

Section 2

Workshop Safety Infrastructure and Safety Communication

- To understand the Safety Infrastructure in workshops and Fab Lab.
- General Workshop Safety Communications
- Attire for workshops and Fab Lab.
- Safety Posters and Safety Warning Placards.
- Safe Work Procedure.

Workshop Safety Communication

In workshops or Fab Lab, hazard communications are visible to remind students of workplace hazards and the safety precautions to take at specific work areas, especially when working with a hazardous machineries.



Demarcation machine zone



Attire Poster



Safety Warning Placard

Proper Attire for Male



Proper Attire for Male





Gloves



Protective Glasses



Covered Shoes



Hearing Protection



Protective Apron



Mask



Face Shield



Safety Cloth



Crush Hazard



Hot Surface



RADIATION
HAZARD



RISK OF
ELECTRIC
SHOCK



LASER
BEAM



Acid



Cutting Hazard
Keep Hand Away



Beware Chips Flying



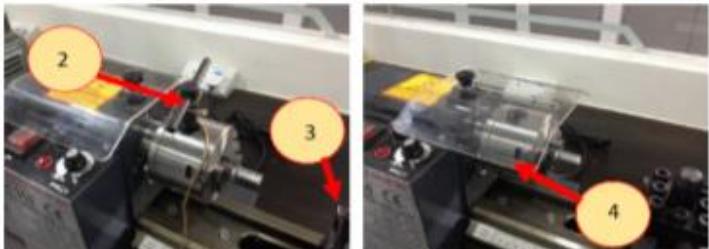
WELDING IN
PROGRESS



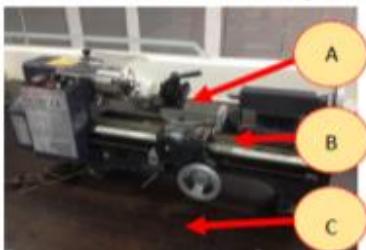
POISON

Safety Warning Placards

Desktop Lathe



1. Ensure work is clamped securely.
2. Remember to remove the Chuck key.
3. Check that cutting tool is secured to tool holder.
4. Ensure that the safety guard is in place.



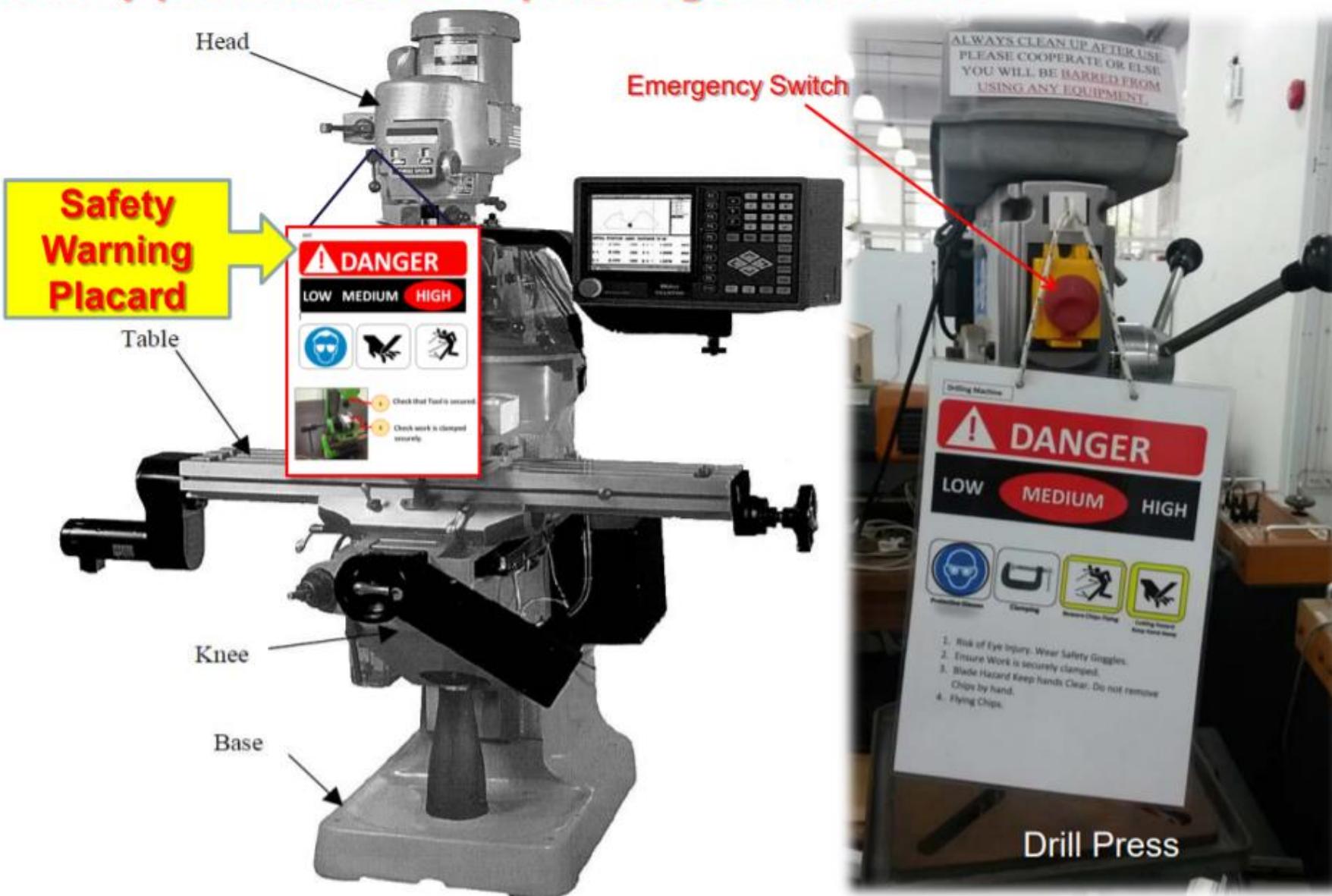
After use, clean & dust off starting from
A. Carriage
B. Under & around the machine Bed
C. Bench top

CNC Router



1. Ensure safety cover is present.
2. Wear safety goggles or glasses.
3. Ensure workpiece is clamped securely.
4. Keep away from moving parts during operation.
5. Clean up the work area after use.

Always read and understand the information printed on the safety placard before operating the machine.



Safe Work Procedure (SWP)

SCHOOL OF MECHANICAL & AERONAUTICAL ENGINEERING SAFE WORK PROCEDURE

Name of Lab	INDUSTRIAL AUTOMATION LAB	Room No	W1421
Equipment	Drill Cum Mill	Risk Category	High /Medium/Low

DO NOT use this machine/equipment unless you have been trained in its safe use & operation and permission has been granted by TSO of this facility.

Description of Work/Activity	Operating the Drill Cum Mill process					
Potential Hazards: (list the hazards associated to this equipment)						
1. Hot & sharp chips produced in large quantity. Do not use hands to touch or remove them. Use brush to sweep them away. 2. Rotating spindle & chuck. Beware loose clothing sleeves and remove jewellery and watches. 3. Flying chip, wear safety glass to protect eyes.						
Personal Protective Equipment (PPE) Required (Check the box for required PPE):						
						

Safe Work Procedure Checklist (List & describe the safe procedure in operating the equipment) :

- 1. PRE-OPERATION :**
 - Dress appropriately. Remove all watches and jewellery. Wear Safety glasses or goggles
 - Plan out your work thoroughly before starting.
 - Know the location of the machine OFF button.
 - Clamp all workpiece securely on to the work table using a machine vice.
 - Always check that the chuck key is removed from spindle immediately after using it.
 - Never let the chuck key leaves your hand except to put it back into its holder.
 - Select appropriate spindle speed for the material.
- 2. OPERATION :**
 - Do not stop a rotating drill press spindle with your hand after you have turned off the machine.
 - Chips often build up around the chuck during the drilling process; use a brush, not your hands, to remove chips from the machine.
 - Do not clean the machining area while the machine is running.
 - Focus your attention on the drilling process and do not distract with other activities.
- 3. POST-OPERATION :**
 - Keep the work area clean. Immediately wipe up any oil spills.
 - Use the brush to clear off chips from workpiece, table and vice into dust-pan.

Section 3

Hazards associated with machinery & workplace

1. To know and understand **Mechanical Hazards**.
2. To recognise **primary areas** in machineries or workplace where mechanical hazards are present.
3. To identify the “**danger areas**” in machines.
4. To know & understand of **Non-Mechanical Hazards**.

Hazards associated with machinery

Three primary areas at a machine where hazards can be encountered.

1. The machine's "perimeter"

Area around a machine, where falling objects, flying debris or other hazards can be encountered.

