

# Alpena Community College

## Bob Tosch Cad/Cam CNC

### MFG/IND Engineering

# Cad/Cam CNC

- Instructor - Robert Tosch Ext. 7421
- Objectives
  - Careers/training opportunities
  - Safety/PPE
  - Speeds & feeds
  - Precision inspection
  - Projects
- Lunch
- Shop tours
- Guest speakers

# Career Outlook CAD/CAM & CNC

- Job growth (2012-2022)
  - Source: Michigan Bureau of Labor Market Information
- CAD/Mechanical Designer = 0%
- **CNC Set-Up/Machinist = +26%**
- **CNC Programmer = +38%**
- Inspection/Quality Assurance = +15%
- Machinist = +17%
- Tool Makers = +11%
- Welders = +10%

# Skill / Knowledge for this career

- Skills

- Programming
- Complex Problem Solving
- Critical Thinking
- Equipment Monitoring
- Operation Monitoring

- Knowledge

- Mathematics
- Mechanical skills
- Design
- Engineering and Technology
- Computers

# CAD/CAM & CNC

- CAD is a valuable skill
  - Many careers require CAD skills
  - Most CAD design jobs requires a 4 year degree
- CAD/CAM is a valuable set of skills
  - CAD/CAM = Automation of machines & inspection
  - Most CAD/CAM & CNC jobs requires a 2 year degree
    - CAD – computer aided design
    - CAM – computer aided machining programming
    - CNC – computer numerical control [programming](#)
    - CMM – coordinate measurement machine programming

# CAD/CAM Careers

- Main careers areas
  - CAD design
  - Conventional machining – tool making
    - Maintenance – millwright
  - CNC machining
  - CAM programming
  - Quality control – inspection
  - Automation
    - Flexible manufacturing
  - MFG engineer

# Type of Industries

Over 120 Machining & Fabricating companies in [N. Michigan & Eastern U. P.](#)

- Aerospace & Defense
- Automotive
- Energy
- Heavy Equipment
- Medical
- Mining & Drilling
- Clean, healthy work environment

# CAD/CAM Program Layout

## 1<sup>st</sup> Semester

- Machining Processes I
- Print Interpretation
- Technical Math I
- English I\*
- Material Science

## 3<sup>rd</sup> Semester

- Machine Design
- Introduction to CNC
- Political Science\*
- Computer-Aided Machining (CAM)

## 2<sup>nd</sup> Semester

- Machining Processes II
- Technical Math II
- English II\*
- 3D Modeling

## 4<sup>th</sup> Semester

- Tool Design
- Advanced CNC
- Applied Physics\*
- CAD Elective

\*=Required for AAS Degree

# CAD/CAM

## Multiple career paths

- Up & Out
  - Supervision
  - Design
  - Programming
  - Inspection
- Transfer to  
**Engineering**  
**Automation**  
**Robotics**  
Program

# Careers in the CAD/CAM Industry

# CAD Design

- CAD operators/drafter
  - use CAD systems to prepare drawings & prints.
  - They may work for engineers, architects and other professionals in producing plans and drawings
- CAD designers
  - Check dimension of parts, materials to be used, relation of one part to another, and relation of various parts to whole structure or project.
  - Utilize knowledge of various machines, engineering practices, mathematics, building materials, and other physical sciences to complete drawings.

# CAD Design

- Tool Design
  - Designs a wide variety of tools including cutting and forming tools.
  - Works with engineering & shop personnel to resolve design problems related to material characteristics, dimensional tolerances, service requirements & manufacturing procedures
  - Draws preliminary sketches and prepares layout and detail drawings, using CAD design/drafting software.
  - Modifies tool designs according to trial or production service data to improve tool life or performance.

