure (roads, utilities), leading to higher public costs.
- Regulatory Challenges: Poorly regulated manufacturing can result in substandard labour practices and lack of worker protections.

Conclusion

- Overall Impact: While manufacturing has significant benefits, it also poses challenges that can negatively affect local and international economies, necessitating balanced approaches to development and regulation.

5. How the Manufacturing Industry Can Improve Local Community Lifestyle

Economic Improvements

- Job Creation
- Local Investment
- Support for Local Businesses

Skill Development

- Training Programmes
- Career Advancement

Community Engagement

- Corporate Social Responsibility (CSR)
- Partnerships with Schools

Environmental Sustainability

- Green Manufacturing Practices
- Community Awareness

Quality of Life Enhancements

- Access to Goods and Services
- Community Infrastructure

Cultural and Social Contributions

- Support for Local Events
- Diversity and Inclusion

Overall Impact:

- By focusing on job creation, community engagement, sustainability, and quality of life improvements, the manufacturing industry can significantly enhance the lifestyle of local communities.

6. Improved Worker Well-Being
   - Reduction in Injuries
   - Increased Morale

Enhanced Productivity

- Reduced Downtime
- Focused Workforce

Cost Savings

- Lower Insurance Premiums
- Reduced Legal Risks

Quality Improvements

- Consistent Output
- Employee Training

Regulatory Compliance

- Meeting Standards
- Positive Audits

Fostered Innovation

- Encouraged Reporting
- Resource Allocation

Overall Impact

- By prioritising workplace safety, manufacturers not only protect their employees but also enhance productivity, quality, and overall operational efficiency, contributing to a more successful manufacturing process.

7. The Importance of Safety Practices in a Manufacturing Environment

Introduction

- Definition of safety practices in manufacturing
- Overview of the manufacturing industry's role in the economy

Importance of Protecting Workers

- Reduction of Workplace Injuries
- Health and Well-Being
- Employee Retention

Enhancing Productivity

- Minimising Downtime
- Focused Workforce
- Cost Efficiency

Ensuring Quality

- Consistency in Output
- Employee Training
- Encouraging Responsibility

Regulatory Compliance

- Adherence to Regulations
- Positive Reputation
- Regular Audits and Inspections

Fostering a Culture of Safety

- Encouraging Open Communication
- Involving Employees
- Continuous Improvement

Conclusion

- Recap of the significance of safety practices in manufacturing
- Emphasis on the multifaceted benefits

Extended Reading

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