Basic Mill

Objective

To gain proficiency on the Mill. This lab has 2 parts, you will complete Mill or Lathe training in part 1, then complete the training you haven't done in part 2. Each part is 3 hours.

Background

When performing any kind of machining process where you are removing material the speed at which you remove that material is of utmost importance. End mills, drill-bits and other cutter-based tools are only made to withstand certain cutting conditions. As such it is critical for the life of the tool and the efficiency of the machining process that the tools are run within their working parameters.

Milling Machine

The milling machine is a machine that allows geometric shapes to be machined and created. They come in two basic formats – horizontal and vertical. The workpiece is clamped or held in a work holding device fastened to a movable table while a rotating cutter removes material from the workpiece.

Some of the key parameters of a milling machine include its table size, table travel (X, Y, Z), maximum distance from the quill to the table, the motor power, the speed range of the spindle, the method of spindle speed change (Variable, belts, gear head), power requirements, feed rate range, spindle taper, and HP. [May be better in a table]

The mills can be fitted with a variety of accessories and tools to enable them to perform a wide range of operations. Some of these include rotary tables (to mill arcs, drill bolts circle hole patterns, and perform indexing operations etc.), boring heads, tapping heads, Digital Readouts (DROs), drill chucks, vises, as well as many others.

The main variables to consider when milling are:

- The tool step over Percentage of the tool's diameter you're cutting with
- The type of material For specific properties and tool selection
- The coolant selected Specific to the type of material and tool
- Machine and work-holding Setup rigidity
- Tool Type and Material

Cutting Speed

Considering these factors, there is still a level of understanding that is required before the correct values can be found. This comes with experience, however there is a simple equation that may be used as a starting guideline for the correct rotation speed of the cutter (mill) or rotational speed of the workpiece (lathe).

RPM = $4 \times CS/Dia$.

Examples

Milling with a 1/2" endmill in steel Fly-cutting a surface on alun cemented carbide tool		luminium with a
CS (steel) =80 SFPM	CS(Aluminium)	= 600SFPM
Drill Dia. $= \frac{1}{2}$	Cutter Dia.	=3" Dia
$RPM = 4 \times CS/DIA.$	$RPM = 4 \times CS/DIA$	
$= 4 \times 80/.5$	$= 4 \ge 600/3$ "	
= 640 RPM	= 800 RPM	

Apparatus and Equipment Overview

The following components will be used in this lab:

- 1 x mill
- 1 x mill accessories
- 1 x 2x1.8x0.5in aluminium stock



Y-axis Feed Wheel

Figure 1. Vertical Mill (found in MTC)



Figure 2. Mill Head



Figure 3. Bridgeport Style Mill (found in Brunsfield)



Figure 4. Bridgeport Mill Head

Terminology

Backlash: Backlash is a term used to identify the space of no contact on a gear train when switching from reverse to forward. As a general rule the more backlash a system the harder it is to control the precision of the instrument and therefore is something to be avoided.

Chatter: Chatter occurs when the tool bit or the workpiece is vibrating during machining leaving a patterned finish rather than a smooth finish and making a loud "chattering" noise. The simplest and, usually, the most effective way to remove chatter is to make the tool clamping or piece clamping more rigid to try and mitigate vibration. Chatter is bad because the constant vibration of the tool will significantly decrease tool life as well as affect the overall precision of the work.

Coolant: Coolant is a liquid that is applied either as a light mist or a flow of liquid at the area of contact between the tool bit and the piece. It performs several functions, the primary function being to dissipate the heat generated from the cutting. Coolant also cools the workpiece and provides lubrication during cutting to reduce tool wear. Coolant is not required on all materials and the type of coolant varies depending on the material being machined. It can produce a better surface finish on some materials.

Milling Operations

Facing Cut: A facing cut is a cut with a small depth of cut in order to true up a face of the workpiece.

Boring: Boring is an internal cut that hollows out the end of the workpiece and can be a very precise cut

Drilling: Drilling is done by using drill bit held in a drill chuck inserted into the spindle of the mill.

Grooving: This type of cut leaves a groove in the part

Slotting: An endmill can be used to plunge and move in any direction creating a slot into the workpiece.

Tapping: A mill can be used to cut internal threads into a workpiece either with manual drive or a tapping head.