# CNC Machinist Operator/Programmer

- Duties vary from shop to shop
- Skills include how to:
  - Visualize a CNC program
  - Load program into machine
  - Write short manual G&M programs
  - Understand machining processes and the sequence of operations
  - Select cutting tools, adjust wear offsets
  - Make machine & tooling setups
  - Calculate speeds and feeds

# CNC Machine Programmer

- Duties vary from shop to shop
- Skills include how to:
  - All the skills of a CNC machinist
  - CAD & CAM computer skills
  - Be skilled in print reading
  - Have a good knowledge of computer programming languages and procedures
  - Be able to visualize machining processes and operations

# Quality Control Inspector

- Checks and examines machined parts to determine whether they meet specifications
- Have technical or vocational education
- Skills necessary
  - Understand and read mechanical drawings
  - Make basic mathematical calculations
  - Use micrometers, gages, comparators, and precision measuring instruments

# Job Classifications

- Technician
  - Works at level between professional engineer and machinist
  - May assist engineer with cost estimates & technical reports
- Technologist (testing)
  - Works at level between graduate engineer and technician
  - 3-4 year graduates from technical college
    - Design studies, production planning & lab experiments
  - Does the work of an engineer with out the pay

# Job Classifications - Continued

- Tool and Die maker – Highly skilled craftsperson
  - Able to make different types of dies, molds, cutting tools, jigs, and fixtures
  - Serve an apprenticeship, have above-average mechanical ability, operate all standard machines
- Engineering technologist (non Degreed)
  - Do many jobs normally performed by an engineer
  - Often employed in middle management
- Supervisor
  - Hire, train & assist new employees
  - Run the shop including most equipment
  - Deal with budgets & discipline issues

# MFG Engineer

- New Product launches
- Process improvement on existing products
- Problem solver
- Referee
- What makes a good MFG engineer
  - Hands on skills
  - Doesn't want to be tied to a desk
  - Getting a C in Calculus

# PPE

- Safety Glasses – always
  - Even in the Layout & Inspection rooms
- Clothes and Hair
- Safe Conduct in the Shop

# Speeds & Feeds

- Proper RPM & Feed rate, determine the tool life of the cutter
- RPM has the greatest affect on Tool wear
- Materials that have similar microstructure/grain structure will have similar machining characteristics
- These material are grouped together on the basis of their microstructure (hardness)

# HSS RPM Calculations

- CS = Cutting Speed
- D = Diameter of rotating part or cutter
- $$\text{RPM} = \frac{\text{CS} * 4}{D}$$
 (Practical formula)
- **Form cutters** - Threading, Necking, Reaming, Counter boring, & Counter sinking use 1/3 the RPM
- Typical Feed rates/range for lathe
  - Roughing cuts: .010 to .015 feed per rev
  - Finishing cuts : .003 to .005 feed per rev

# CS = Cutting Speed

- Based on material

**table 47.1** Lathe cutting speeds in feet and meters per minute using a high-speed steel cutting tool

Material	Turning and Boring				Threading	
	Rough Cut		Finish Cut			
	ft/min	m/min	ft/min	m/min	ft/min	m/min
Machine steel	90	27	100	30	35	11
Tool steel	70	21	90	27	30	9
Cast iron	60	18	80	24	25	8
Bronze	90	27	100	30	25	8
Aluminum	200	61	300	93	60	18

# RPM chart

- Clausing Drill press

POWERMATIC, INC. McMINNVILLE, TENN.		DRILL SPEEDS R. P. M.		
DRILL DIA.	STEEL	ALUMINUM	STAIN. STEEL	
1/16	3000	FULL SPEED	1520	
1/8	1520	FULL SPEED	760	
3/16	1020	4800	510	
1/4	760	3000	380	
5/16	610	2400	300	
3/8	510	2030	—	
7/16	440	1740	—	
1/2	380	1520	—	
9/16	340	1350	—	
5/8	300	1220	—	

