Manual Mill

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Key Info

Model: King Canada PDM-30 Milling Machine

https://s3-us-west-2.amazonaws.com/secure.notion-static.com/56571445-1dbe-4d17-93b3-ec351e2bfe7f/PDM-30_manual-eng.pdf

Machine Info & Specs

Location: IGEN Machine Shop

Book Manual Mill Training Here!

You must complete Safety Training & Manual Mill Training to use this tool.

Introduction

This document provides important background information and safe procedures for using the manual mill. Please read it before trying to mill things, and if you're unsure of anything, don't hesitate to ask for help from a shop supervisor.

Hazards & Emergency Protocols

- Always wear safety glasses and optionally hearing protection or an apron depending on the situation

- Do not stick your hands anywhere near the spinning endmill when machining!
- Do not wear gloves, long drawstrings, necklaces, or untied hair when machining
- End Mills are sharp, handle with care
- Ensure that your stock is securely mounted before machining it

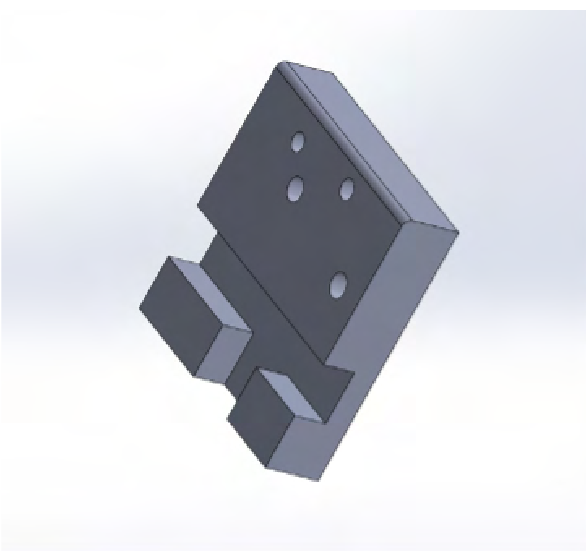
In an Emergency:

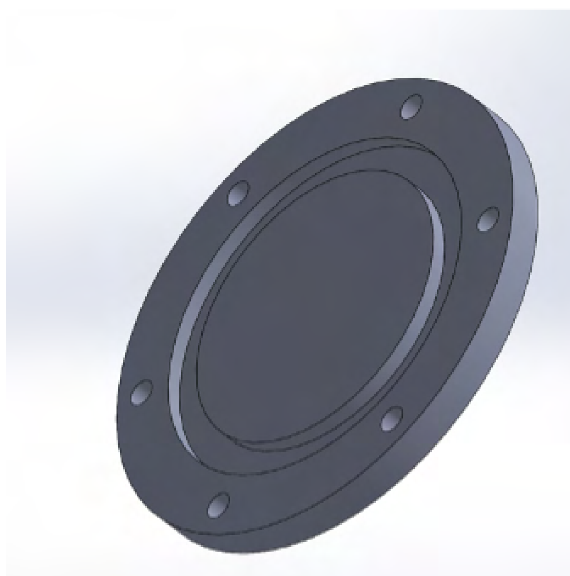
1. Call 9-1-1
2. Call Campus Security – 604-822-2222
3. Call Zach Huser (IGEN Shop Supervisor) - 778-316-3601

Designing for The Manual Mill

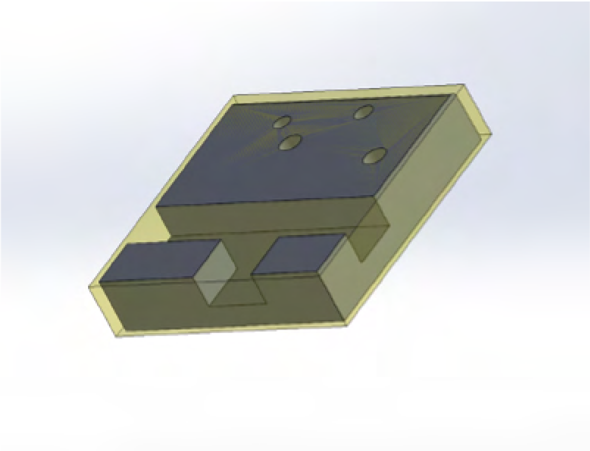
The Manual Mill can produce metal, plastic, or wood parts with simple geometry. In general, if you can fully define your part with a traditional engineering drawing it can be made on a manual mill. If your part contains exclusively rectangles and circles it should be possible to manufacture accurately on a manual mill.

