Footwear Production Level II

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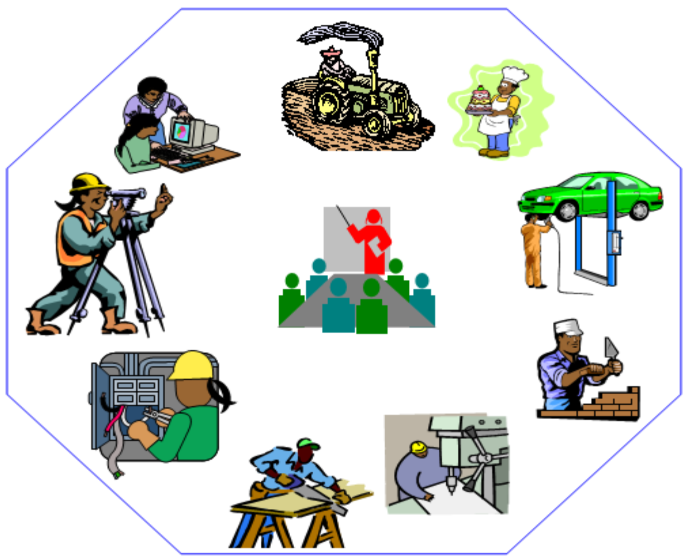
Version 1 Curriculum



Module Title: Coordinating Die Making Operations

LG Code: - IND FWS4 M08 LO (1-6) LG (39-44)

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LG # 39	LO #1- Prepare die making tools, materials and equipment

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Identifying the different types die and their methods of arrangement
- Obtaining work instructions, specifications, and operational details relevant to the tasks
- Identifying, preparing and checking hand tools, equipment and materials
- Identifying, preparing and checking machines
- Cleaning, checking, maintaining and storing hand tools and equipment
- Identifying safety with regards to tools, equipment and machines
- Identifying safety of operator and workplace

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Identify types of die and method of arrangement
- Obtain relevant tasks about work instructions, specifications and operations
- Examine hand tool, equipment and material
- Arrange Setup and arrangement of machines and check
- Maintain and store hand tools and equipment
- Identify OSH practices with regard to tools, equipment and machines
- Identify operator and workplace OSH practices

Information Sheet-1	**Identifying the different types die and their methods of arrangement**

1.1. Definition and types of die

A die is an integral part of the manufacturing and engineering process. If you work in the footwear industry, it's crucial to understand the many kinds of dies and how they can benefit your operations. Each die type has its own set of strengths and weaknesses that makes it more effective for certain applications. For each job, a die, which is a shaped blade, is custom made for the item being created. This die is then lowered onto the material and makes a cut into it. .

1.1.1. TYPES OF DIE

1. SIMPLE DIE

Also known as a single operation die, the simple die is a shaping tool that performs one operation per press slide stroke. This type of die is typically used for smaller applications in the workplace. For example, it may be useful for the manufacturing of simple metal parts.

The benefit of a simple die is that it's an excellent option if you're looking for a tool that can handle blanking and piercing jobs. It consists of a die block and stripper plate, which hold onto the metal sheet while the punch cuts a hole and removes the blanks. The main downside is that the simple die is less efficient and less suited for larger applications than other dies.

2. COMPOUND DIE

For more demanding or complex blanking and piercing applications, a compound die can do the job faster. Rather than handling just one operation at a time, the compound die can simultaneously complete the blanking and piercing processes.

The compound die is less useful for bending and forming operations, and it tends to require a higher level of force than some of the other options. That said, it's a more cost-effective option than the simple die when it comes to manufacturing washers and other flat metal parts. If you're looking for types of punches and dies that you can use in general cutting applications, the compound die could be the solution you need.

3. PROGRESSIVE DIE

While a progressive die can handle more than one operation at a time, it does so in several stages throughout multiple work stations. The progressive die's main advantage is that it's more efficient thanks to its high work speed and the reduced level of force.

While the multi-station design is more challenging to manage than the single-station unit, it's easier for the progressive die to maximize punching productivity. That's why engineers use progressive dies to make automotive parts, electronics and similarly complex components.

4. COMBINATION DIE

The combination die is similar to the compound die in terms of design and efficiency. It can handle more than one operation at once, which allows it to deliver faster, more reliable results. As an added bonus, the combination die is well-suited for both cutting and shaping applications.

If you need to complete a blanking or punching operation combined with a bending operation, the combination die will have you covered. This versatile tool can play a role in all types of metalwork applications, from mining equipment manufacturing to electronics and appliance development.

Shoe parts cutting Dies

Used to cut out shoe parts. These steel cutting dies look just like cookie cutters. Each die is coated with rust proof paint and marked with the shoe size and model number. Making a shoe requires hundreds of dies. One die for each part, for every size of a shoe.

Figure 1. Shoe cutting die

Types of leather Dies and their Uses:

Dies is of various types. Some of them are listed below

(i) **Dies as per Height** –

(ii) **Dies as per Edge** –The single edge die is generally used for layer cutting.

(iii) **Straight Edge and Decorative Edge Dies** –

(iv) **Perforated Dies** – Dies can be perforated. e.g. Brogue, Moccasin etc.

Types of Dies as per Edge for Machine cutting

- **Single edge clicking die**
- **Double edge clicking die**

Figure2. Cutting dies

A die is a specialized tool used in manufacturing industries to cut or shape materials mostly using a press. Like moulds, Dies are generally customized to the item they are used to create.

Mass production of footwear requires cutting every type of footwear material. Leather, fabric, foam, and reinforcing materials must be cut into the product pattern of footwear. While there are many new technologies for cutting leather materials such as a laser, water jet, and CNC drag knife; the steel rule-cutting die is still the most common for production. Used to cut out leather goods parts, these steel cutting dies look just like cookie cutters.

Each die is made of sharpened rule steel then coated with rust proof paint and marked with the footwear size and model number. Making shoe requires hundreds of dies. One die for each part, for every size of a product. For high volume shoe production, the factory may need many sets of cutting dies.

The cutting die maker starts with the cut paper pattern templates of the shoe pattern. The worker will then bend the rule steel into shape using the paper pattern as a guide.

Pins for perforations are also added to the cutting dies. Once the die is fully assembled a worker will test it to make sure the cutting surface is aligned flat and level.

Figure 3. Cutting dies getting a coat of paint

The final operations to make the garment or goods cutting dies include coating it with rust proof paint and a final check to make sure the cutting edge is very sharp.

While there are many operations required to make shoe cuttings dies the production is fast, the materials and labor are relatively inexpensive. For small orders, a cutting die fee may be charged by the factory, but usually, the cost of the cutting dies are accounted for the LOP (labor, overhead and profit) charges.

Types of die based on cutter

Steel-rule die

Steel-rule die, also known as *cookie cutter* dies, are used for cutting sheet metal and softer materials, such as leather, fabrics, and paperboard. The cutting surface of the die is the edge of hardened steel strips, known as *steel rule*. These steel rules are usually located using saw or laser-cut grooves in plywood. The mating die can be a flat piece of hardwood or steel, a male shape that matches the work piece profile, or it can have a matching groove that allows the rule to nest into. Rubber strips are wedged in with the steel rule to act as the stripper plate; the rubber compresses on the down-stroke and on the up-stroke it pushes the work piece out of the die.

The main advantage of steel-rule dies is the low cost to make them, as compared to solid dies; however, they are not as robust as solid dies, so they are usually only used for short production runs.

Rotary die

In the broadest sense, a *rotary die* is a cylindrical shaped die that may be used in any manufacturing field. However, it most commonly refers to cylindrical shaped dies used to process soft materials, such as paper or cardboard. Two rules are used, cutting and creasing rules. This is for corrugated boards whose thickness is more than 2 mm. Rotary dies are faster than flat dies.