CHANGE SPEED ONLY  
WHILE MACHINE IS  
RUNNING

RUN THROUGH ENTIRE  
SPEED RANGE DAILY

MODEL NO.  
1150

SERIAL NO.  
3-3463-1

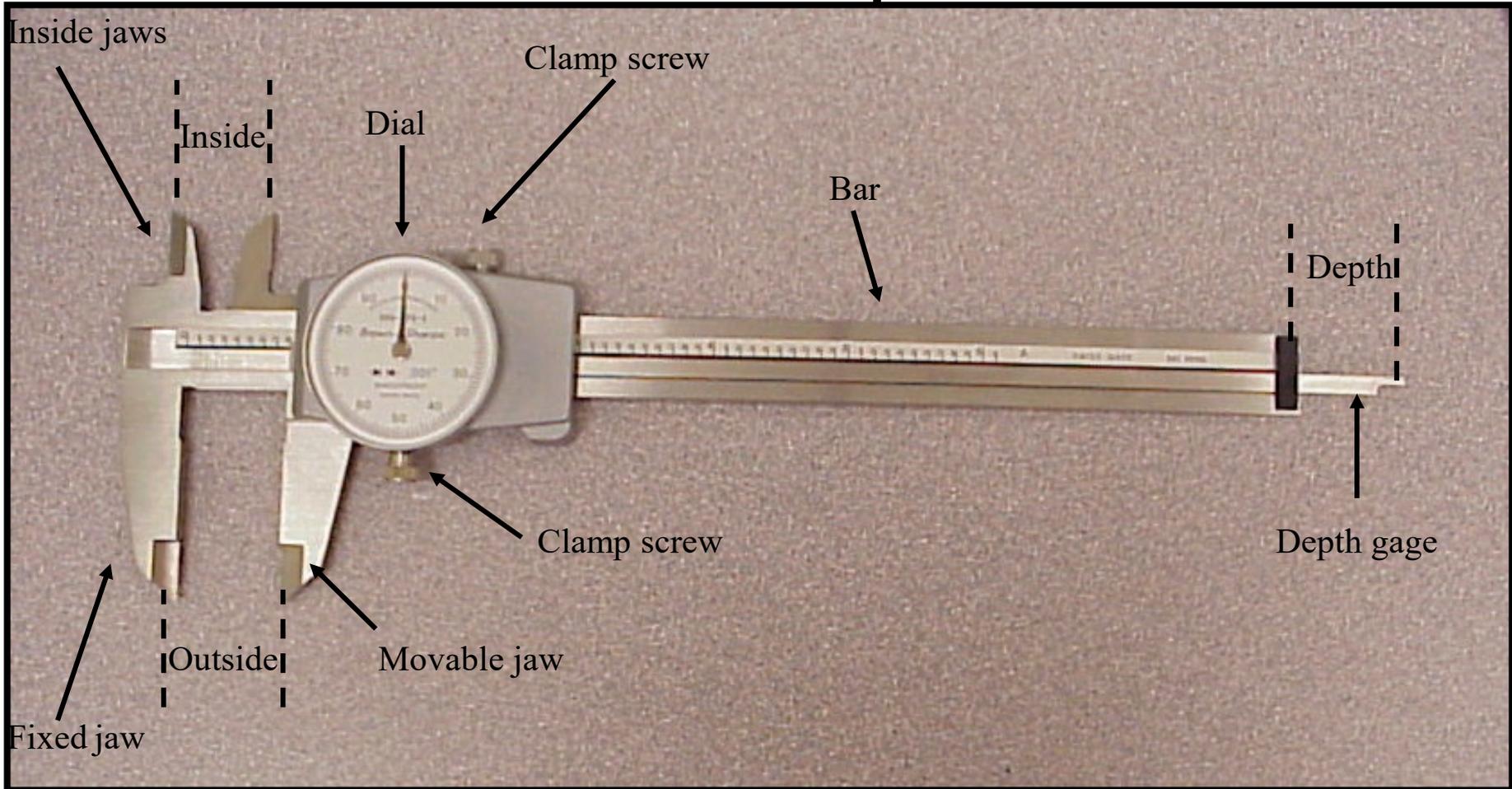
# Phone Apps

- There is a APP for that
  - Cutting tool companies have free APP's for RPM calculations using their carbide inserts

Material		Machine		Tool	
Steel - Medium Carbon (1045)		Machining Center 1		HP Face Mill	
RPM	IPT	Pass Length	Tool Diameter	Minutes	TPI / MM
400	.0092	23.5400	5.	Per Pass	Pitch (tpi)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.589	80
SFM	IPR	XY Clearance	Inserts	Total	
647	.0737	.1000	8	.589	Drill Depths
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pass Qty	Drill Chart
RPM Limit	IPM	Cut Depth	<b>Options</b>	1	Center Drills
8000	40.108	.1520	<input type="radio"/> Inch	<input type="checkbox"/>	Cap Screws
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="radio"/> Metric	HP	Hardness
Spindle %	Feed %	Cut Width	<input checked="" type="checkbox"/> Tips	16.003	Surface Finish
98	128	5.	<input checked="" type="checkbox"/> Sticky Data	MRR (ci)	Material
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Mill Radius	18.289	Threads
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Radial Feed	Efficiency	Job Planner
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<b>Decimals</b>	80	Data Specs
Reset	Reset	About MEPro	<input type="radio"/> 3 <input checked="" type="radio"/> 4 <input type="radio"/> 5	<input type="checkbox"/>	Configure
					User Guide
					Hide Quit