Pre-Lab Preparation

Before arriving in the lab, students should review the lab manual and familiarize themselves with the lab setup and procedures. Students must also watch these two videos in preparation for the lab.

https://www.youtube.com/watch?v=mbqeWWSPUzk&list=PLA-oTz8kRbrpllV-FJd7Sa6jRnBd5 Tm3c

https://www.youtube.com/watch?v=_pTbpEf2020&list=PLA-oTz8kRbrpllV-FJd7Sa6jRnBd5T m3c&index=2

Prelab Questions

Name 2 operations on a mill.

How many axes does the vertical mill have?

What is the RPM you should use for a 5/8in end mill with brass?

Coolant is used for what purpose?

What is chatter?



General Rules and Safety

- 1. Following the completion of basic training, students will be permitted to use the Brunsfield Centre's workshop, and only those whom have already completed basic training will have access. Basic training will however grant limited access to the space as students will not have access to the mill, lathe, and welding area without having completed subsequent trainings for the respective equipment.
- 2. It is important to never work alone in the shop and to always have a supervisor on duty in the space. If working alone there is no one to help in the case of an accident or injury which makes it very dangerous.
- 3. Safety glasses must always be worn within the workshop. Safety glasses must be worn even if a face shield or welding helmet is being used overtop of them. Never approach anyone actively working the workshop without wearing safety glasses.
- 4. Proper footwear must be worn when working in the workshop to avoid hazardous situations (e.g. sparks, sharp metal, hot chips from operations) where the inappropriate footwear would cause greater levels of risk/harm. Closed-toed shoes must be worn. Not flip flops, crocs, mesh-toed running shoes or and similar style or type of footwear. Steel-toed or similar footwear is recommended when working on larger, heavier projects.
- 5. Clothing that is long, baggy and/or loose must be rolled up. Strings on the front of a hoodie and hanging jewelry must be tucked under a shirt or taken off. Rings must not be worn inside of the machine shop. Long hair must also be tied back and up. These rules are in place to avoid the danger of having machinery grab and pull you into them causing severe harm.

- 6. No food or drink should be brought into the workshop. There are many chemicals, coolants and other contaminants that can be harmful if ingested.
- 7. The Brunsfield centre is a serious workspace and must be treated as one. Pranks, rough-housing, and general fooling around while within the workshop will not be tolerated. Any behavior deemed unprofessional way by a supervisor will be met with an immediate suspension of shop privileges.
- 8. All persons within the MTC and Brunsfield Centre must always be of good health both physically and mentally as well as not being under the influence of any drugs and or alcohol.
- 9. A first aid kit is located within the Brunsfield office (Room A139). Any injury severe or small should be reported to a supervisor and an incident report should be filled. In the case a supervisor is not present, contact the nearest designated first aider (a list of first aiders can be found on the main door).
- 10. An emergency spill kit is available in the Brunsfield Centre. The spill kit can be used to clean and or contain hazardous materials that get spilled in the shop. A supervisor must be advised whenever the spill kit is used.
- 11. There are fire extinguishers and emergency stops located throughout the Brunsfield Centre. There is one fire extinguisher located at each of the main entrance doors, and one near the designated welding area. There are three emergency stops located at the main entrances and in the office. Students should be familiar with the location of each fire extinguisher. If an individual is not familiar with these locations, they should request the information from a supervisor their first time in the workshop.
- 12. Students are responsible for knowing their own limited knowledge of facilities and equipment, and to ask for assistance from a supervisor when encountering any unfamiliar equipment or processes (i.e. if you're not sure: Ask). Supervisors are there to help with any matter pertaining to the workshop and would much rather taking the time to explain something many times then having someone get injured or equipment break because of improper use of the space.
- 13. Before working with unfamiliar materials and chemicals, become familiar with the product's handling procedures. MSDS (Material Safety Data Sheets) info can be obtained by using the Google search engine and typing "MSDS" followed by the product name and/or asking a supervisor to see the MSDS.
- 14. Students as well as supervisors are entitled to a safe working environment. Safety is everyone's responsibility, thus anyone witnessing any unsafe behavior or working practices must advise a supervisor immediately.
- 15. Any damaged equipment must be reported to a supervisor immediately to ensure shop safety and that the issue related to the equipment is correctly addressed. A supervisor must also be notified in the case of a broken tool to ensure that the tool was being used properly as to avoid damage of future tools.
- 16. Students are responsible for keeping the workshop clean and tidy. It is required that students clean up any work areas or machines that have been used after you have finished. The floor must be kept free of debris and tripping hazards. All tools must be put back in their proper places after use. Unplug all power tools while not in use.