Wire pulling

Wire-making dies have a hole through the middle of them. A wire or rod of steel, copper, other metals, or alloy enters into one side and is lubricated and reduced in size. The leading tip of the wire is usually pointed in the process. The tip of the wire is then guided into the die and rolled onto a block on the opposite side. The block provides the power to pull the wire through the die.

The die is divided into several different sections. First is an entrance angle that guides the wire into the die. Next is the approach angle, which brings the wire to the nib, which facilitates the reduction. Next is the bearing and the back relief. Lubrication is added at the entrance angle. The lube can be in powdered soap form. If the lubricant is soap, the friction of the drawing of wire heats the soap to liquid form and coats the wire. The wire should never actually come in contact with the die. A thin coat of lubricant should prevent the metal to metal contact.

For pulling a substantial rod down to a fine wire a series of several dies is used to obtain progressive reduction of diameter in stages.

Standard wire gauges used to refer to the number of dies through which the wire had been pulled. Thus, a higher-numbered wire gauge meant a thinner wire.
Typical telephone wires were 22-gauge, while main power cables might be 3- or 4-gauge.

1.2. Methods and arrangements of die

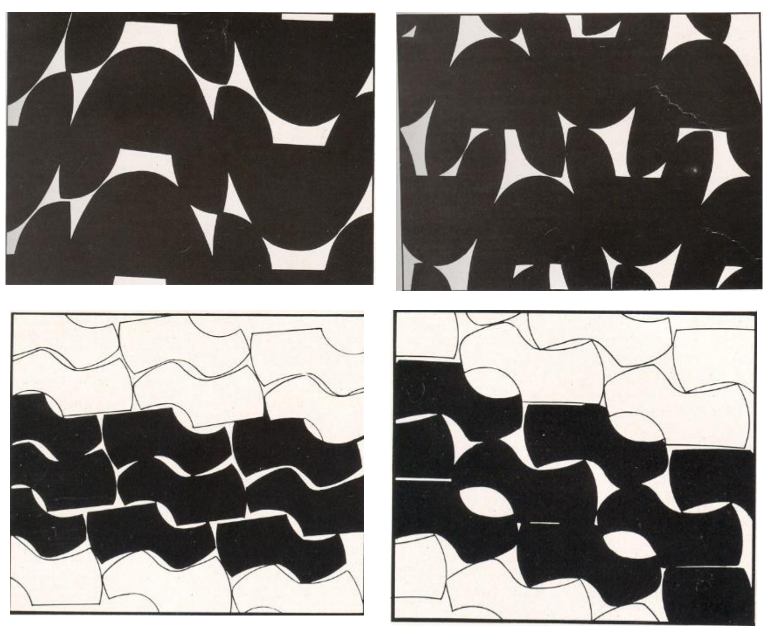
Dies positioning and arrangement

In die cutting, dies are templates with sharp edges that are pressed through a machine to make uniform shapes in thin materials like leather.

A. Interlocking

There are guidelines given for achieving better dies/knives interlocking. One may consider the following while interlocking:

a. Curve to curve interlocking.
b. Straight edge to straight edge.



a)

b)

Figure 5: arrangement of die

(i) The person must be clear about the lines of tightness of all the components to make a pair of shoe, their quality division & the allowances.

(ii) The cutter must be able to virtually divide the skin correctly in various parts i.e. butt, belly, shoulder and should have a clear understanding of lines of tightness in different parts of the skin/side.

(iii) The aim of the cutter should be to use his/her leather as economical as possible by avoiding wastage due to bad die interlocking.

(iv) Cutters are not required to interlock components in pairs in the case of corrected grain cutting exercise. Rather on completion of the work, they should end up with approx. equal no. of pairs.

(vii) Cutting usually commences from the butt, continue along the backbone, working outwards as far as the substance (thickness) and quality permits, utilizing the poor quality areas for the parts which have little or no strain during wear.

(viii) If by reason of defects the material near the backbone is unsuitable, cutting should still be in accordance with the principle of working in the direction from backbone to bank commencing as more as possible to the defects, in order to ensure the minimum waste of the best material, which invariably is to be found in the butt.

(ix) Change the direction of the patterns for getting components pair wise.

Self-Check 1	Written Test

Name: ___________________________ Date: ________________

Time started: ________________________ Time finished: _____________________

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

Information Sheet-2	**Obtaining work instructions, specifications, and operational details relevant to the tasks**

Information Sheet-3	**Identifying, preparing and checking hand tools, equipment and materials**

- Measuring tape: A **tape measure** or **measuring tape** is a flexible ruler used to measure size or distance. It consists of a ribbon of cloth, plastic, fibre glass, or metal strip with linear-measurement markings. It is a common measuring tool. Its design allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners.

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- Marker: an object used to indicate a position, place, or route.

- Scotch tape: is a brand name used for pressure-sensitive **tapes** manufactured by 3M.

- Welding rod or Mig welding wire: is the generic name used to refer to electrodes or filler metal that is used to join two other base metals when performing shielded metal arc **welding.**

- Steel ruler die: also known as cookie cutter **dies**, are used for cutting sheet **metal** and softer materials

- Reinforcement steel: is a **steel bar** or mesh of **steel** wires used in **reinforced** concrete and masonry structures to strengthen and hold the concrete in tension.

- Wire brush: a tool consisting of a **brush** whose bristles are made of **wire**, most often **steel wire**.

- Hammer: a tool with a heavy metal head mounted at right angles at the end of a handle,

- Working table: a table for holding working materials and implements especially : a small table with drawers and other conveniences for needlework.

- Cutting tools (like jigsaw, grinder, hacksaw etc.)

Welding Tools and Materials

Power Tools

- Angle grinder with a paddle switch
- Metal Band Saw

Consumables

- Angle grinder wheels
- Welding wire
- Steel - more on this below
- Shielding gas

Clamping, Measuring & Marking

- Soapstone
- Squaring Tools
- Welding magnets
- Scribe
- Welding clamps
- Permanent markers

Hand Tools

- Welding pliers
- Steel wire brush - specifically a steel brush, not a stainless steel or aluminum brush
- Hack saw

Studio Safety

- Welding table
- Welding curtain
- Bricks - available at your local hardware store, or your driveway.

Personal Safety

- Welding helmet
- Welding jacket
- MIG welding gloves
- Safety glasses
- Ear protection
- Grinding visor
- Face Mask
- Work shoes

Supplies for Projects

- 16 gauge cold-rolled sheet steel
- 1" Square tube, 16 guage
- 2" Flat bar, 1/8th inch

1" Flat bar, 1/8th inch

The right material for die-making

In the die making practice a large variety of materials are available for use. These include many different kinds of steels, castings of both ferrous and non-ferrous metals, and even non-metallic materials.

Carbon Die Steel-This steel may contain 0.90-1.15 Carbon, 0.20-0.45 Manganese, 0.16 Silicon, 0.025 Phosphorus, and 0.025 Sulphur.

Carbon Die Block Steel- 0.55-0.65 carbon, 0.50-0.70 manganese, 1.25-1.75 nickel, 0.60-1.10 chromium.

Tungsten Oil Hardening Steel- This steel contains about 1.20 carbon, 1.75 tungsten, and 0.25 manganese.

High –Alloy Oil-Hardening Steel- This class of non-deforming steel contains about 2.15 carbons, 12.00 chromium, and manganese content of about 0.35.Vanadium, tungsten, and nickel are other elements which may be added to this class of steel.

Manganese Air Hardening Steel- A typical composition contains 0.90 carbon, 2.5 manganese, 1.5 chromium, 1.00 molybdenum, and 0.30 silicon.