# Precision Inspection



**Calipers can be used to make outside, inside, and depth Measurements.**

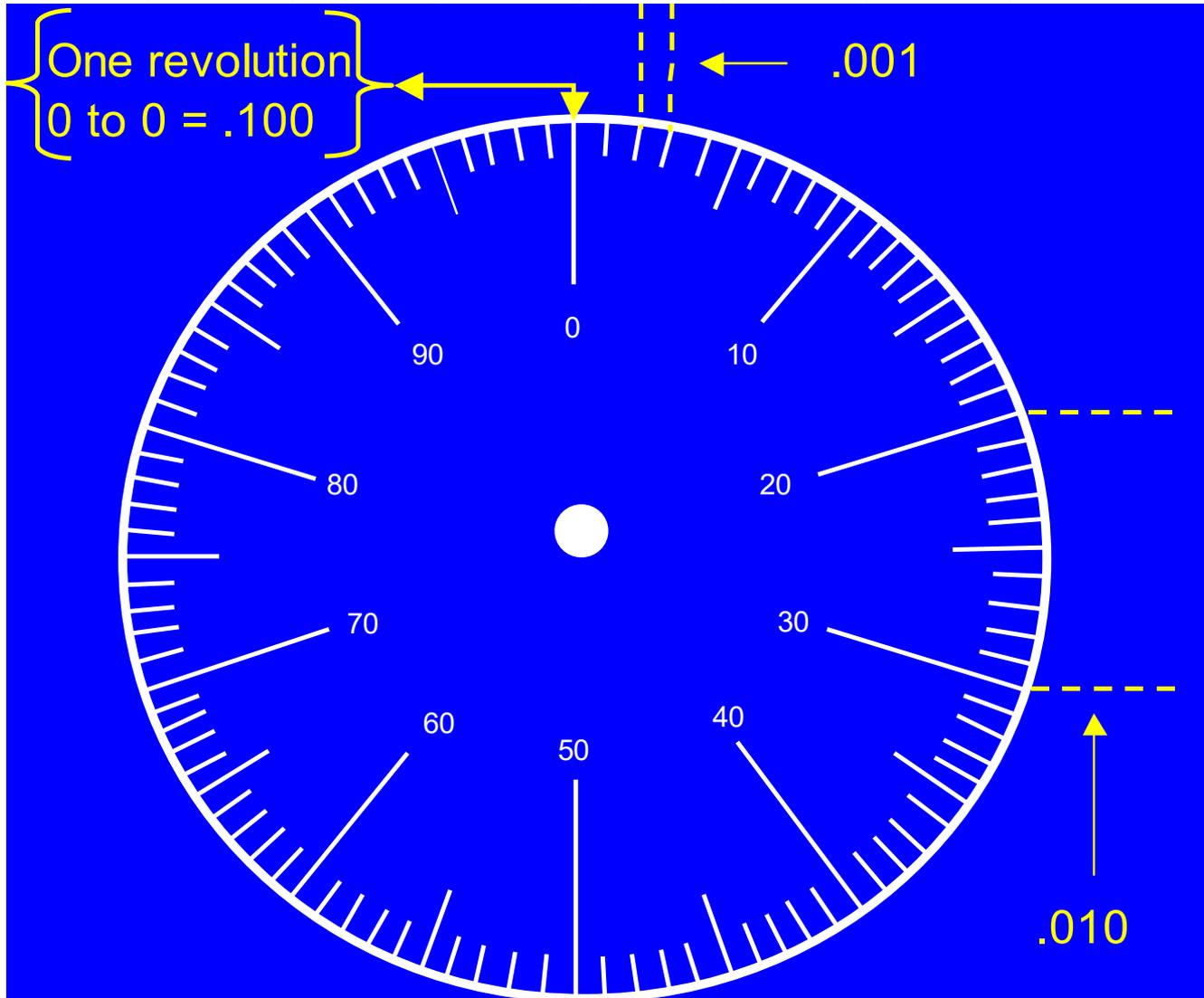
# Explanation of Caliper

- **The bar is divided in to .100 increments.**
- **The caliper dial is divided into 100 division.**
- **The reading is made by combining the division on the bar and the dial reading.**