2. The "drive train"

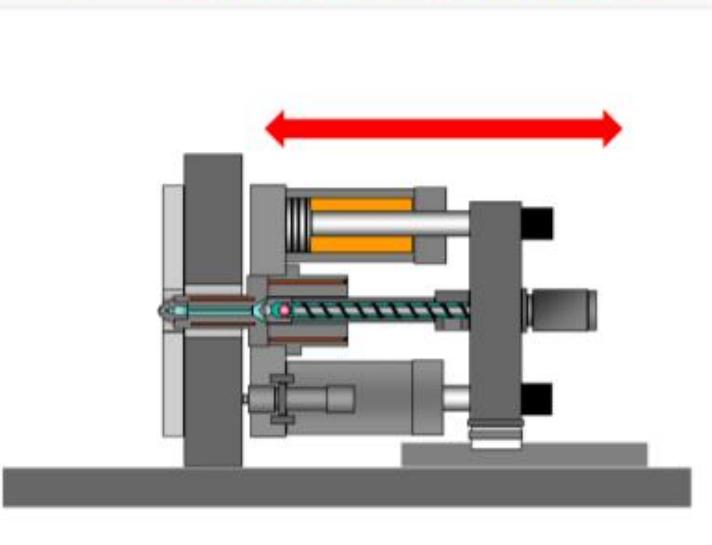
The moving parts that run the machine.

3. "Points of operation"

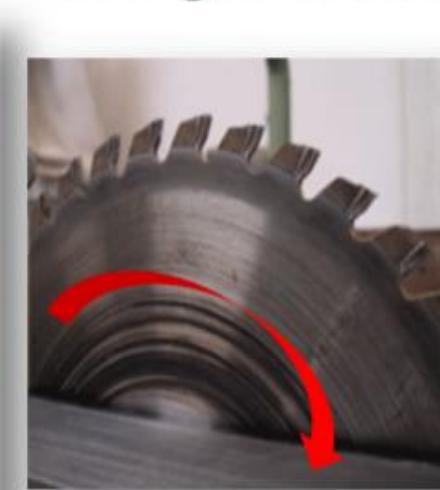
Location where a machine's mechanical or electrical energy is used to cut, bend or otherwise process materials.

All equipment or machine operates using a combination of
THREE basic motions :

1. **Rotation** - moving in a circular pattern.
2. **Reciprocation** - moving back and forth.
3. **Traverse motion** - moving in a straight line.



Sliding or reciprocating motion



Rotation
High speed sawing



Combine
Rotation/Traverse
“Slot Milling”

Machine Hazard Identification

- **Hazard** is something which could cause injury.
- **Risk** is the likelihood of the hazard causing an injury, and the severity of an injury.
- The parts of a machine or area on the machine to pose hazards are the **Danger Areas?**



Danger Areas

Typically, **2** areas on machinery are dangerous, and can be a hazard to anyone near the machine:

1. *Parts which move or transmit power*

- Belts, chains & pulleys
- gear trains & sprocket gears
- shafts & spindles
- slides & flywheels

2. *Parts that do the work*

- Blades
- Cutters & Tool bits
- Saw
- Drills & chucks

Danger Areas of Machine

Part that transmits power (motor)

Spindle

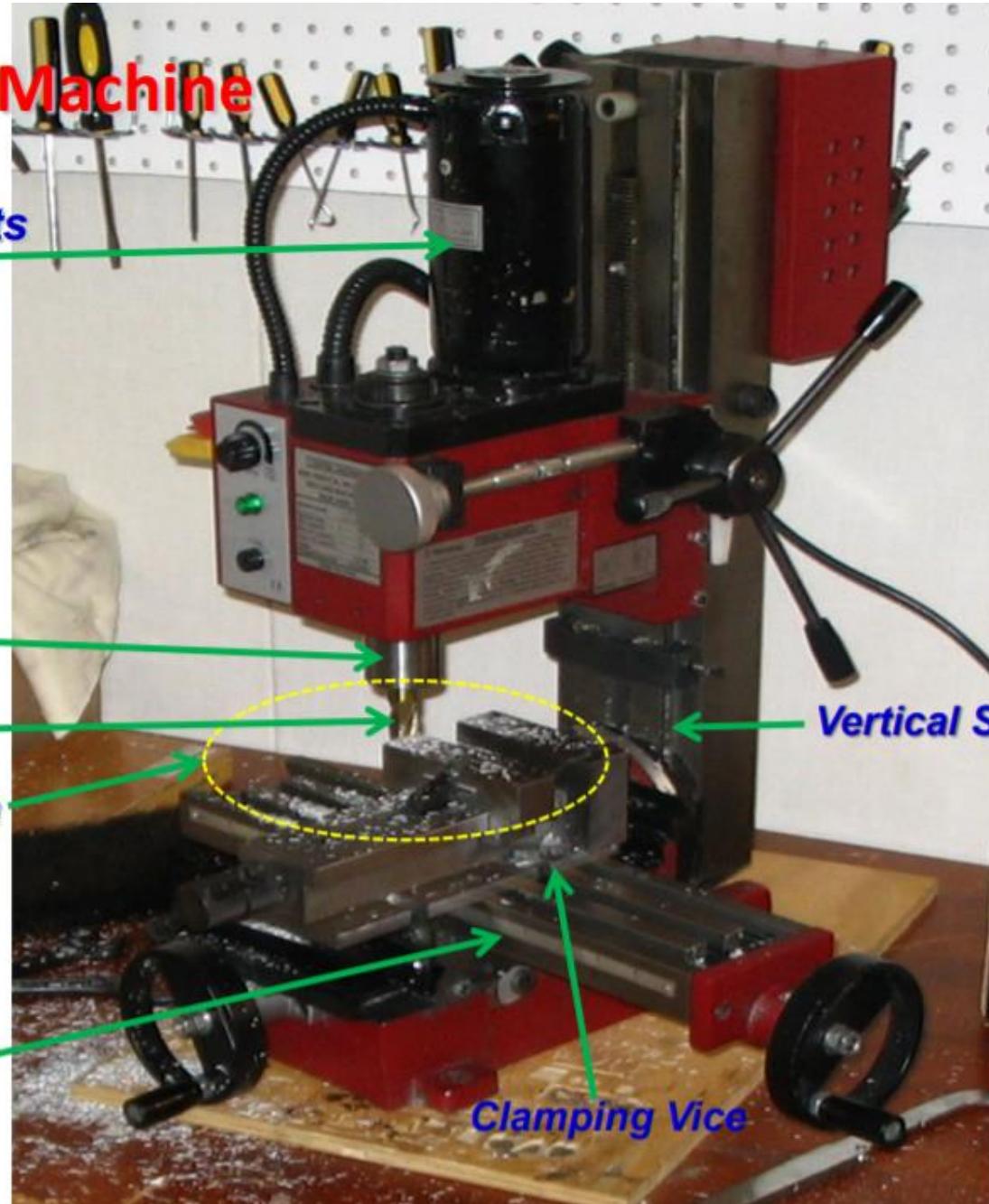
Cutter

Cutting area

Table Slide

Vertical Slide

Clamping Vice



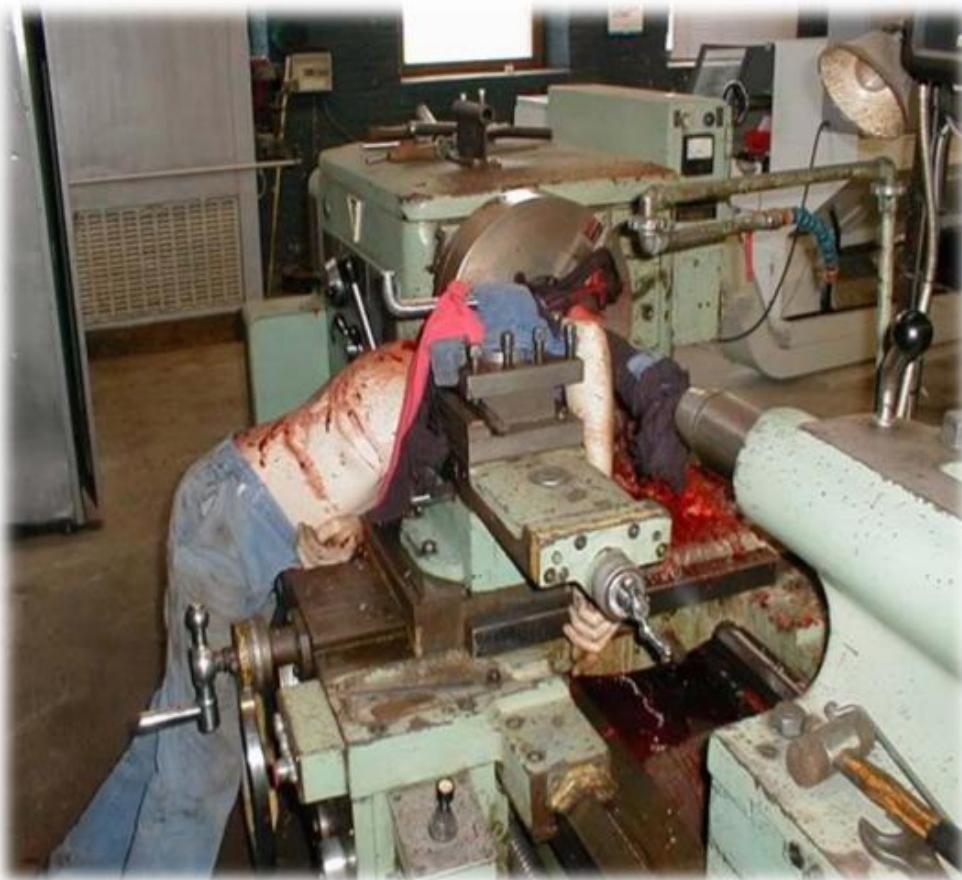
Mechanical Hazards

Type of hazards due to machinery motions :

1. Entanglement hazards
2. Cutting hazards
3. Impact hazards
4. Shearing hazards
5. Crushing hazards
6. Draw-in hazards
7. Friction and abrasion hazards



Entanglement Hazards



Entanglement arise when loose clothing, hair or loose item got caught with the moving parts of a machine.