Chromium Air Hardening Steel- This steel usually contains about 1.00 carbon, 5.00 chromium, 1.00 molybdenum, 0.50 manganese, 0.25 silicon, and in some cases 0.50 vanadium is added.

High Alloy Air-Hardening Steels- These steels like the high alloy oil-hardening type, have about 12.00 chromium. The carbon content varies from 1.00 to 2.15, manganese 0.35, silicon 0.35, molybdenum 0.80, and in some cases 0.50 vanadium.

Material for producing low cost dies.

In the manufacture of air craft and various other products their have been important developments in making die other than steel or cast steel, which meet practice requirements and yet make it possible to greatly reduce the die cost. This is particularly true where sheets, such as aluminium and magnesium, must be formed or drawn but in quantities that are not large enough to require as durable and expensive a material as steel, for example. These low cost die may be made of non-ferrous alloys such as Kirksite and Cerrobend and non-metallic material may also be used such as Masonite, plastics, Bakelite, dancified wood, and rubber. These die are utilized for drawing or forming in the usual manner and also in conjunction with stretch-forming process. The low cost dies referred to are extensively used for medium

Shoe Pattern

The design of the shoe's cut parts. Just like clothing. The shoe pattern is fitted to the last. Designer and developers often make pattern corrections when creating a new shoe.

Information Sheet-4	**Identifying, preparing and checking machines**

- Bending machine: a machine used to bend something that is flat or straight, you use force to make it curved or to put an angle in it.

Welding machine: by generating heat that melts metal parts, so that these parts can be joined.

CNC Die & Mould Making Machine:

- Grinding machine: used to grind or sharpen the surface and the edge of the welded material.

- Notch marking machine: used to mark notches on the material surface.

- Punching machine: is a machine tool for punching and embossing flat sheet-materials to produce form-features needed as mechanical element and/or to extend static stability of a sheet section.

- Drilling machine: used to make hole on metal.

- Hacksaw metal shearing machine: used to cut metals with a sharpen edge.

- Die holder: A plate or block on which the **die** block is mounted; it is fastened to the bolster or press bed.

- Size marking machine:

- Punch insertion machine: used for inserting the punch into the molded die.

Information Sheet-5	Cleaning, checking, maintaining and storing hand tools and equipment

Clean, Check, Maintain and Store Hand Tools and Equipment

6.1.1 Cleaning of Tools and Equipment

Every time a piece of equipment is used, the general rule is to clean it straight away so it is ready for the next person to use. The manufacturers' instructions should be strictly followed when maintaining and cleaning equipment. The first step to healthy tools is keeping them clean. your tools to clean them after use will improve their lifespan. While cleaning, it also may be appropriate to inspect your tools for any signs of wear or damage. Wood-handled tools may need sanding, metal tools may need sharpening, and a quick inspection during cleaning can help catch problems before they become more serious.

Skills and actions need to clean up tools: -

- Select and use an appropriate method for cleaning
- tools and specialist equipment
- Restore your work area to a safe and tidy condition
- Make sure that any materials, components, tools and equipment that you may need for the next task are set up ready for use.

6.1.2 storing and maintaining of hand tools

Storing your tools will not only help you stay organized but keep your tools away from the elements. Air circulation and dryness are also important factors when storing gardening tools. Hang them from the wall to save space as well as protect the metal edges and surfaces. Treat your tools well, and they will last longer and work better. Better-working tools means a better-working, and the cost of replacing tools can add up over time. Getting into a habit of cleaning and maintaining your tools will make more expensive and better-made tools a lifetime investment.

- Location: - Hand tools should be safely located when not in immediate use.
- Safety: - Hand tools should be used safely and effectively according to their intended use.

Systematically arrangement: - Hand tools should be clamped or fixed in position.

Figure :

Information Sheet-6	**Identifying safety with regards to tools, equipment and machines**

Make Use of Safety Devices

Safety devices are an important way to protect operators from machine hazards. For example, a fixed guard provides a barrier that prevents people from reaching into a machine and crushing their hands.

These machines can interfere with visibility, but they may be worth it for the protection it provides.

Make Sure All Machines Are in Working Order

Before starting to work with die casting, it's important to ensure all machines you'll be using are clean, functioning properly and will not present any obvious threats to safety. The time to find out that a machine is not functioning correctly is not in the middle of a production run.

Wear Protective Gear

You should wear appropriate protective gear (also called PPE – personal protective equipment) which includes safety glasses, ear protection, and safety shoes at all times when working on your die casting. Even if you are spending a short amount of time on the production floor, you need to wear your safety equipment.

It only takes a moment for a crippling accident to occur.

Pay Attention and Follow All Established Protocols

Most accidents are caused when someone loses focus or doesn't perform a task as safety protocols recommend. Die casters are working with high levels of heat and molten metal, and it is very easy to get badly burned if you are not paying proper attention to what you are doing.

Read Provided Safety Information

NADCA, the North American Die Casting Association, provides extensive literature for your safety during die casting. This includes the General Safety Book and Safety Orientation for Die Casters, the NADCA Machine Safety Standard Safety Audit

Checklist and Electrical Interface Report, the Safety Signage for Machines booklet and a variety of informative safety videos.

As a professional die caster or the manager of a die casting company, it is important to make sure you are fully versed in and follow all necessary safety procedures. 96 percent of injuries in the die casting workplace are caused by unsafe acts, meaning they can be avoided by staying focused and following proper safety procedures.

Information Sheet-7	**Identifying safety of operator and workplace**

7.1. Safety of operator and workplace

Machines, equipment's and tools can help improve production efficiency in the workplace. However, their moving parts, sharp edges, and hot surfaces can also cause serious workplace injuries such as crushed fingers or hands, amputations, burns, or blindness. Safeguards are essential to protect workers from injury. Any machine part, function, or process that might cause injury should be safeguarded. When the operation of a machine may result in a contact injury to the operator or others in the area, the hazard should be removed or controlled. Machinery guards come in many types, but they are all designed to protect the operator. Guards prevent debris and sparks from flying out of the equipment. Barriers are also designed to prevent a worker from coming into contact with cutting tools or getting trapped in moving parts the only time guards can be removed safely is when the machinery is taken out of service for maintenance or repairs. This work must be done by trained, authorized personnel. Workers must report any damage to barrier systems and the equipment must not be used until the guard is inspected or replaced. Accidents frequently occur when an operator thinks a job will only take a second and bypasses the barrier system. Injuries also come from employees reaching around a guard to dislodge a jam in the machinery. Full training is necessary to prevent these kinds of accidents.

The following safety measures must track while using tools equipment's and machines in pre-fabrication: -

- Use Personal Protective Equipment (PPE)

Even with machinery guards, many operations require the use of personal safety equipment. Common equipment for most manufacturing plants includes safety glasses, gloves and closed-toe shoes. Full wrap goggles give the best protection, as this style eliminates the entry of debris through the side of the glasses. Gloves should fit well, but not too snugly. Loose gloves can become caught in equipment. Cut-resistant gloves should be utilized by anyone working around cutting equipment or sharp edges. Workers must be reminded the cut-resistant gloves only reduce the chance for injury; they do not completely prevent it. Proper footwear is required for a couple of reasons. Workers need to protect their feet from dropped or falling objects. Slip-resistant soles reduce the likelihood of accident falls in wet or slippery locations. Job specific PPE must be used when required.

- Never use machinery, tools and equipment without proper training

Ask your supervisor for training if you do not know how to use a piece of machinery or a power tool. All machinery has different safety features and techniques for operation. No employee should ever be allowed to operate equipment without instruction. The person providing the training should assess the worker's skills and make recommendations for any modifications needed to make the process easier and safer for the trainee.