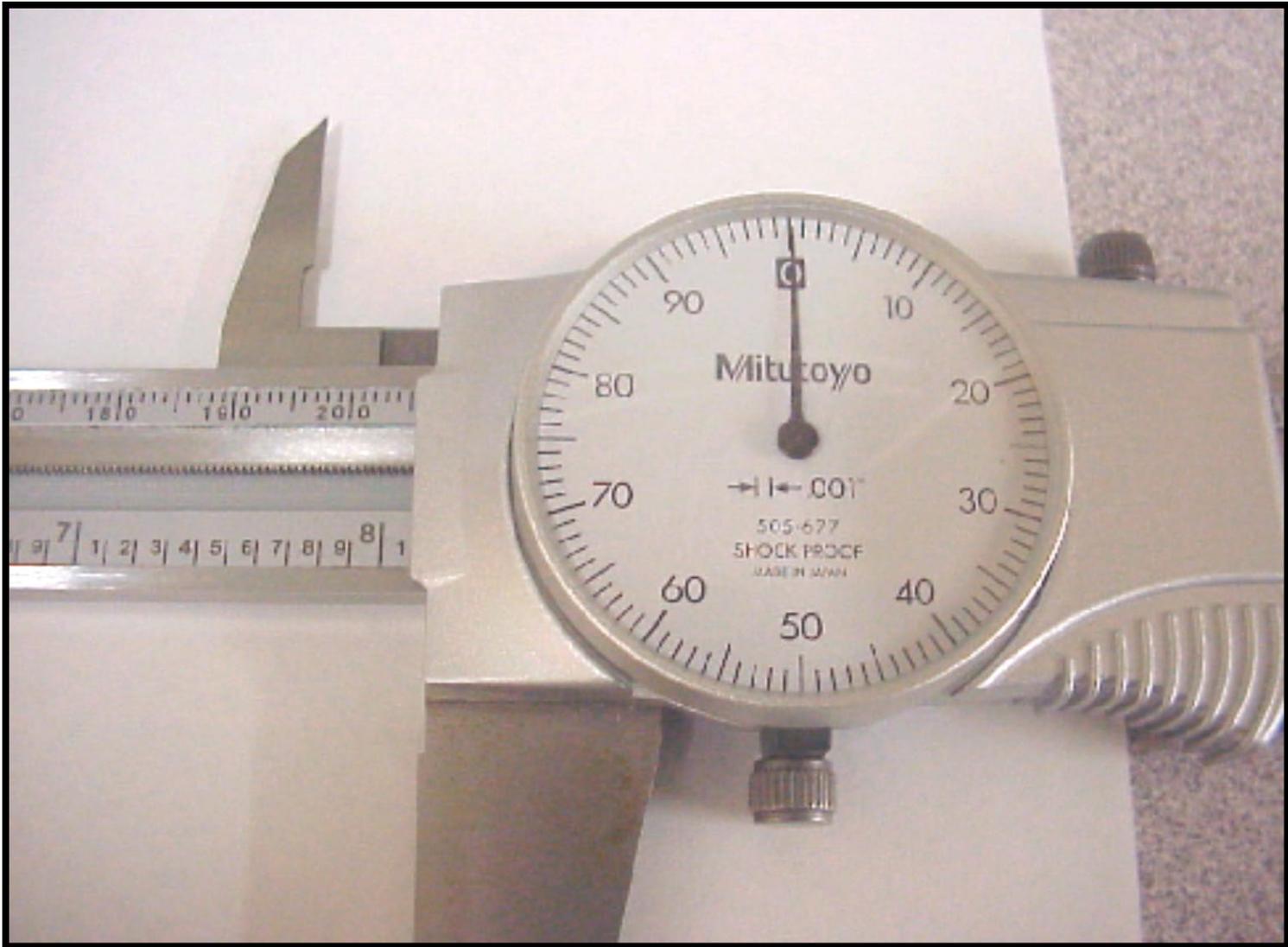
# Caliper: Continued

- **The dial hand makes one full revolution for each .100 movement.**
- **Each dial graduation, = .001 therefore represents  $.001 \times 100 = .100$**
- **Always place the calipers in their protective box after each use**