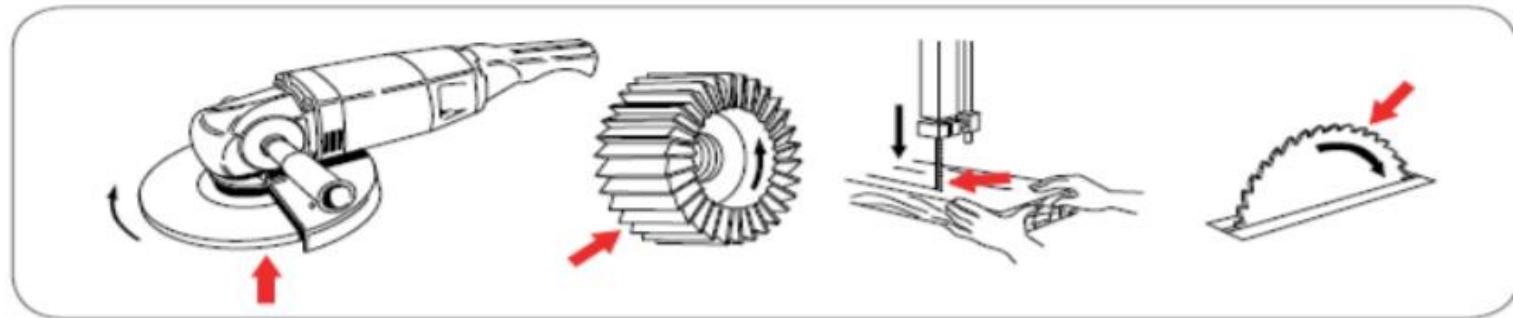


Cutting Hazards

Cutting hazards are present in machines used to cut wood, metal or other materials at the point of operation.

Machines with moving cutting elements are dangerous.

They can cause severe injury (eg. deep cuts, amputations) due to its own momentum when they come into contact with a worker's body.



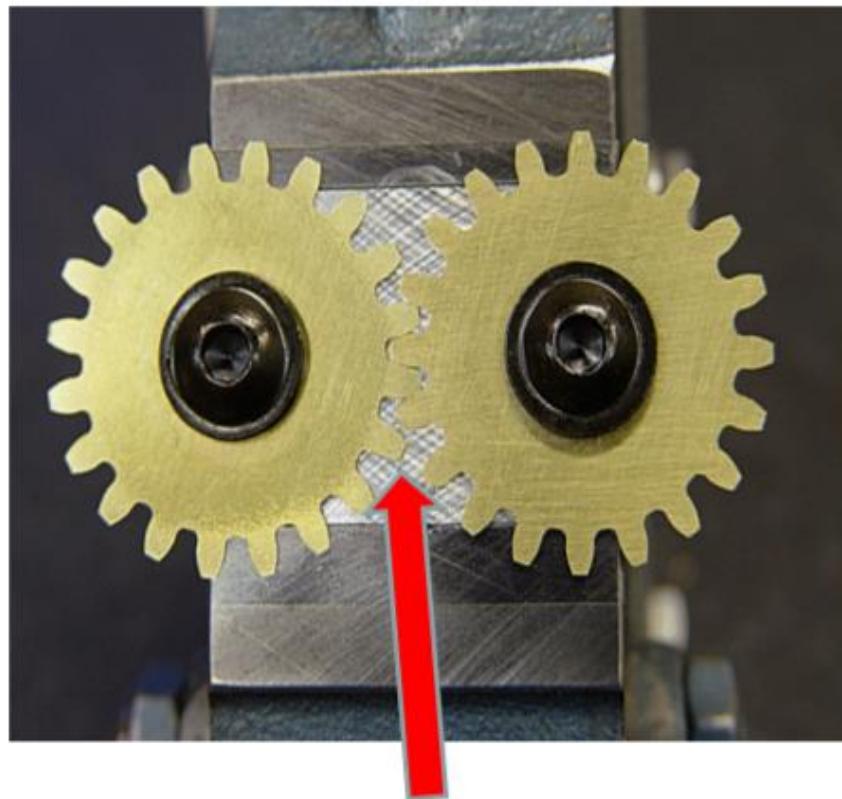
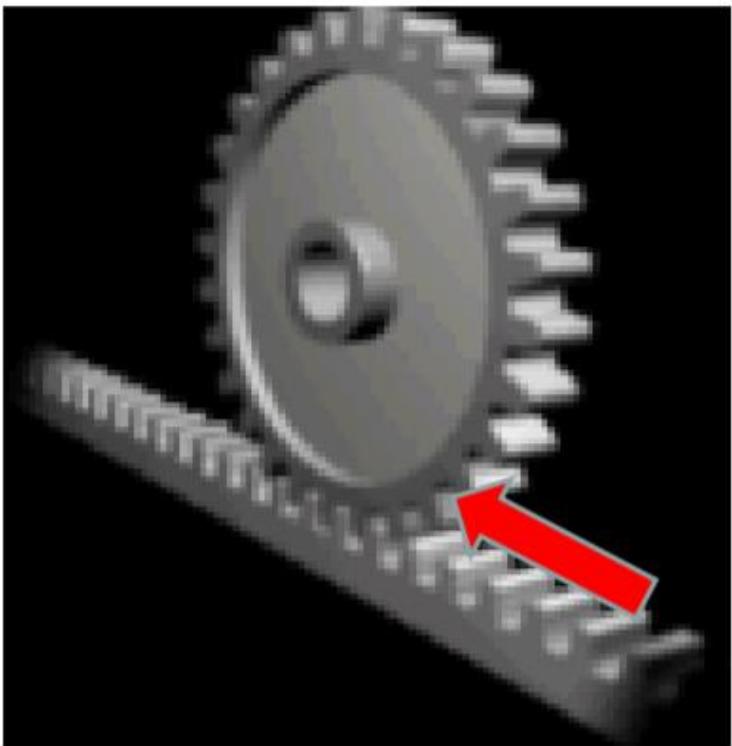
Examples of cutting hazards. From left: disc blades, sharp edges, band saw, circular saw.



Possible injury to hands due to the unguarded rotating saw blade.

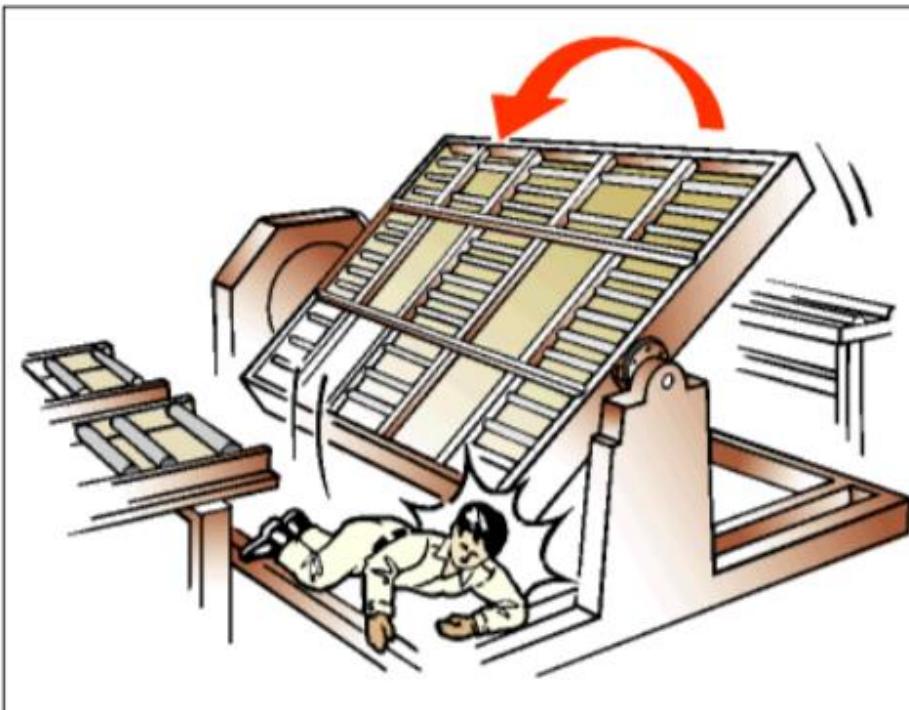
Draw-in Hazards

Injuries can occur when a body part is drawn-in by in-running nip points formed by two counter-rotating parts or between rotating and tangentially moving surfaces.