- Awareness of surroundings

Safety requires being aware of the surroundings. trainers must know what other equipment or machinery is operating in the immediate area. Awareness also means the trainers should never operate equipment under the influence of alcohol or other substances than can delay reaction times or interfere with clarity.

- Make sure operating controls are clearly labeled and easy to reach
- Select the appropriate machine/tool for the job.
- Follow instruction manuals.
- Inspect any equipment for defects prior to its use

LG #40	**LO #2 Prepare workstation and set up the die/cutting knife machines**

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Setting up workbench and seating
- Setting up and adjusting die making machines for operation
- Cleaning and maintaining die making machines routinely

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Set up workbench and seating according to OHS
- Set up and adjust Die making machines for operation according to task requirements
- Clean and maintain Die making machines routinely

Information sheet 1	**Setting up workbench and seating**

Work station setup:

Before starting the die making process, machine are adjusted as per the die height and type of material to be cut. During cutting the most important factor is interlocking pattern of dies, both widthwise and lengthwise. Smaller patterns used at the edges can save materials.

Further it is always advisable to cut pair wise for the same fold so as to provide uniformity in the lot. Proper checking, stamping and bundling of all the cut-components is required before packing and transfer.

Cutting of Synthetic, Textile, Toe-puff, Counter Stiffener Sheets, Insole board, Shank board dies etc. can be carried out by following methods:

- Hand Cutting
- Machine Cutting

Hand Cutting

Hand Cutting is opted for making samples and small production runs when either dies are required very quickly or orders are not sufficiently high to warrant the cost of tooling up for the machine cutting. This system is used more often for longer production runs in low labor cost countries like India.

For a clean, accurate cut, it is important to hold the template firmly against the material on a cutting block and to keep the hand held knife blade perpendicular to the material when moving it around the template. The risk of distortion is high with thin, stretchy synthetic materials.

Workstation:

- The workstation is the place a worker occupies when performing a job.

- A well designed workstation is important for preventing disease related to poor working conditions, as well as for ensuring work is productive.
- Every workstation should be designed with both the worker and the task in mind.
- A properly designed workstation should allow the worker to maintain a correct and comfortable body posture.

Sitting:

A sitting job should be designed so that the worker does not have to stretch or twist unnecessarily to reach work area. On some jobs arm supports and rests may reduce arm fatigue. For example:

The working position should be as comfortable as possible. The arrows indicate areas that need to be improved to prevent potential injuries from developing. To improve the sitting position for the worker on the right, the chair height should be lowered, tilted slightly forward and the worker should be provided with a footrest.

The job should be designed to allow the workers to keep the arms low and the elbows close to body.

Standing:

- Standing for long periods of time to perform a job should be avoided wherever possible.
- Long periods of standing works station can cause health problems. For example

A chair, footrest, a mat to stand on, and an adjustable work surface are essential components for a standing workstation.

Information sheet 2	**Setting up and adjusting die making machines for operation**

Self-Check -2	Written Test

Name: _______________________________ Date: _____________________________

Time started: ________________________ Time finished: _____________________

Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations /answers:

Information sheet 3	**Cleaning and maintaining die making machines routinely**

3.1. **Cleaning and maintaining routine finishing machineries**

The objective of this information sheet is to show you how to keep work areas and tool clean and operational. At the end of each working day clean the tools and equipment you used and check them for any damage. If you note any damage, tag the tool as faulty and organize a repair or replacement.

Work area should be cleaned as per standard procedure:

Work area should be cleaned by following workplace standard procedures:

- **Dust bins for bio-degradable waste materials**

  Bio-degradable garbage (waste materials) means the garbage or waste materials that are capable of being destroyed by the action of living beings.

- **Dust bins for non-biodegradable waste materials**

  A Non-bio-degradable waste material (garbage) means the garbage or waste materials that are not capable of being destroyed by the action of living beings.

- **Cleaning of workshop**

  Clean floors and decking at the end of each shift and place all rubbish and waste in approved containers for disposal. Some cleaning agents are toxic. Refer the instructions on any cleaning agent and follow any recommendations before using it.

  - Do not use flammable cleaners or water on electrical equipment.
  - Make sure designated walkways are kept clear of any obstructions.
  - Always wear protective clothing and the appropriate safety equipment.
  - Make sure that you understand and observe all legislative and personal safety procedures when carrying out the maintenance tasks. If you are unsure of what these are, ask your Instructor.

Cleaning of Work Area

You have to be:

- Clear and clean the area
- Store any reusable materials
- Check, clean and store away any tools and equipment
- Dispose of hazardous and non-hazardous waste according to legal and workplace requirements.

- **Housekeeping of cutting department**

  -Good housekeeping promotes safety and prevents accidents.

  -Do not use any equipment if it is damaged. It is important to tag it out and report it to your supervisor immediately.

  - Always practice good housekeeping before, during and after the job.

Cleaning of Tools and Equipments

Equipment and tools that will need cleaning includes:

- Garbage receptacles
- Pans
- Brooms, dusters and brushes
- Mops and buckets
- Electrical equipment, Ex: vacuum cleaners, polishers, scrubbers.

Every time a piece of equipment is used, the general rule is to clean it straight away so it is ready for the next person to use. The manufacturers' instructions should be strictly followed when maintaining and cleaning equipment.

Skills and actions need to clean up tools

Cleaning and clearing techniques:

- Select and use an appropriate method for cleaning
- tools and specialist equipment
- any leakages
- Restore your work area to a safe and tidy condition
- Make sure that any materials, components, tools and equipment that you may need for the next task are set up ready for use.

Safe disposal techniques:

- Handle and dispose of waste materials appropriately according to organizational and legal requirements
- Recognize what materials are hazardous and require special procedures
- Report any problems associated with cleaning, storing or disposing of materials and equipment to the relevant person.

Hazardous and non-hazardous materials:

- Types of waste material generated in the work area
- Know how to handle hazardous waste and reusable materials safely including:
    - Fluids
    - Adhesives
    - Solvents.

- Personal protective equipment is required and how to use it.

Self-check	Written test

NAME________________________________ DATE______________ TOTAL POINT (10)

Instructions: Write all your answers in the provided answer sheet

LG #41	LO 3. Bend the die/cutting knife and welding

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Measuring the pattern perimeter to determine the required size of the die/knife
- Cutting the steel ruler die based on measurement
- Carrying out die bending operation as per the pattern profile
- Cutting and grinding extra die edge after bending
- Joining edge knife together/punta using welding machine

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Measure the pattern perimeter to determine the required size of the die/knife
- Cut the steel ruler die based on measurement according to OHS practices
- Carry out Die bending operation as per the pattern profile by using foot press bending machine
- Cut and grind extra die edge after bending according to OHS practices
- Join edge knife by using welding machine

Information sheet 1	Measuring the pattern perimeter to determine the required size of the die/knife

1.1. Measuring the pattern perimeter by using rope

In the footwear manufacturing process, the sample size shoe pattern is always confirmed first. Afterward, the pattern master will make the pattern pieces for all the remaining shoe sizes. This process of adjusting the pattern for each shoe size is called shoe pattern grading. A complete, graded, production pattern for shoe will require individual shoe pattern parts. Each pattern part will require its own cutting die.

For proper die-making we have to measure the required pattern perimeter by using rope.

Figure : measuring pattern perimeter by rope

Self-check 1	

Information sheet 2	Cutting the steel ruler die based on measurement

Steel Rule Die Making Process

Steel rule dies are constructed using a pre-hard / pre-sharp steel rule die blade. Blades can range from 2pt (0.028″, 0.71mm) to 8pt (0.112″, 2.84mm) thick and have heights from 0.75″ (19mm) to 3.00″ (76.2mm). The cutting edge can vary from serrated (many options) to center bevel to side bevel.