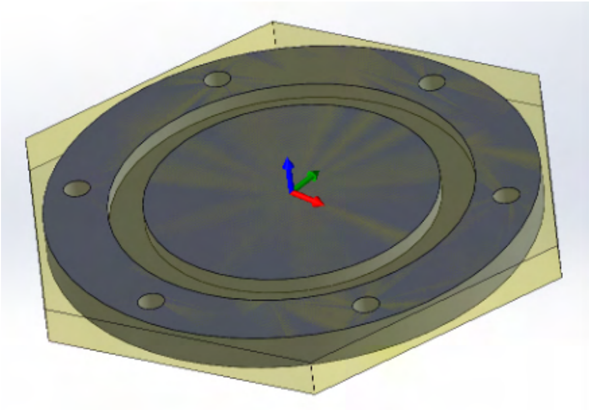
A few examples of parts that can be made on a manual mill:





The first step in designing and/or manufacturing a part on a manual mill is to determine what your piece of material you will start with will look like. Typically, it is a rectangular prism slightly larger than your part in every direction, but it could also be a cylinder or a plate or a tube or anything that contains your part within its volume.





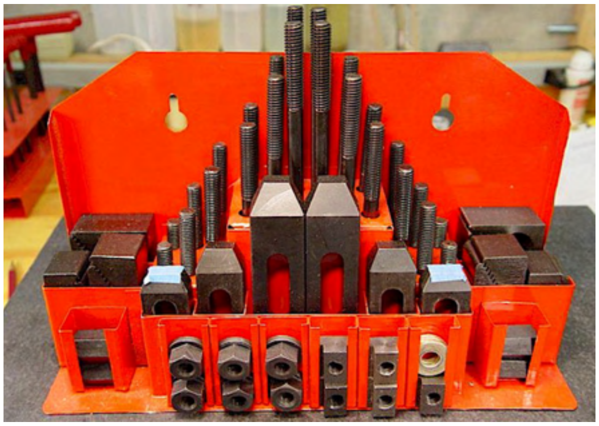
Workholding

While considering the size and shape of the piece of material you're starting out with, you also need to consider how you're going to hold it in place on the mill table while you're machining it. It must be held as securely as possible so that the large forces that are produced during machining don't move it around or make it come loose.

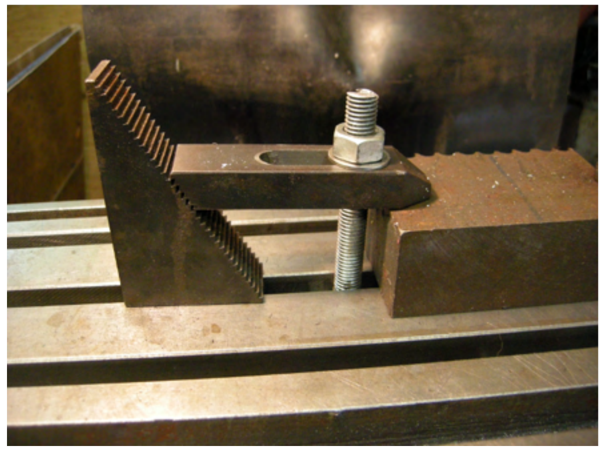
A common and effective solution is to hold your material in a vise. Materials held in the vise typically need two parallel flat faces to grab onto in order to be secure enough to machine.

Mill Mounted Vice

Another solution is clamping your material straight to the table with fastenings called Toe Clamps. This can work well with large and flat pieces of material that are too large for the vise or would be too unstable if they were only supported at either end. Usually, you want to put something underneath your material so that your material is a distance from the table surface to avoid cutting the table.