Impact Hazards

Impact hazards relate to objects that strike the human body, but do not penetrate it. The severity of an impact hazard depends on the speed, force and inertia of the moving machine part during operation or upon ejection from the machine .



Worker being struck by moving part of machines

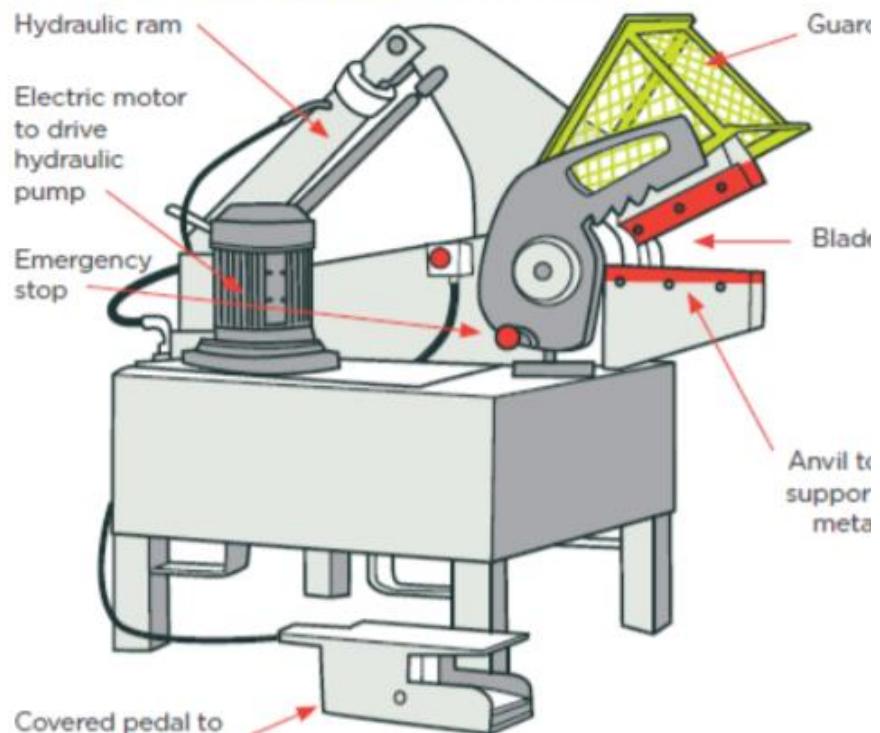


Stuck by the rotating arm of robot

Shearing Hazards

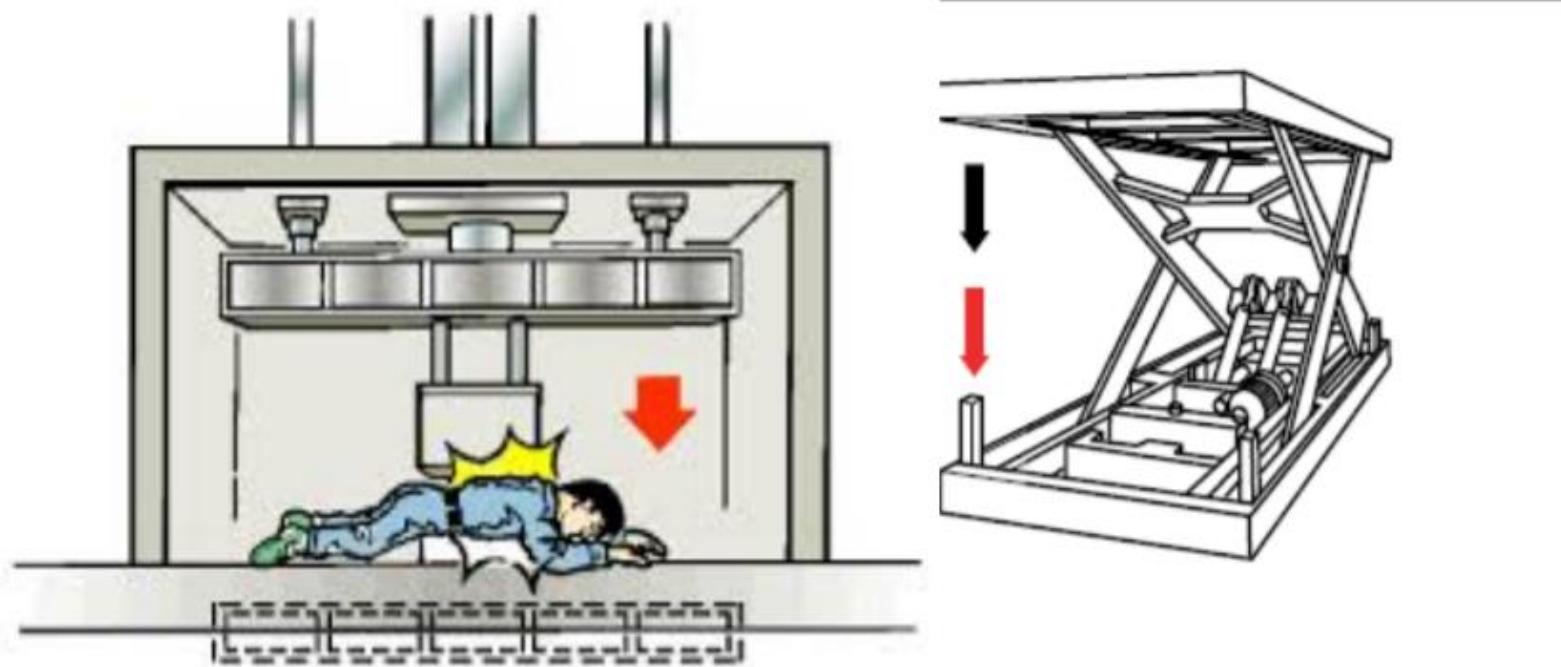
Parts of machines that move past each other or stationary objects can cause a shear point resulting in a crushing or cutting action.

In general, shearing hazards are present between two machine parts such as power press punch, shearing machine, etc..



Crushing Hazards

It is caused when part of the body is caught between either two moving parts of machinery or a moving part and a stationary object.



Friction and Abrasion Hazards

Friction burns and abrasions occurs when encountering rough surfaces moving at high speed e.g. sanding machine, grinding wheel etc. can cause abrasion injuries.



<https://www.youtube.com/watch?v=V-aoqvUpOrPs>



<https://www.youtube.com/watch?v=P22Q46dlwug>

Non-Mechanical Hazards

- 1. Fall from Heights Hazards**
- 2. Noise Hazards**
- 3. Electrical Hazards**
- 4. Heat-related Hazards**
- 5. Chemical Hazards**
- 6. Fatigue**
- 7. Ergonomic Risk factors**

Fall from Heights Hazards

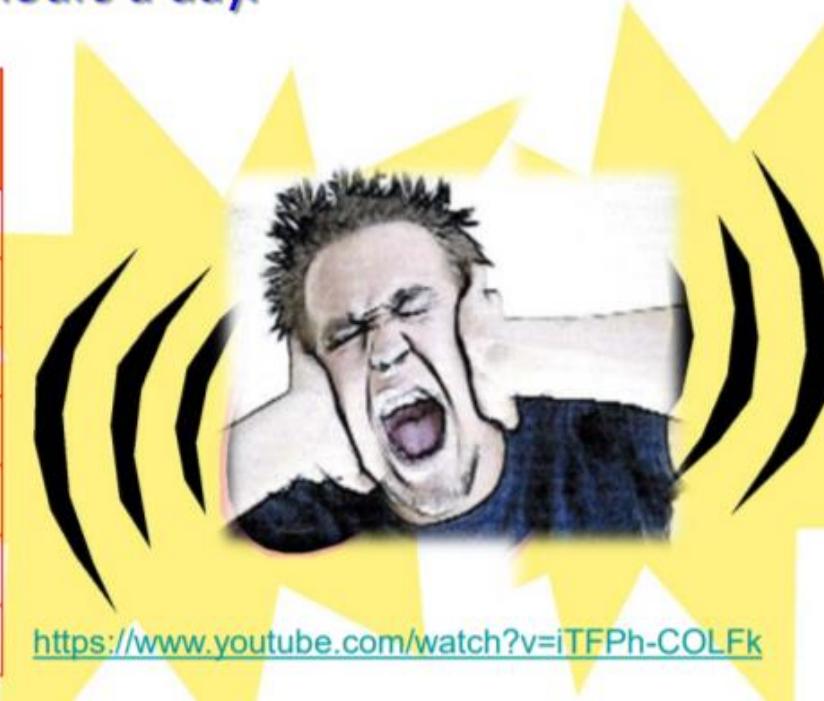
When required to work at heights, fall can lead to sprains or broken bones and in more serious cases, head injuries or even death.