Ejection materials, locators, weld, braze, and mounting holes can all be added, as required in most cases.

Technical Details

Die Life: Low to medium (10,000 to 100,000 impressions). Depending on logistics and die size, many times it makes sense to have the die re-ruled once dull. Once a steel rule die is dull, it cannot be re-sharpened due to the case hardening of the steel rule.

Tolerance: From 0.010″ (.25mm) to 0.060″(1.52mm), depending on cutting rule selection and, more importantly, the shape of the part that is being produced.

A steel rule die has three components: a die base (board), steel rule cutting blade, and rubber ejection material. The process for making a die looks like this:

- Select and gather the required specifications and measurements.
- The design shape is cut into the die base using cutter.
- The steel rule cutting blade is bent into the shape of the design, either by hand or with automated equipment, and fitted into the cut channel in the die board.
- Full optical inspection is performed to ensure the cut edge parts that meet the requirements.
- Finally, rubber or foam material is used to eject the waste material from the die-cut cavity and sometimes to add stability to the tool.

Figure : measuring the steel rule by using rope

Figure : cutting steel rule

Self-check 2	

Information sheet 3	Carrying out die bending operation as per the pattern profile

3.1. Bending, Bending Methods and Bending dies:

3.1.1. Bending and bending dies:

Bending is the metal working process by which a straight length is transformed into a curved length. It is the process of deforming a base material through pressure from a die. For example, if the product requires an "L" bracket design, the die descends and curves the length of material into a 90-degree angle.

During the bending operation, the outer surface of the material is in tension and the inside surface is in compression. The strain in the bent material increases with decreasing the radius of curvature. The stretching of the bend causes the neutral axis to move toward the inner surface. In most cases, the distance of the neutral axis from the inside of the bend is 0.3 t to 0.5 t, where "t" is thickness of the part.

Bending terminology is illustrated in figure.

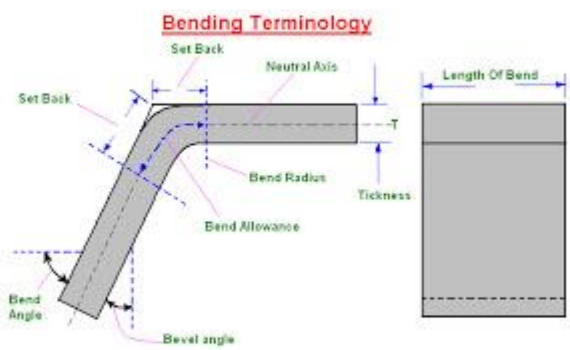

Figure : bending terminologies

Bending Methods:

The two bending methods commonly used are v-bending and edge bending.

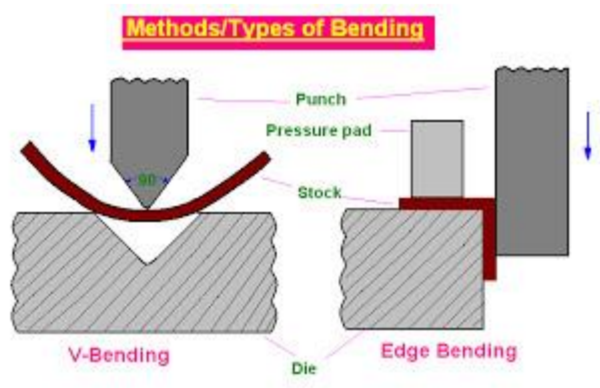

Figure : bending methods

V- Bending:

In v-bending, a wedge shaped punch forces the metal sheet or strip into a wedge shaped die cavity, shown in fig.

The bend angle may be acute 90°, or obtuse. As the punch descends, the contact forces at the die corner produce a sufficiently large bending moment at the punch corner to cause the necessary deformation. To maintain the deformation to be plane strain, the side creep of the part during its bending is prevented or reduced by incorporating a spring loaded knurled pin in the die.

2: Edge Bending:

In edge bending, a flat punch forces the stock against the vertical force of the die. The bend axis is parallel to the edge of the die and the stock, is subjected.

Figure : die bending process

Self-check 3	

Score = ____________
Rating: _____________

Answer Sheet

Name: ___________________________ Date: ________________

Answer

1-____

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2-____

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Information Sheet- 4	Cutting and grinding extra die edge after bending

After bending the steel rule the extra die edge must have to cut (trim) and grind to remove excess materials and to make smooth surface for the required die.

What is grinding?

Grinding is where the rubber hits the road, or more precisely, where the grain hits the metal. At every process upstream, most precision sheet metal fabricators employ at least some level of automation. But there’s no getting around it: Grinding down a weld on a formed workpiece is and probably will remain an intensely manual operation.

Figure : grinding tool

Self-Check 4	**Written Test**

Name: ___________________________ Date: ________________

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Answer

1-____

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2-____

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Information Sheet- 5	Joining edge knife together/punta using welding machine

5.1. Introduction

Joining the edge or welding process is one of the main process for die-making. It is done by welding machine after bending and grinding the edge of steel rule.

What is welding?

Welding is a fabrication process whereby two or more parts are fused together by means of heat, pressure or both forming a join as the parts cool. Welding is usually used on metals and thermoplastics but can also be used on wood. The completed welded joint may be referred to as a weldment.

4 Types of Welding Processes

- Gas Metal Arc Welding (GMAW/MIG)

This style of welding is also referred to as Metal Inert Gas (MIG). It uses a shielding gas along the wire electrode, which heats up the two metals to be joined. This method requires a constant voltage and direct-current power source, and is the most common industrial welding process. It has four primary methods of metal transfer: globular, short-circuiting, spray and pulsed-spray.

- Gas Tungsten Arc Gas Welding (GTAW/TIG)

Welding together thick sections of stainless steel or non-ferrous metals is the most common use for this method. It is also an arc-welding process that uses a tungsten electrode to produce the weld. This process is much more time consuming than the other three and much more complex.

- Shielded Metal Arc Welding (SMAW)

With this particular type of welding, the welder follows a manual process of stick welding. The stick uses an electric current to form an arc between the stick and the metals to be joined. This is often used in the construction of steel structures and in industrial fabrication to weld iron and steel.

- Flux Cored Arc Welding (FCAW)

This was developed as an alternative to shield welding. The semi-automatic arc weld is often used in construction projects, thanks to its high welding speed and portability.

LG #43	Reinforce the die /cutting knife

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Measuring reinforcement steel for cutting knife
- Cutting the reinforcement steel based on measurement
- Welding bended knife and reinforcement steel together

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Measure reinforcement steel for cutting knife
- Cut the reinforcement steel according to OHS practices based on measurement
- Weld bended knife and reinforcement steel are together

Information sheet 1	Measuring reinforcement steel for cutting knife

Weld-reinforcement: often referred to as the "included angle" between the parts to be joined by a groove weld.

The groove radius is the radius used to form the shape of a J- or U-groove weld joint. It is used only for special groove joint designs.

The root opening refers to the separation between the parts to be joined at the root of the joint. It is sometimes called the "root gap."

To determine the bevel angle, groove angle, and root opening for a joint, you must consider the thickness of the weld material, the type of joint to be made, and the welding process to be used. As a general rule, gas welding requires a larger groove angle than manual metal-arc welding.