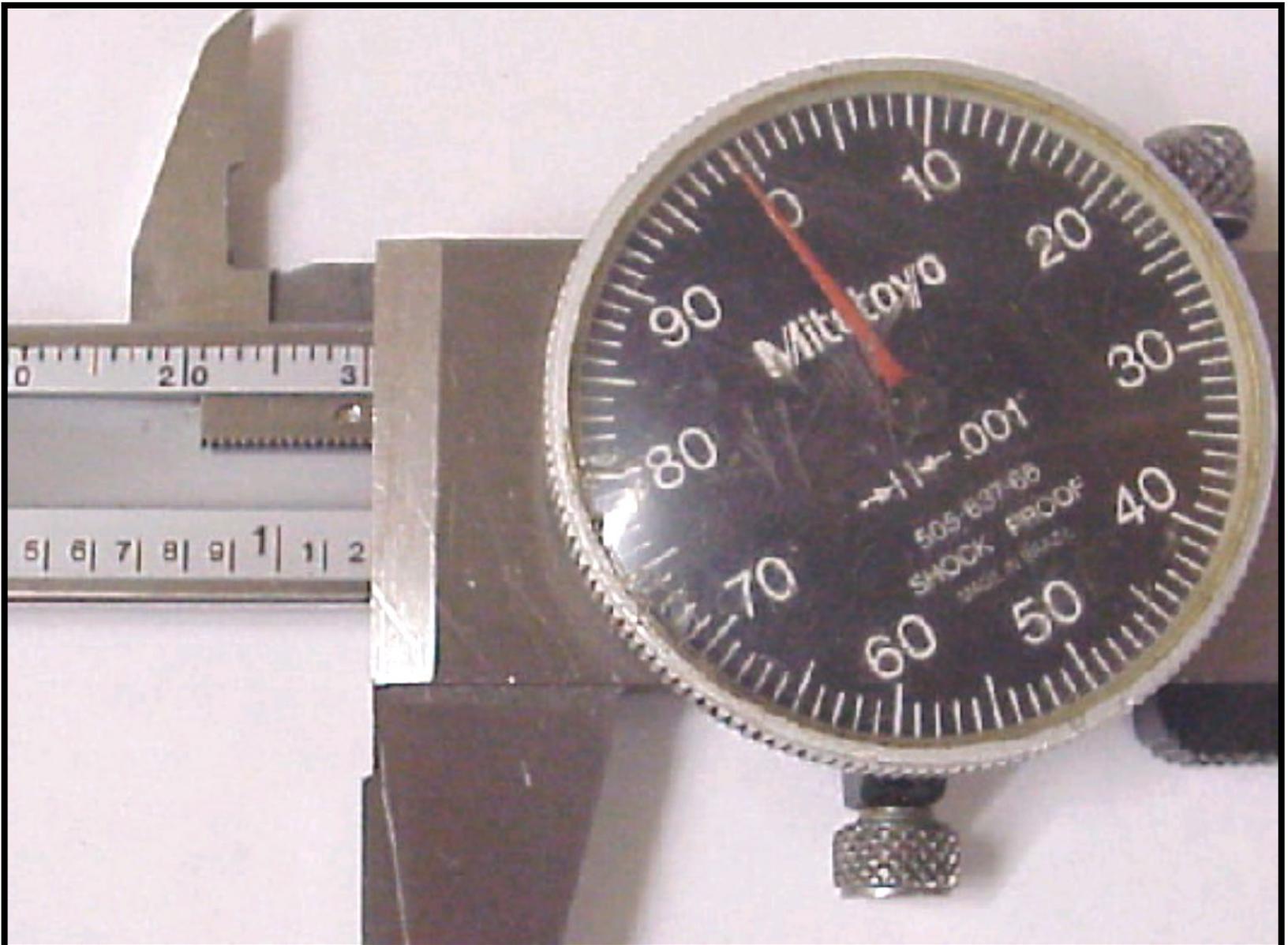
# Caliper Image