Noise Hazards

- Noise is often generated during machine operations and work activities.
- Prolonged exposure to excessive noise can cause NID (**Noise-Induced Deafness**).
- To prevent hearing loss, one should not be exposed to noise levels exceeding 85 dB (A) for 8 hours a day.

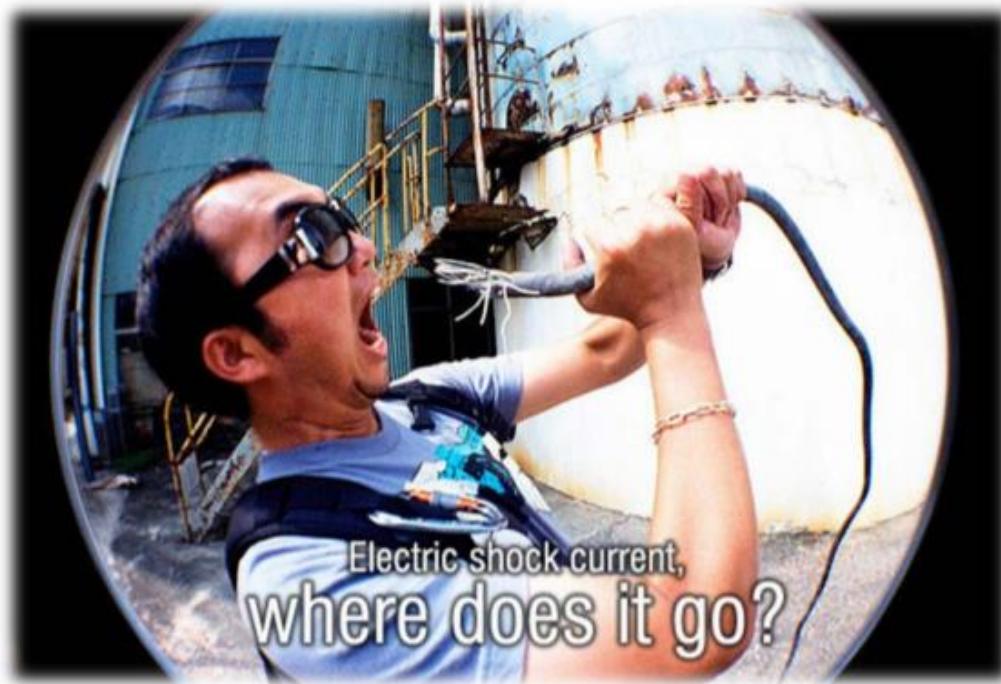
Sound Pressure Level dB(A)	Maximum Duration per Day
85	8 hours
88	4 hours
91	2 hours
94	1 hour
97	30 minutes
100	15 minutes
106	4 minutes



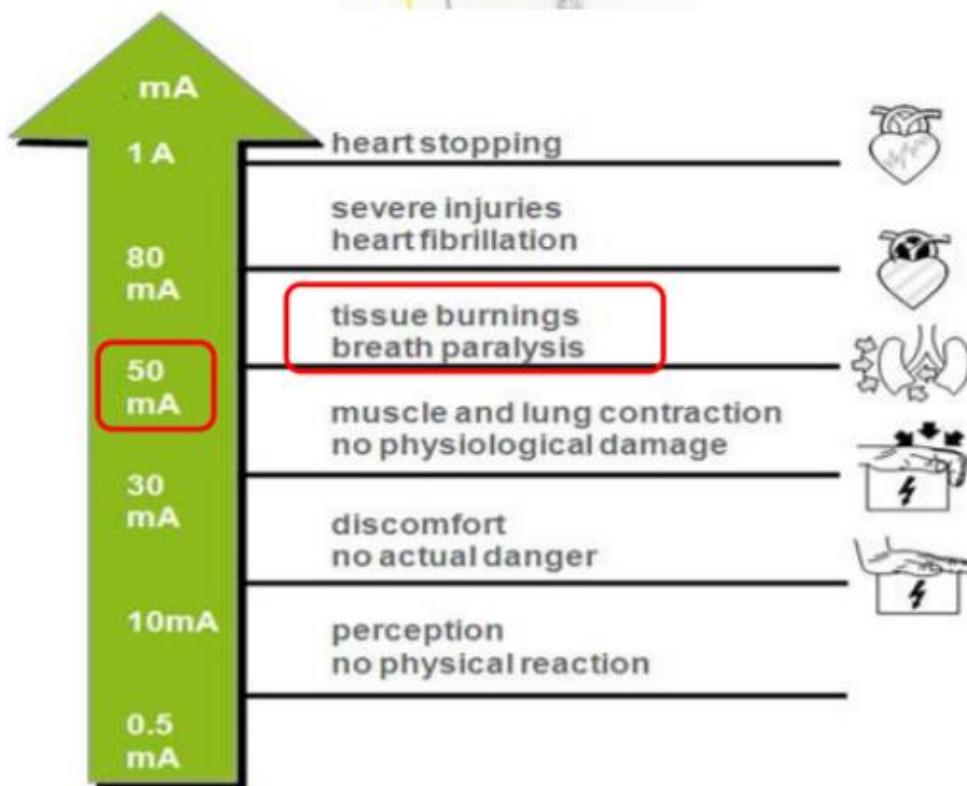
<https://www.youtube.com/watch?v=iTFPh-COLFk>

Electrical Hazards

- Workers may be exposed to electrical hazards, for example, during electrical installations or when machines or power tools are in use.
- Accidents involving contact with electricity can happen when an electrical machine failed, electric circuits are overloaded or short-circuited, or when one comes into contact with a live wire.



Danger of Electricity



Electrical Safety

1. Don't Overload Outlet



2. Don't Use Electricity Around Water



3. Wear Rubber



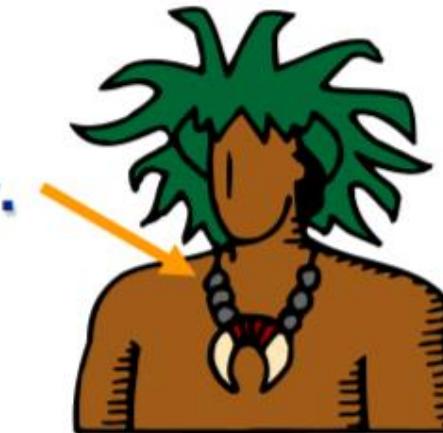
- To reduce the risk of power overload and fires due to the wires getting too hot.
- Water is a conductor (low resistance)
- Rubber is an insulator (high resistance)

Moisture provides a conductive path that could result in death.



Never work with wet hands, tools or clothing.

Remove Your Jewelry.



Electrical Hazard

Cords & Equipment

- Power tools and extension cords must be inspected each time they are used.

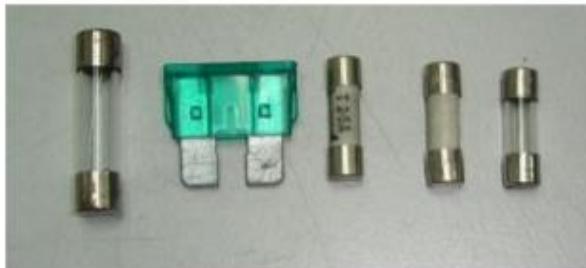
- They must be taken out of service immediately upon discovery of worn or broken insulation.



Protective And Safety Devices

- Every machine should incorporate special devices to protect the operator, protect the machine and building against fires
- These devices designed to **cut off the power** when it detects **overcurrent**

Fuse & MCB



Ground fault circuit interrupters (GFCI) /Residual Current Circuit Breaker (RCCB)

Heat-related Hazards

- Contact with hot surfaces of machines can cause severe skin burns.
- Operations involving high temperatures, high humidity or strenuous physical activities cause heat-related illness (e.g. heat exhaustion or in severe cases, heat stroke).



Fatigue

Fatigue is tiredness leading to reduced mental and physical performance that can endanger safety and health.

Fatigue can also lead to near-miss incidents, serious injuries and even fatal accidents due to reduced concentration and alertness.

Fatigue can be caused by:

- long working hours without rest;
- intense and sustained physical exertion/mental effort;
- lack of adequate rest and sleep.

Warning signs of fatigue



Chemical Hazards

Many equipment use chemicals in operations such as :

- Lubricants for moving parts of machines for smooth operation;
- Hydraulic fluids to operate mechanisms of machine;
- Coolant to cool the cutting process in machining;
- Acids for wet etching in wafer productions;
- Cleaning agents in machine maintenance



Prolonged chemical contact with the skin can lead to skin disorders (e.g., dermatitis)



Prolonged exposure thru inhalation of chemical mist or vapour, can cause poor respiratory health (e.g. asthma).



Section 4

Machine Guarding and Safety Devices

- 1. WSH (General Provisions) Regulations related to machine guards and safety devices**
- 2. Types of machine guards and their functions**
- 3. Types of safety devices and their functions**

WSH (*General Provision*) Regulations

Every danger area of a machine shall be securely fenced or provided with effective safeguard to prevent the worker from coming into contact with the part.