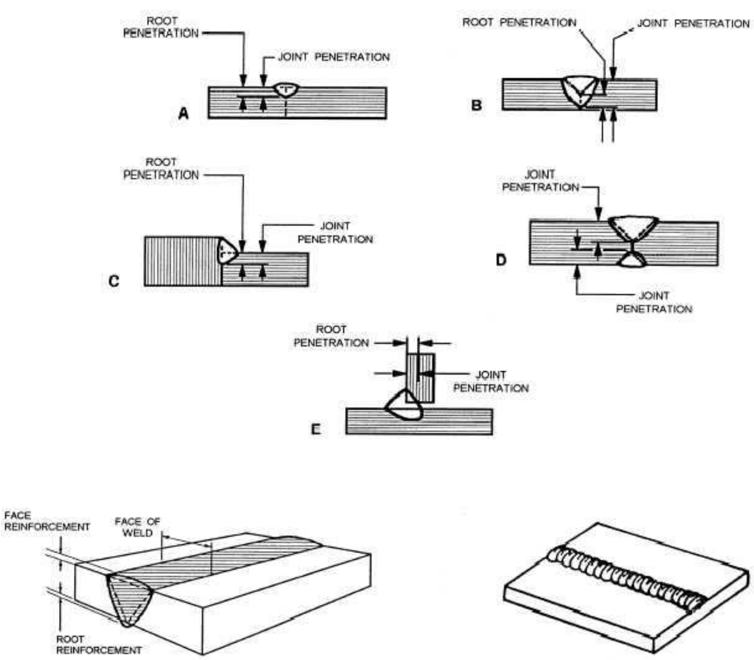


Figure : reinforcement for die welding

Measuring the reinforcement by using measuring-tape taking into account the overall length, any overlap and especially the curves can be a bit tricky.

Information Sheet- 2	**Cutting the reinforcement steel based on measurement**

2.1. Introduction

Cutting reinforcement steel or rebar can be done easily with a **metal cutting** hacksaw blade. You can also use a reciprocating saw, portable band saw, or grinder equipped with a blade suitable for **cutting** "mild **steel**".

Self-Check 2	**Written Test**

Name: ___________________________ Date: ________________

Time started: ________________________ Time finished: _____________________

Information Sheet- 3	Welding bended knife and reinforcement steel together

3.1. The process of welding bended knife with reinforcement steel

The process of welding bended knife with reinforcement steel is the crucial process for making a proper die.

Welding refers to the uniting or fusing of pieces by using heat and/or compression so that the pieces form a continuum. The source of heat in welding is usually an arc flame produced by the electricity of the welding power supply. Arc-based welding is called arc welding.

The fusing of the pieces can occur solely based on the heat produced by the arc so that the welding pieces melt together. This method can be used in TIG welding, for example.

Usually, a filler metal is, however, melted into the welding seam, or weld, either using a wire feeder through the welding gun (MIG/MAG welding) or by using a manual-feed welding electrode. In this scenario, the filler metal must have approximately the same melting point as the material welded.

Before beginning with the welding, the edges of the weld pieces are shaped into a suitable welding groove, for example, a V groove. As the welding progresses, the arc fuses together the edges of the groove and the filler, creating a molten weld pool.

For the weld to be durable, the molten weld pool must be protected from oxygenation and effects of the surrounding air, for example with shielding gases or slag. The shielding gas is fed into the molten weld pool with the welding torch. The welding electrode is also coated with a material that produces shielding gas and slag over the molten weld pool.

The most commonly welded materials are metals, such as aluminum, mild steel, and stainless steel. Also, plastics can be welded. In plastic welding, the heat source is hot air or an electric resistor.

Self-Check 2	**Written Test**

Name: ________________________ Date: ______________

Time started: ______________________ Time finished: ___________________

LG #44	**LO 5: Finish the die /cutting knife**

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Stamping size of the die by using notch marking machine or manually
- Carrying out sharping and hammering of the edge
- Removing welding chips using wire brush and hammer
- Carrying out of lubrication or antirust painting

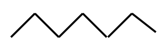
This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

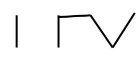
- Stamp the size of the die using notch marking machine or manually
- Carry out Sharping and hammering of the edge
- Remove welding chips by using wire brush and hammer
- Carry out lubrication or antirust painting

Information sheet 1	**Stamping size of the die by using notch marking machine or manually**

1.1. Die size notches

The size notches on dies for upper components cutting can be done as per the specification given and could be in following ways:

- Size can be Pointed in various size systems like English and French sizes.
- It also can be Pointed as 41 
- It also can be Pointed as 42 
- It also can be Pointed as 43 
- And so on

For English size Pointing "U" shape notch shows size 5. For 6 sizes it shows 

This information might be used to:

(i) Trace faulty footwear and send back to the unit that made it.

(ii) Order new stocks of the same styles, sometimes known as "repeats".

(iii) Ensure that any returned shoes can be repaired on the correct size and shape of lasts.

(iv) Enable the production units to see what size uppers they are dealing with.

The sizes of the dies/knifes:

The article size must also be Pointed on the die and matched by the clicker during die selection. This avoids any mistake in cutting an order.

Clicking knives are of various types. Some of them are listed below:

(i) Knife as per Height – 19 mm, 32 mm and 50 mm height knife are available for various purposes. Normally19 mm die is used for leather upper and lining cutting 32 mm and 50 mm dies are normally used for synthetic cutting, layer cutting or cutting thick materials.

(ii) Knives as per Edge – Single edge and double edge knives are available. Using Double edge die we can cut right and left component from the same die which reduces the die cost.

(iii) Straight Knife and Decorative Edges – Knife edges can be straight or gimped as per the design.

(iv) Perforated Knives – Knives can be perforated. It can be perforated for punched designs.

Information sheet 2	**Carrying out sharping and hammering of the edge**

Sharping is the process of creating or refining a sharp edge of appropriate shape on a tool or implement designed for cutting. Sharpening is done by grinding away material on the implement with an abrasive substance harder than the material of the implement, followed sometimes by processes to polish the sharp surface to increase smoothness and to correct small mechanical deformations without regrinding. By using sharpening tools and machines, like: grinder and hammer… the edge of the die blade could be sharpen.

Hammers have been continuously used for both open die and impression die forging, and are generally considered the most flexible in the variety of forging operations they can perform. They are characterized by a heavy ram, which contains the upper die. The ram is raised and allowed to fall or is driven onto the workpiece, which is placed on the bottom die. A large, heavy anvil supports the structure and holds the lower or stationary die. Hammers apply energy and cause deformation at very high rates. They are therefore suitable for alloys that can be deformed rapidly without forming cracks and splits in the workpiece.

Information sheet 3	Removing welding chips using wire brush and hammer

There is nothing worse after a welding session than slaving away trying to clean up ugly, stubborn slag residue with a blunt chipping hammer, especially one with an uncomfortable grip that lacks shock absorption.

Types of chips

The three common types of chip from a single point tool are.

1; Discontinuous or segmental chip:

Discontinuous chips is formed by a series of rupture occurring approximately perpendicular to the tool place face' each chip element passing off along the tool face the chip element' in the form of small segment may adhere loosely to each other and becomes slightly longer.

Since the chips break up into small segments the friction between the tool and the chips reduces' resulting in better surface finish. These chips are convenient to collect' handle and dispose off. Discontinuous chips tends to be formed when one or more or the following conditions exist:

1. Brittle material, such as cast iron and bronze.
2. Large chip thickness
3. Low cutting speed
4. Small rack angle

Discontinuous chips are also produced when cutting more ductile material with the use of a cutting fluid.