Toe Clamps in Holder



Toe Clamps on Mill

Cutting Tools

Once you have your piece of material and you have an idea to hold onto it while machining, you need to decide which cutting tools you'll use. Cutting tools used on a milling machine are typically called "End Mills". They look like drill bits but can cut sideways instead of just down. They're also usually much shorter and thicker for increased bending stiffness and strength.

Square End Mill **Ball End Mill**

There are many different types of end mills, and a quick google images search for “End Mill” produces all different types of mills of different shapes and sizes. You can usually guess what a certain end mill might be used for based on its shape or its name. We have most types of end mills that exist in igen in all different sizes. As long as your part falls within the boundaries of a manual milling machine, we will not be constrained by what tools we have and should be able to get it done.

Box of End Mills in Cabinet

When selecting end mills for steel and aluminum, the main consideration is flute count. For aluminum, you usually want to select a 2 flute end mill to reduce the chance of the end mill becoming clogged with melted aluminum while milling. A 2 flute has more space in between the flutes for chips to be carried out of the cut than a 4 flute, whose flutes do not have as much empty volume between them. For steel, which produces smaller chips which don’t clog the end mill as readily as aluminum, a 4 flute end mill can provide more strength and stiffness as well as wear life versus a 2 flute.

Setting Up The Machine

Once we have our stock material, tools, and workholding (method of holding the stock material in place on the machine table = workholding) sorted out, we need to set up the machine.

Fix your stock material in place using your chosen workholding method, which could be the vise or toe clamps directly onto the table or something else entirely. Ensure that it is secured well to avoid it coming loose and injuring you and damaging the machine, tool, and stock material.

Tool & Spindle

We will now install our tool in the spindle of the milling machine. Our machine has a R8 spindle which uses R8 collets to grip tools securely while milling.

R8 Spindle

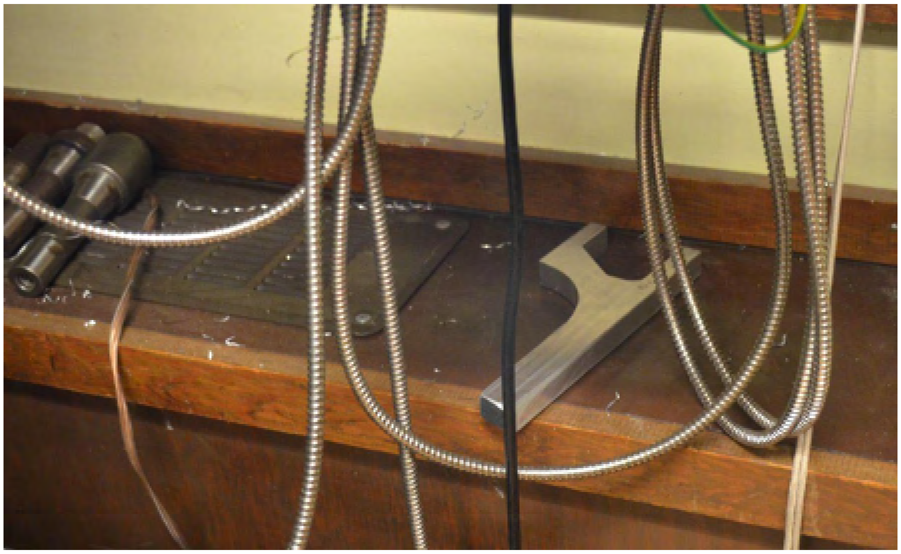
End Mill & R8 Collet in Spindle

IGEN's Collection of R8 Spindles

Other Large Tools & Drill Chuck

The spindle has a threaded rod that reaches all the way from the very top down to the collet, running through its center. This rod, called the drawbar, pulls the collet into the spindle taper and grips the tool. To change the tool, the collet must be screwed into the drawbar. If a tool is in the mill, it must be unscrewed first. To access the drawbar, lift up the top cover of the end mill. There is a stool hanging out under a table in the elec side if additional height is required.