Efficient safety devices must be provided by which the power can be promptly cut-off from the machinery.

WSH (*General Provision*) Regulations

Machine Guards

Fencing or barriers are provided to :

- 1. keep workers from touching moving parts of machines.**
- 2. protect workers from flying debris, sparks and splashing chemicals.**

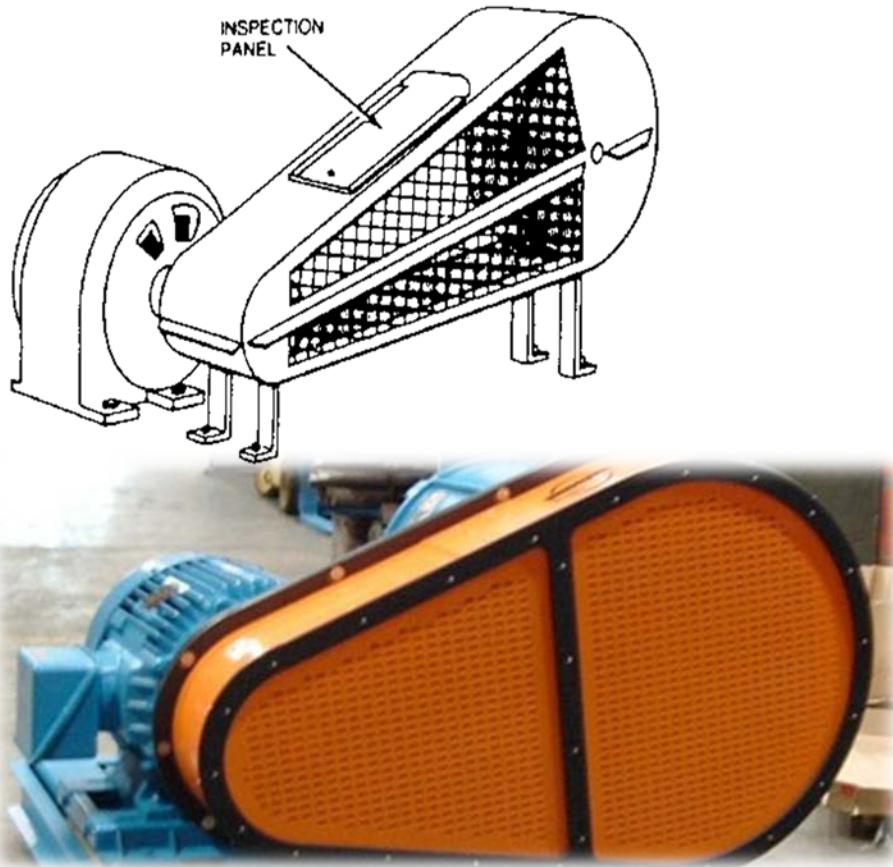


Guard that Machine !

Types of Machine Guards

Fixed Guards

They are stationary (immovable) barriers that are usually firmly fastened in place, making it difficult to remove them.



Types of Machine Guards

Adjustable Guards

In situations where fixed guards **would interfere with machine functions**, **Adjustable and Self-Adjusting Guards** are commonly used.

These guards are movable, allowing them to be used in many situations; particularly around points of operation.

Adjustable Guards are manually set/moved by a machine operator.

- Some simply swing into position.
- Others must be carefully set up to accommodate different sized raw materials.

ADJUSTABLE GUARD OF LATHE MACHINE



Guard in
OPEN
position



Guard swing
downwards to
CLOSE
position



Self-Adjusting Guards

Self-Adjusting Guards automatically moves as materials enter or move through the machine and do not require constant re-positioning.

- These self adjusting guards automatically move out of the way to allow materials of different sizes to be processed.
- Once the material passes, the guard falls back into place again covering the point of operation.

**Circular table Saw
self-adjusting guard**



Safety Devices

Safety Devices are used to provide protection and allow workers to operate the machinery with minimal restrictions.

Most Safety Devices protect a worker's entire body by quickly shutting down the machinery when tripped.

Others only protect the hands.

They do this by either:

- Keeping a machine from starting if a hand is in the wrong place.
- Restricting the machine operator's hand and arm movements.

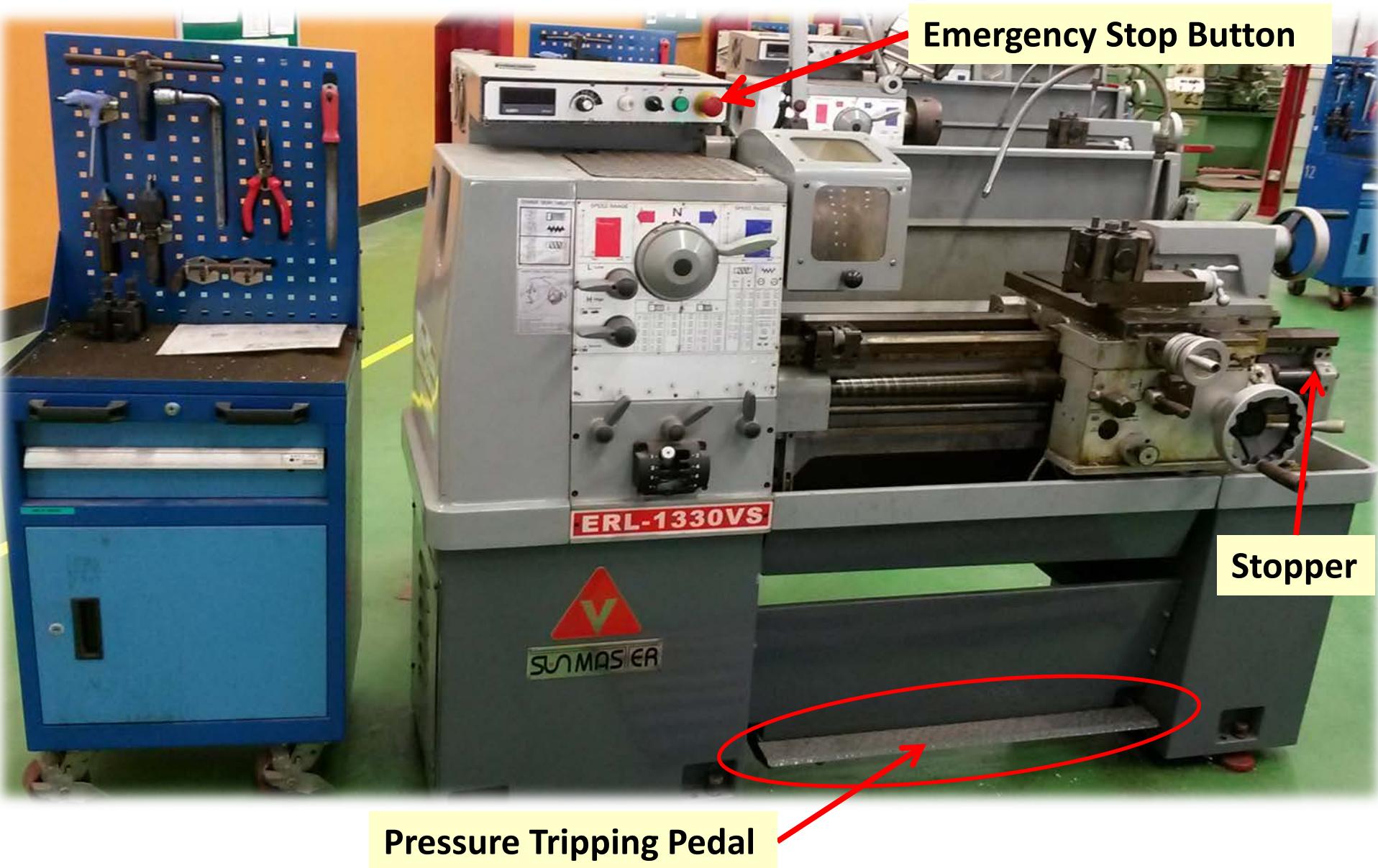
Safety Devices - Pressure-Sensitive Trips

They are simply wires or cables that are attached to switches. If a worker touches the cable, the switch "trips" and stops the machine.