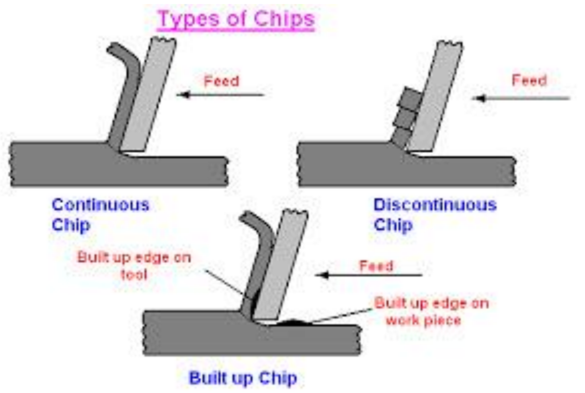


Figure : types of chips

2: Continuous Chips:

Continuous chips are formed by the continuous plastic deformation of metal without fracture in front of the cutting edge of the tool and is formed by the smooth flow of the chip up the tool face. Mild steel and copper are considered to be most desirable materials for obtaining continuous chips. The chips obtained have same thickness throughout. This type of chip is the most desirable. Since it is stable cutting, resulting in generally good surface finish. On the other hand these chips are difficult to handle and dispose off.

Continuous chips tend to be formed when the following condition exist:

1. ductile material
2. high cutting speed
3. small chip thickness
4. large rack angle
5. minimum friction of chip on tool face by :
   - polished tool face
   - use of efficient cutting lubricants.
   - Use of tool material with low-coefficient of friction.

3: Continuous Chip with Built up Edge:

This type of chip is very similar to the continuous chip. With the difference that it has a built up edge adjacent to tool face and also it is not so smooth. It is obtained by machining on ductile material, in this condition of high local temperature and extreme pressure in the cutting and high friction in the tool chip interference, may cause the work material to adhere or weld to the cutting edge of the tool. Successive layers of work material are then added to the built up edge. When this edge becomes larger and unstable , it breaks up and part of it is carried up the face of the tool along with the chip while the remaining is left over the surface being machined, which contributes to the roughness of the surface. The built up edge changes its size during the cutting operation. It first increases , then decreases, then again increases etc.

. The 5 Best Welding Chipping Hammers

1. Estwing BIG BLUE Welding/Chipping Hammer – Best Overall

Figure : hammer

It's forged in one piece without a spring handle to help make it unbreakable, and it withstands the shock of every hit through a specially designed grip for chipping. It's made to absorb an impressive seventy percent of the shock, removing all those dreadful feelings that make you want to give up before you begin.

It's built with toughened steel that's durable enough to withstand constant hammering and chipping away at spatter while preserving the edge. One end is a medium width chisel used for chipping off large areas of spatter quickly. The other end is narrow, with a sharp, strong point to help you get into corners and awkward spots where the chisel end won't fit.

2. Hobart Welding Chipping Hammer with Brush

Figure : hammer with brush

This is a standard spring handle hammer, which, other than a fully forged, anti-shock hammer, is the best design to date. These hammers are useful for absorbing the shock of frequent chipping; they do a good job, but are uncomfortable to hold. However, what's unique about this hammer is that it has a weld cleaning wire brush attached to it.

3. Pit Bull Welding Slag Hammer – Best Value

It comes with a double-sided head, with both a chisel and a pointed end for diversity in your chipping needs. For a low-priced option, if you don't require much brushwork on your welds, the Pit Bull is a more suitable option. It costs less and is a better hammer for solely chipping purposes.

4. Forge Economy Welding Chipping Hammer

It's another surprisingly durable hammer for its low price. Normally hammers this price are low in quality. It's not a bad hammer design-wise, though it lacks the size and weight for significant projects. The head of the chisel is smaller and narrow. It has a tip like a center punch on the pointed end, which effectively keeps it from becoming blunt or damaged quickly, but it's not the most effective pointed hammer end to use for chipping.

Self-check

Information sheet 4	**Carrying out of lubrication or antirust painting**

LG #44	**LO6. Check quality and dispatch**

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Checking die /cutting knifes against standards
- Addressing or resolving faults or irregularities
- Carrying out handling of cutting die/knife
- Carrying out necessary records and dispatching

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Check Die /cutting knifes against job specifications and workplace standards.
- Address or resolve faults or irregularities
- Handle cutting die/knife as per the operating instructions.
- Carry out necessary records and dispatching

Information sheet 1	**Checking die /cutting knifes against standards**

Information sheet 2	Addressing or resolving faults or irregularities

Identifying the Cause of Tool and Die Failure

Steels used for tools and dies differ from most other steels in several aspects. First, they are used in the manufacture of other products by a variety of forming processes. Second, tools and dies are generally used at a higher hardness than most other steel products. These high hardness values are required to resist anticipated service stresses and to provide wear resistance. However, the steels must also be tough enough to accommodate service stresses and strains without cracking. Premature failure caused by cracking must be avoided, or at least minimized, to maintain minimum manufacturing costs. Unexpected tool and die failure can shut down a manufacturing line and disrupt production scheduling.

Tools and dies must also be produced with the proper size and shape after hardening so that excessive finishing work is not required. Heat-treatment distortion must be controlled, and surface chemistries must not be altered. Because of the careful balance that must be maintained in heat treatment, control of the heat-treatment process is one of the most critical steps in producing successful tools and dies. In addition to controlling the heat-treatment process, tool and die design and steel selection are integral factors in achieving tool and die integrity.

Tool and die failures caused by breakage, which are generally catastrophic, are the most spectacular and draw the most attention from the failure analyst. Such failures are usually the easiest to diagnose, but the analyst should not halt the investigation when one obvious problem is identified. Several factors can contribute to a failure in varying degrees. The goal of any failure analysis should be to provide a total picture of all problems present so that complete corrective action can be taken on future parts.

Aside from cracking, a variety of problems can be encountered that cause limited tool or die life. These include, but are not limited to, excessive wear, galling, pickup, erosion, pitting, cosmetic problems, corrosion problems, and distortion during heat treatment, machining, or service.

Gathering Evidence

Knowing the manufacturing and service history of a failed part can aid in the analysis of tool and die failures. In many instances, however, such information is sketchy, and the analyst must rely on experience and engineering judgment. A basic approach can be followed for most tool and die failures to maximize the likelihood of identifying reasons for the failure. At times, however, no reason for failure can be discovered. In such cases, the failures are usually attributed to unknown service conditions.

Before beginning the investigation, a complete history of the manufacture and service life should be compiled if possible. Next, the part should be carefully examined, measured, and photographed to document the extent and location of the damage. Relevant design features, as well as some machining problems, are generally apparent after this study. The origin of the failure, when caused by fracture, will also usually be determined.

Only after a careful visual examination has been completed should any destructive work be considered. In certain cases, various non-destructive examination techniques – ultrasonic, X-ray, or magnetic particle inspection – should be implemented before cutting to obtain a more complete picture of the damage, either internal or external.

When this work is completed, several other phases of the study can begin. First, the composition of the component should be verified by a reliable method. Tool and die failures occasionally result from accidental use of the wrong grade of steel.

While this work is under way, the analyst can continue macroscopic examination of the fracture features by opening tight cracks, if they are present. Because quench cracking is a common cause of failures, the fracture surfaces should always be checked for temper color. Scale on a crack wall would indicate that it was exposed to temperatures higher than those used in tempering.

Visual inspection of the damage done to a tool and die is usually adequate to classify the type of failure. High-magnification fractographic examination is required in only a small percentage of cases. A simple stereomicroscope examination generally suffices. If this indicates that something may be present at the initiation site, then SEM examination and EDS or WDS analysis would be required.

Microstructural examination at and away from the damaged area and at the origin is imperative. This generally requires good edge-retention preparation, which is relatively easy for tool steels. A large percentage of tool and die failures are caused by heat-treatment problems; the value of proper metallographic procedures cannot be stressed enough.