There is a large shiny aluminum wrench hanging out near the mill that is used to grip the spindle. A normal adjustable wrench is used to turn the bar itself to the left, like unscrewing a lid. Make sure you're turning it the right direction! Once it has just come loose, give the top of the drawbar a tap with the wrench to un-stick the collet from the spindle taper while holding onto the tool. Do not unscrew the drawbar all the way before tapping it as it will be more likely to damage the threads if less of them are engaged with the collet.



Spindle Wrench

The tool may drop out or you may need to pull it gently out of the collet once it is un-stuck from the spindle. Put the tool away in its proper spot so we don't lose it.

If the tool shank is the same diameter as your desired tool, it is not necessary to fully remove the collet. You can slide in your desired tool and re tighten the drawbar. Ensure that you are gripping the end mill fully on the shaft and not on the flutes, which may damage it and hold it less securely. If you are removing and installing a different collet, ensure that you don't drop the collet when it unscrews fully from the drawbar. When installing collets, note that there's a groove in the collet that has to line up with a bump in the spindle. The collet must be rotated until it slides in.

Tightening The Drawbar

Tighten the drawbar almost as tight as you can. Once tight, close the lid of the machine and latch it. You are now good to mill!

Axes & DRO

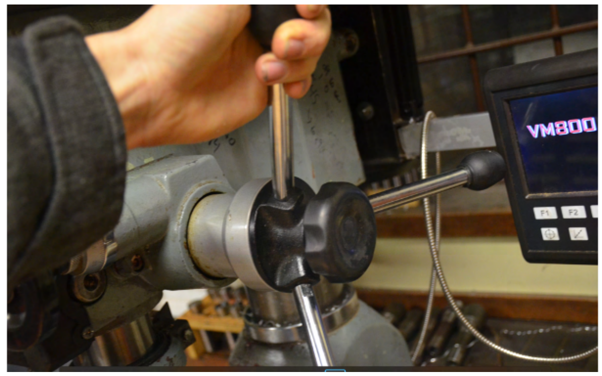
You can move the part sideways with the axis handles. Turning the handle to the left/counter clockwise "unscrews" the axis towards yourself, like unscrewing a lid. You can keep track of the position of your end mill with the Digital Readout to the right of the mill. If you would like to reset the coordinates to 0, it can be done by hitting the X0 Y0 Z0 buttons. The X axis is the side to side axis, the Y axis is the front to back axis, and the Z axis is the up and down axis. The up and down axis of this mill is less user friendly than the x and y axis, and the Digital Readout (DRO) is only accurate to maybe .010" whereas the X and Y are much more reliable.

Digital Read Out (DRO)

You can reference your CAD to determine how you should move the axis of the mill to complete your part. There are 4 little screws that ensure the axis stay tight, seen below. You want to ensure that these are snug but not fully tight while using the mill. It can be beneficial to fully tighten the screws on the axis you are not moving, locking it in place. When you want to move this axis, you can tighten the screws of the axis you finished moving and loosen slightly the screws of the axis you would like to move.

The Z axis can be moved by loosening the short handle on the left to unlock the spindle and then turning the handle on the right to move the spindle downwards. The spindle can then be locked in place by tightening the handle on the left almost as tight as you can. The spindle must be locked in place whenever you are trying to mill sideways. When drilling downwards, it is beneficial to keep the handle snug but not fully tight, so that the spindle can move downwards but is still well constrained.

Z-Axis Lock



Z-Axis Height Adjustment Handle

If you require more Z travel than the spindle can provide by moving up and down, the entire upper portion of the mill can be adjusted up and down. There are two large bolts on the back of the mill that can be loosened. The upper portion of the mill can then be adjusted up and down with the handle on the left. The bolts must be tightened almost as tight as you can before you begin using the mill. Note that the DRO coordinates are lost when you do this since the upper portion of the mill can swivel in addition to moving up and down.