Trip-wire cable

Safety Devices – Pressure Tripping Pedal on a Lathe



Safety Devices – Pressure sensitive mats

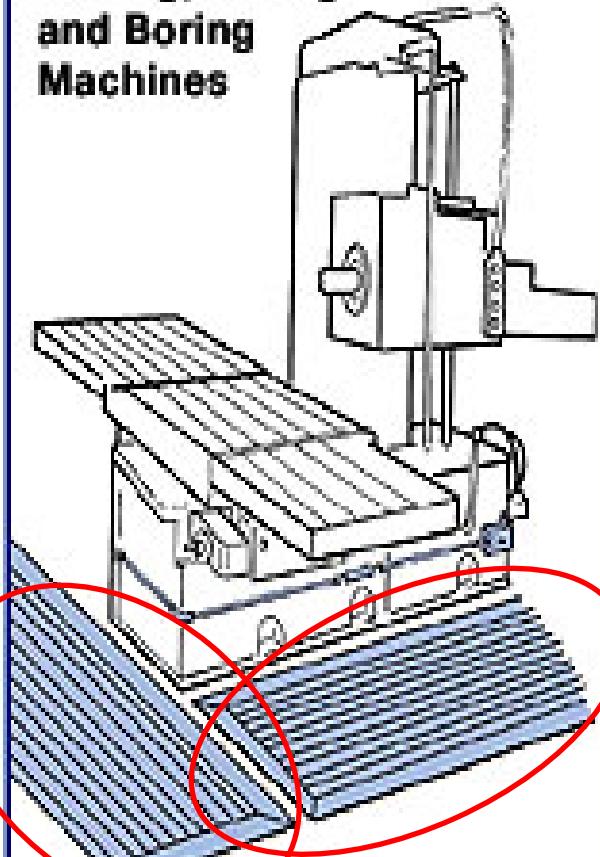
Two ways to apply pressure sensitive mats in machine:

- The mats are set up to **shut** a machine down if a worker steps **on** them. This prevents the worker from getting close enough to touch moving parts.
- Another way, the mat is used to shut down the machine when a worker steps **off** of the Mat. In this case, the worker must be **on** the mat and safely away from hazards for the machine to run.

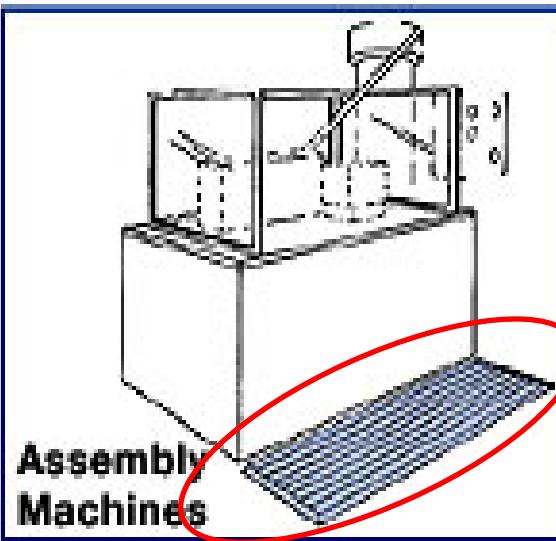
[Video on Safety mat for robotic workspace](#)
<https://youtu.be/dTIPjIRnkbE>

Safety Devices – Pressure sensitive mats

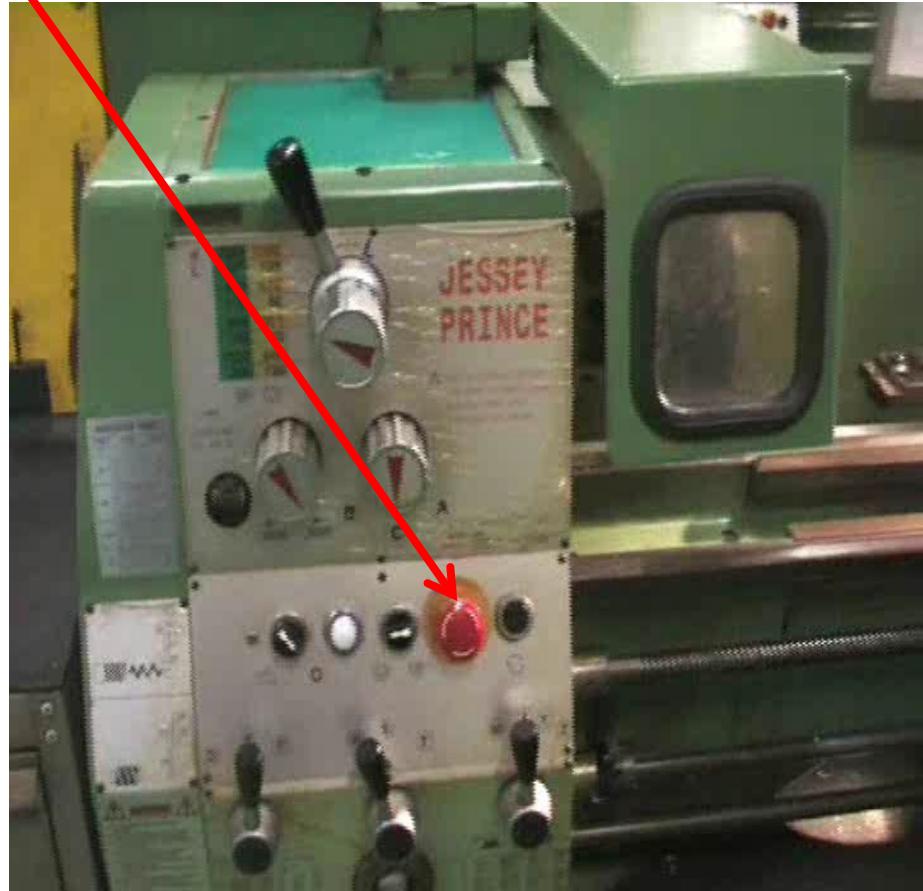
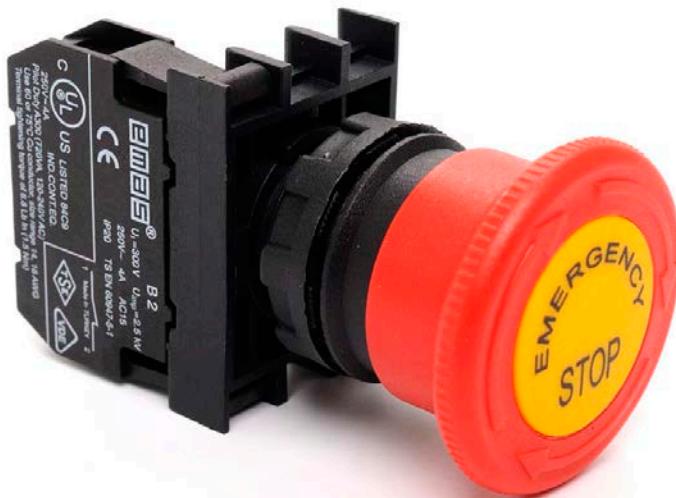
Drilling, Milling
and Boring
Machines



Assembly
Machines



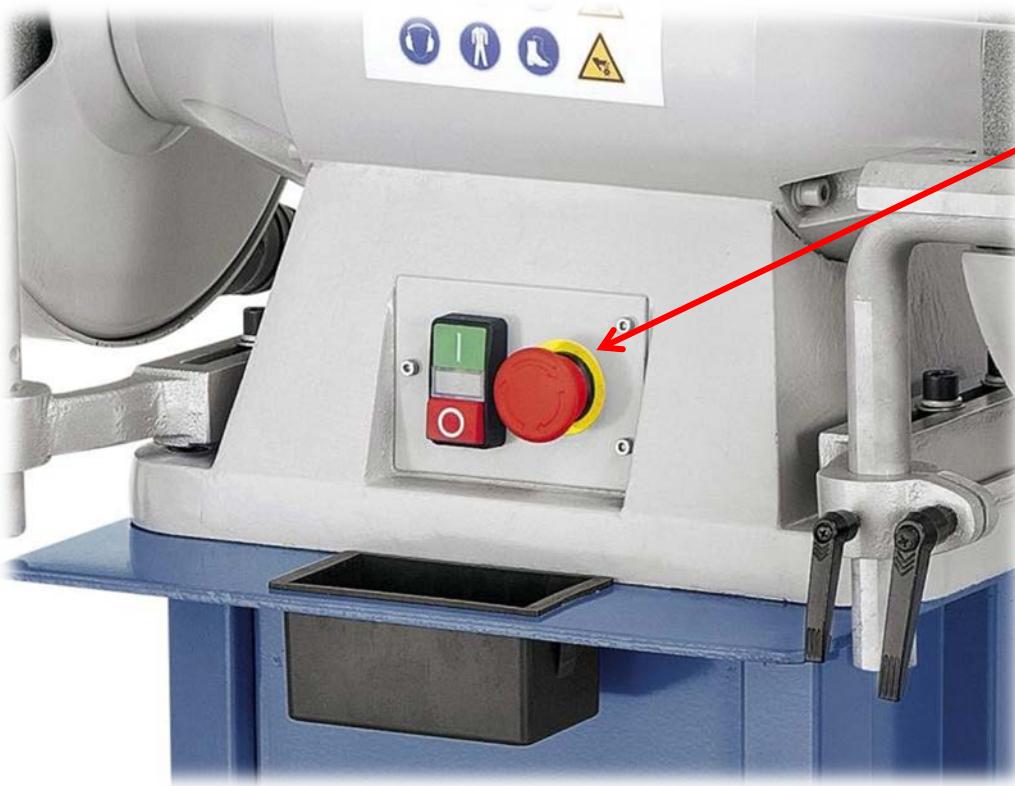
Emergency Switch



Emergency Switch

Emergency switch is provided when emergency stopping of machine is necessary, and hence, the **switch** shall:

- *Be easily accessible to the operator.*
- *Be designed for unexpected activation.*



Section 5

Safe use of Hand & Power Tools

- Types of hand and power tools.
- Hazards relating to the use of hand & power tools
- Hands injury prevention.
- Five basic rules to prevent hand injury.
- Good housekeeping.