Other techniques are also important. Hardness testing is used to confirm the quality of the heat treatment and often reveals problems. Macrostructural examination, either by cold or hot etching, is useful for detecting gross problems. Prior-austenite grain size is frequently evaluated by the Shepherd fracture grain size technique, a simple but accurate approach. X-ray diffraction can be used to determine the amount of retained austenite present.

In some cases, performing simulations or conducting experimental heat treatments, for example, to determine if a part was tempered, are necessary. Chemical analysis of millings or turnings from the surface will define variations in surface carbon content. Electron metallographic devices using either wavelength- or energy-dispersive X-ray analysis can be used to identify inclusion or segregates. Comparing the characteristics of good parts to those of failed parts is also helpful in some studies.

When this data is compiled and analyzed, the analyst is ready to prepare a report that details the cause of failure with the supporting facts. In many cases, making recommendations regarding corrective action for future or existing parts is necessary.

Factors to Consider

A number of factors can be responsible for tool and die failures. They include:

1. Mechanical design. The design must be compatible with the steel grade selected, the procedures required to manufacture the tool or die, and the use of the tool or die.

Any examination of tool or die failures must begin with a careful re-examination of the design to determine if shortcomings are present and if improvements can be made. Tools and dies that perform satisfactorily over the desired service life may not work as well if a new manufacturing process is adopted, the grade is changed, or service conditions are altered. Consequently, obtaining complete details on the history of the component is imperative.

The importance of good design cannot be overemphasized. Poor design can cause or promote heat-treatment failures before any service life is obtained, or it may reduce service life dramatically.

In designing a tool or die, a host of factors must be considered. In practice, separating the design stage from grade selection is difficult because the two steps are interdependent. The choice of a certain grade of steel, such as one that must be brine- or water-quenched, will have a substantial bearing on all aspects of design and manufacture. In general, any steel grade that requires liquid quenching demands very conservative, careful design.

Air-hardening grades tolerate some design and manufacturing considerations that could never be endured by a liquid quenching grade. The design must also be compatible with the equipment available – heat-treatment furnaces and surface-finishing devices, for example.

Designing tools and dies is more difficult than designing components made from structural steels because of the difficulty in predicting service stresses. Despite advances made in design procedures, much design work is still empirically based. Experience is primarily based on past failures; therefore, the findings of the failure analyst must be incorporated into future work. Despite the shortcomings of the empirical approach, a vast body of common-sense engineering knowledge is available for guidance.

2. Grade selection. The grade of steel selected must be compatible with the design chosen, the manufacturing processes used to produce the tool or die, and the intended service conditions and desired life.

Selection of the optimum grade for a given application is generally a compromise between toughness and wear resistance, although other factors may be more important in certain situations. Because most tools and dies operate under highly stressed conditions, toughness must be adequate to prevent brittle fracture. It is usually better for a tool or die to wear out than to break in service prematurely.

Thus, in a new application, selecting a grade that is sure to have adequate toughness is best. As experience is gained, the best grade choice can be made by balancing the required toughness and wear resistance. If experience shows the tool or die is free from breakage but sustains excessive wear, for example, a different grade can be selected to provide better wear resistance but somewhat less toughness.

3. Steel quality. The material must be macrostructurally sound, free of harmful inclusions to the degree required for the application, and free of harmful surface defects.

Despite the care taken in the manufacture and inspection of tool steels, faulty materials occasionally cause tool and die failures. However, such problems are rare. The most common of these defects are voids from secondary pipe, hydrogen flakes, surface cracks, porosity or microvoids, cooling cracks, segregation, and poor carbide distributions. Improper control of annealing may also produce non-uniform carbide distribution or carbide networks that may influence heat-treatment uniformity, lower ductility, or impair machinability.

4. Machining processes. The machining processes used to produce the tool or die must not alter the surface microstructure or surface finish and must not produce excessive residual stresses that will promote heat-treatment problems or service failures.

Machining problems are a common cause of tool and die failures. It is generally best to avoid machining directly to the finish size unless pre-hardened die steels are used.

Obtaining perfect control of surface chemistry and size during heat treatment is difficult. Thus, some final grinding is usually needed after heat treatment. The presence of decarburization is generally quite detrimental. Also, because stresses are high in heat treatment and in service, rough machining marks must be avoided. Identification stamp marks are another common source of failures in heat treatment and in service; they should be avoided.

5. Heat-treatment operation. Heat treatment of tools and dies must produce the desired microstructure, hardness, toughness, and hardness at the surface and in the interior.

Improper heat-treatment procedures are the single largest source of failures during heat treatment, in subsequent processing steps, or in service. Each tool steel grade has a recommended austenitizing temperature range, which is generally rather narrow; a recommended quench medium; and recommended tempering temperatures and times for optimum properties. Some grades are more forgiving than others.

6. Grinding and finishing operations. Grinding and finishing operations must not impair the surface integrity of the component.

7. Tool and die setup. Alignment of tools and dies must be precise to prevent irregular, excessive stresses that will accelerate wear or cause cracking.

8. Tool and die operation. Overloading must be avoided during operation to ensure that the desired component life is achieved.

Tools and dies, although made from the correct grade, well designed, and properly machined and heat treated, can fail after limited service because of improper operation or mechanical problems. In such cases, the failure analyst may spend considerable effort evaluating the design, grade selection, machining, and heat treatment without uncovering any abnormalities. In many cases, the analyst has little information concerning the use of the tool and can only conclude that service problems were responsible for the failure. In some cases, evidence of the mechanical or service problem may be present.

Mechanical factors that may cause premature failures include overloading, overstressing, and alignment or clearance problems. Excessive temperature may be a factor in hot-working die failures, perhaps because of inadequate cooling between operations. Failures have also occurred during assembly-for example, during shrink fitting of one part onto another. Stamp marks, in addition to causing heat-treatment failures, can cause service failures due to stress concentration.

Alignment problems are a common cause of failure of tools used in shearing operations. While most tools and dies fail in a brittle manner, fatigue failures are sometimes encountered. In most cases, the fatigue failure is located at a change in section size, at a sharp corner, or at stamp marks.

Interdependence

This classification of factors can be helpful in categorizing problems, but it will not necessarily deduce the cause of a particular failure. A failure caused by one problem may have been precipitated by other problems earlier in the processing sequence.

For example, many cracking problems attributed to abusive grinding practices are caused by failure to temper the part or by over-austenitization. Both of these problems will make a tool steel almost impossible to grind without producing surface burning and cracking, regardless of the care taken during grinding.

Thus, these factors are interdependent, much like the links of a chain. If one step is poorly executed, the tool or die will have a limited service life regardless of how carefully all of the other steps are conducted. This sensitivity to processing stems from the use of tools and dies at very high hardness levels, at which minor deficiencies in processing exert major influences on performance.

Information sheet 3	**Carrying out handling of cutting die/knife**

3.1. 10 Tips on Correct Die Handling

Tip #1

Check the packing list and contents upon receipt of shipment

Task #2

Keep the test certificate, trial cuts and cutting logs in a safe place. The cutting log will assist you with determining the running performance

Task #3

Never lay the die down unprotected against the blade side

Task #4

Clean the place before mounting the die

Task #5

Clean of ink and adhesive residual. Make sure there is sufficient pressure

Task #6

Do not tighten the pressure screws with tools. Too much or too little pressure can cause cutting blade damage.

Task #7

Consider using an adjustable clearance anvil for extended life.

Task #8

Check and clean bearings, die blocks, press rollers and gears regularly.

Task #9

Clean the die after use.

Task #10

Place the die in the rust preventive blue bag. Store die properly.

Information sheet 4	**Carrying out necessary records and dispatching**