Mill Height Adjustment Handle

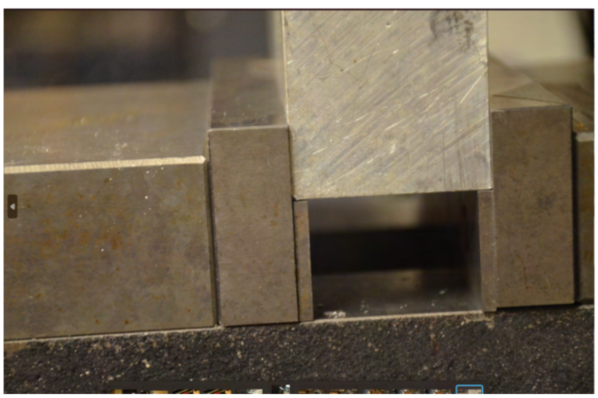
Mill Height Adjustment Screws

If you must reference the DRO coordinates relative to a feature on the part already, there are a variety of ways it can be done. We have some tools called “Edge Finders” which can locate the spindle accurately relative to the edge of a workpiece. Google can provide some videos on how to use them, a written explanation is likely less effective. https://www.youtube.com/watch?v=t2Y6xR7iCto

A less precise and quicker method is to visually line up your tool with the feature if high accuracy is not necessary.

Part Alignment

The bottom surface of your workpiece can be located parallel to the table using metal rectangles called “Parallels” which can be placed under your workpiece, on top of the vise bottom surface.

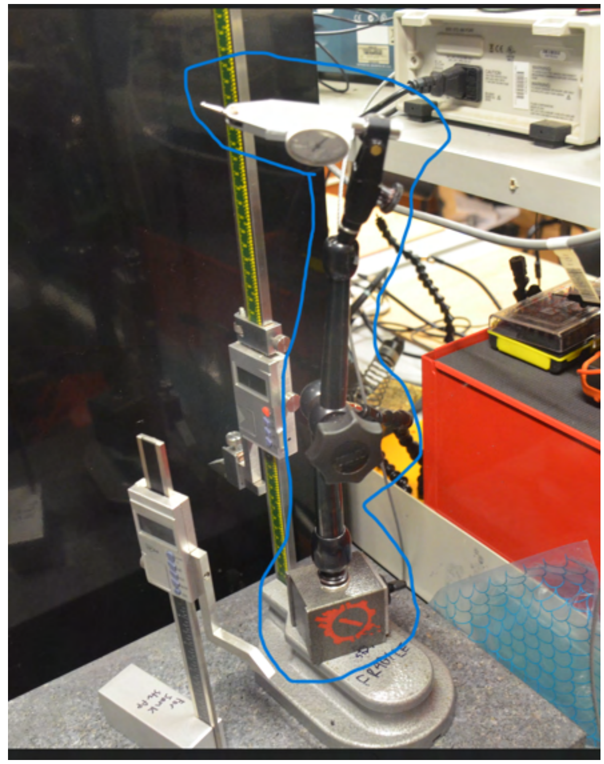


Parallels in Vice

Parallels in Cabinet

It is possible to align the back edge of the vise perfectly with the travel of the X axis using a dial indicator. As it touches the surface of the vise, it should not move as the X axis is moved. While adjusting the angle of the vice, one bolt should be tight and one should be slightly loose so that the vise can rotate around the tight bolt. When the vise is aligned, the second bolt can be tightened. Google can provide video instructions as to how to align a vise.

https://www.youtube.com/watch?v=_Un4-0SKx3Y



Dial Indicator on Magnetic Mount

Rotary Table for Mill

If you are trying to make round parts, we have a rotary table which you can fasten your stock to and produce circles or circular patterns of features using the same methods.

After Machining

After making your part, clean up the chips by putting them in the designated chip container. This gets dumped in the metal recycling by shop supervisors when full. It is acceptable to leave your tool in the machine since the next person may use the same tool and can avoid having to reinstall it. If you used the vise to hold your part, leave it in place as the next person will likely use it. If you clamped your workpiece directly to the table, replace any toe clamps or other fixturing you used and store any material you put underneath your stock back where you got it.