Types of Hand Tools



Screwdriver



Hammers



Punches



Handsaws



Chisels



Files



Hand snips



Axes



Knives



Box cutters



Wrenches



Crowbars/pry bars



Hooks



Pliers

Types of Hand Held Power Tools

Electrical Power Hand Tools



Soldering iron



Portable Grinder



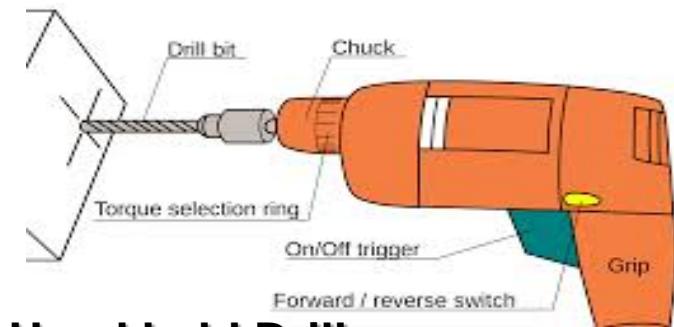
Circular saw



Reciprocating saw



Hand held Router



Hand held Drill



Sander

Types of Hand Held Power Tools

Pneumatic impact tools or air-powered tools

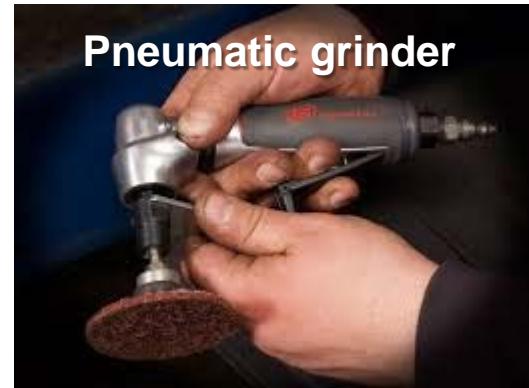
Air-powered Wrench



Pneumatic Screw Driver



Pneumatic grinder



Pneumatic Hammer



Pneumatic Nail Gun



Hand Tools and Hand-Held Power Tools

Hazards from the misuse or poor maintenance of hand tools and hand-held power tools :

- 1. Broken handles on files/chisels/screwdrivers/hammers which can cause cut hands or hammer head flying off.**
- 2. Incorrect use of knives, saws and chisels with hands getting injured in the path of the cutting edge**
- 3. Splayed spanners that slip and can injure hands or faces.**
- 5. Electrocuted or burns by using incorrect or damaged hand held power tools.**
- 6. Use of poorly insulated hand held power tools.**
- 7. Entanglement of electrical wire in rotating spindles.**
- 8. Direct contact with the cutting blades or drilling bits.**

Hand Injury

**Some tools are
irreplaceable...**



**PROTECT
YOUR HANDS**



Common Causes of Hands & Arms Injuries

- 1. Abrasion**
- 2. Temperature Extremes**
- 3. Cuts & Punctures**
- 4. Handling of Chemicals**
- 5. Electrical Shock**
- 6. Skin Infection**
- 7. Disease Or Contamination**

Hand Injury Prevention

Hand injury is the result of :

- Adopting improper work methods.
- Using the wrong hand tools for the job.
- Failure to apply hand protection.

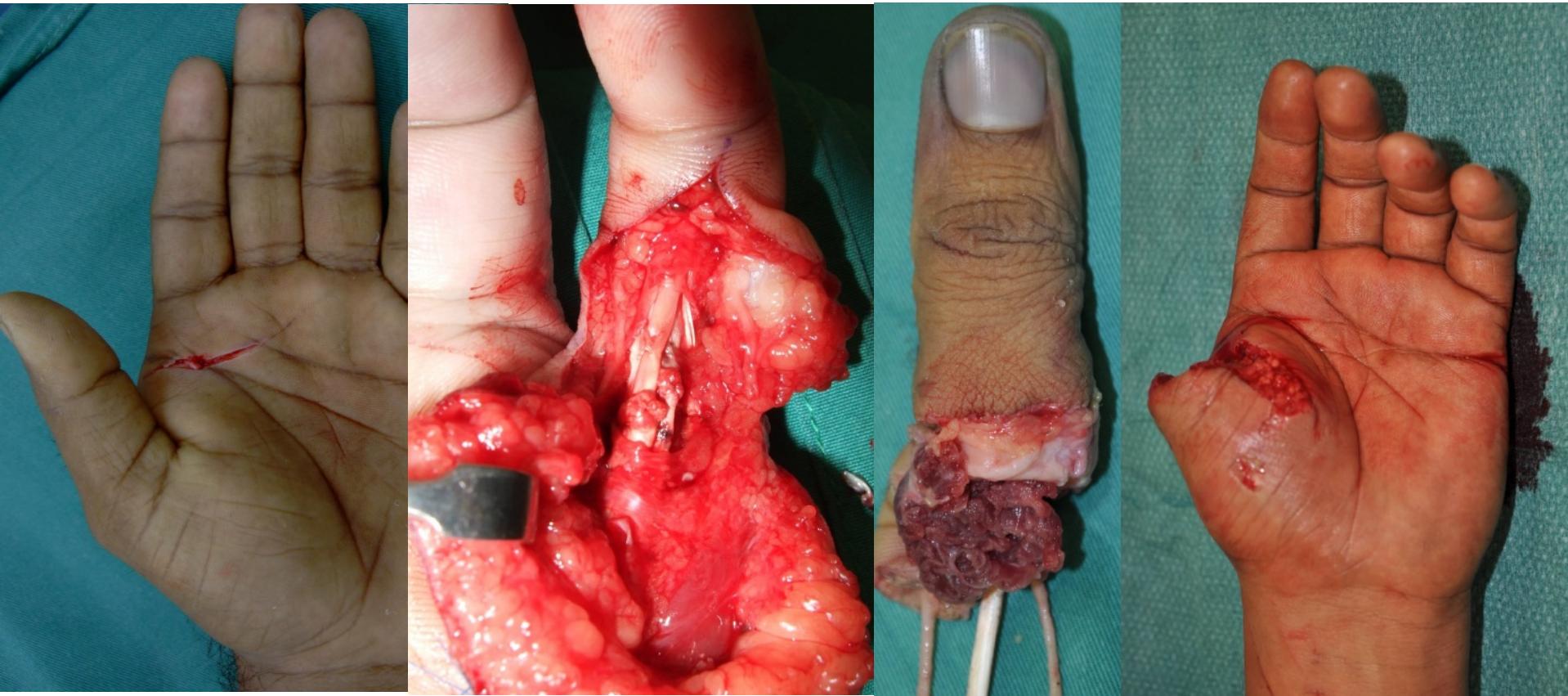


DON'T HURT MY HANDS !

Do you want to be one of these victim?



Finger and Hand Lacerations / Amputations



Hand Injury Prevention



The worker's right hand may be cut by sharp metal sheet even though he has been doing it frequently!

Hand Injury Prevention

Worker's left thumb is resting at Non-Defensive position.

His thumb may be cut by the pen knife if it slips even though he wears hand gloves!



Five basic rules to prevent hand injuries

1. Keep all tools in good condition with regular maintenance.
2. Use the right tool for the job.
3. Examine each tool for damage before use and do not use damaged tools.
4. Operate tools according to the manufacturers' instructions.
5. Properly use of the appropriate PPE.

Housekeeping & Tidiness of Workplace

CLEAN IT UP



Poor Housekeeping



1. Poorly arranged work-area with untidy or hazardous storage of materials and tools.
2. Messy & dirty floor and work surfaces.



Housekeeping

Benefits of good housekeeping

1. Eliminates hazards, accident & fire risks.
2. Provides the best use of workspaces.
3. Creates a safe & conducive workplace.
4. Tools and equipment are orderly returned and kept in proper storage for easy access.



Good Housekeeping



Tools neatly arranged on Rack for easy access



Clean/Neat and Orderly Workplace



Good Housekeeping Practices

- 1. Always return the tools back to their designated positions in the tool racks after use.**

- 2. Always keep the workplace neat and orderly after use.**

- 3. Always clear away the debris and chips off the machines or workbenches after use.**

- 4. Always bring unused or leftover materials to the recycle area.**

Housekeeping and Safety



[Video 1: https://www.youtube.com/watch?v=v1E2CMGVvw](https://www.youtube.com/watch?v=v1E2CMGVvw)

[Video 2 :https://www.youtube.com/watch?v=BAk2bJeh5P8](https://www.youtube.com/watch?v=BAk2bJeh5P8)