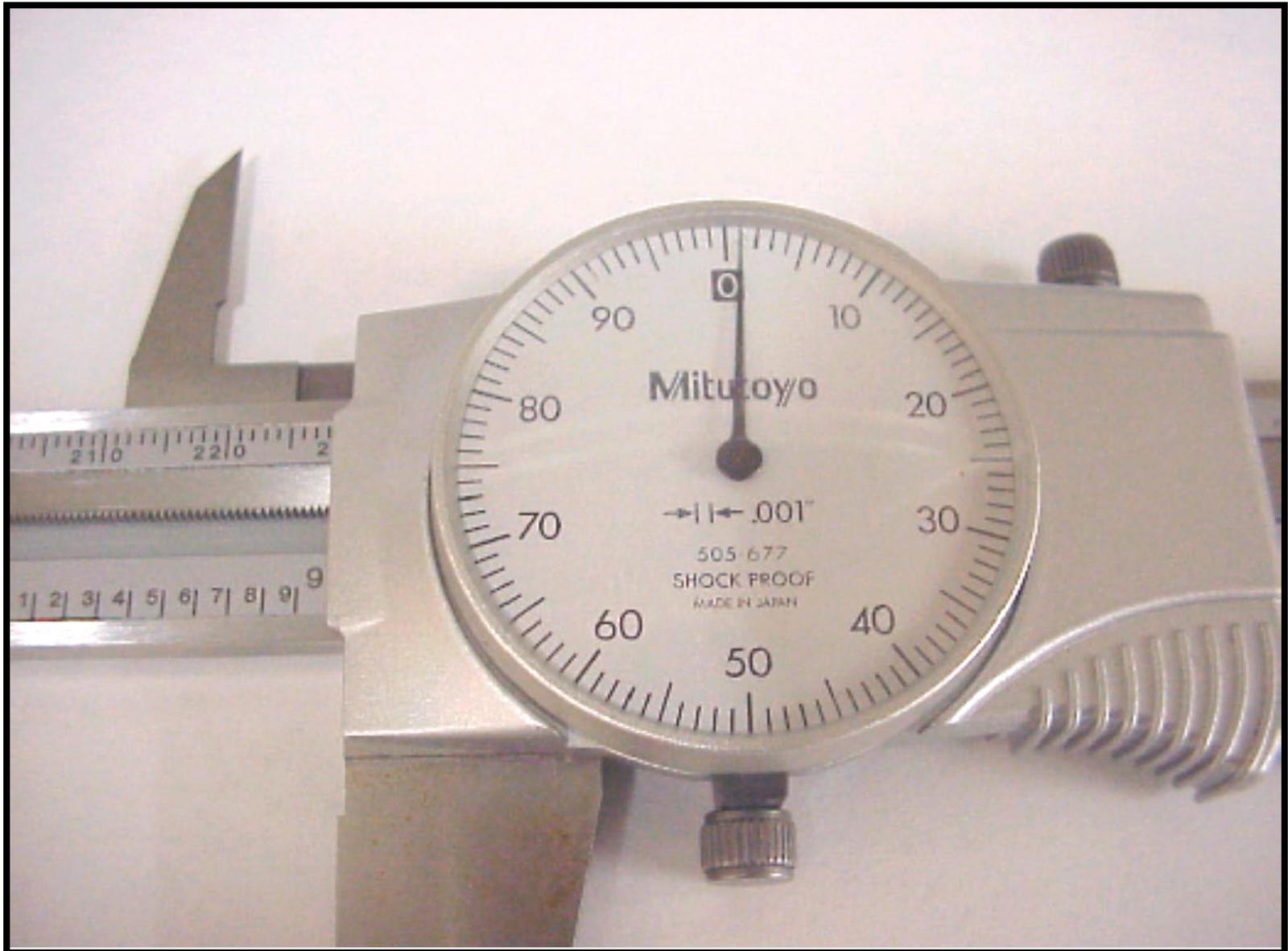
# Caliper Practice



# Caliper Practice #2



# Caliper Practice #3



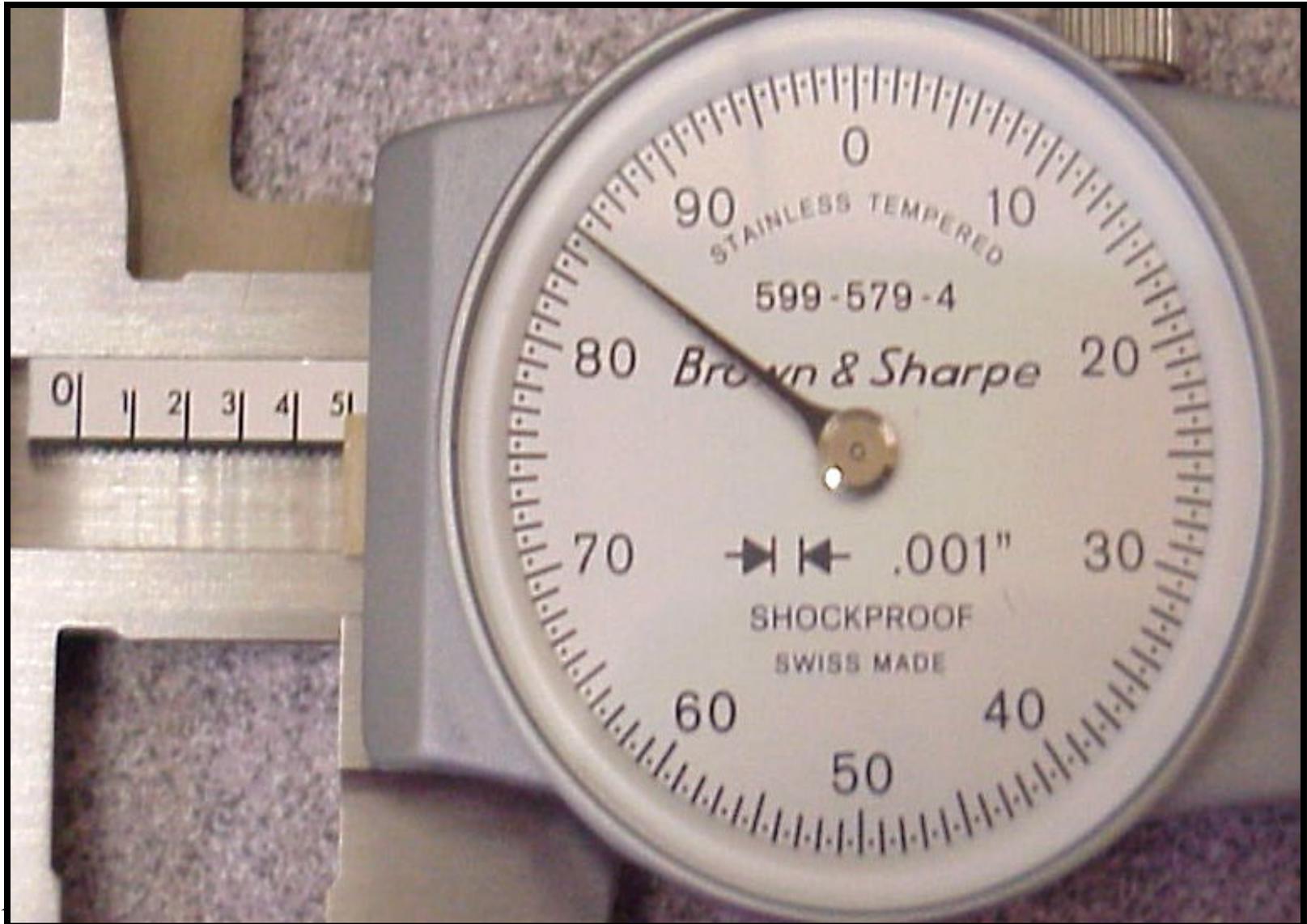
3

7/19/2021

ADV MFG D3w

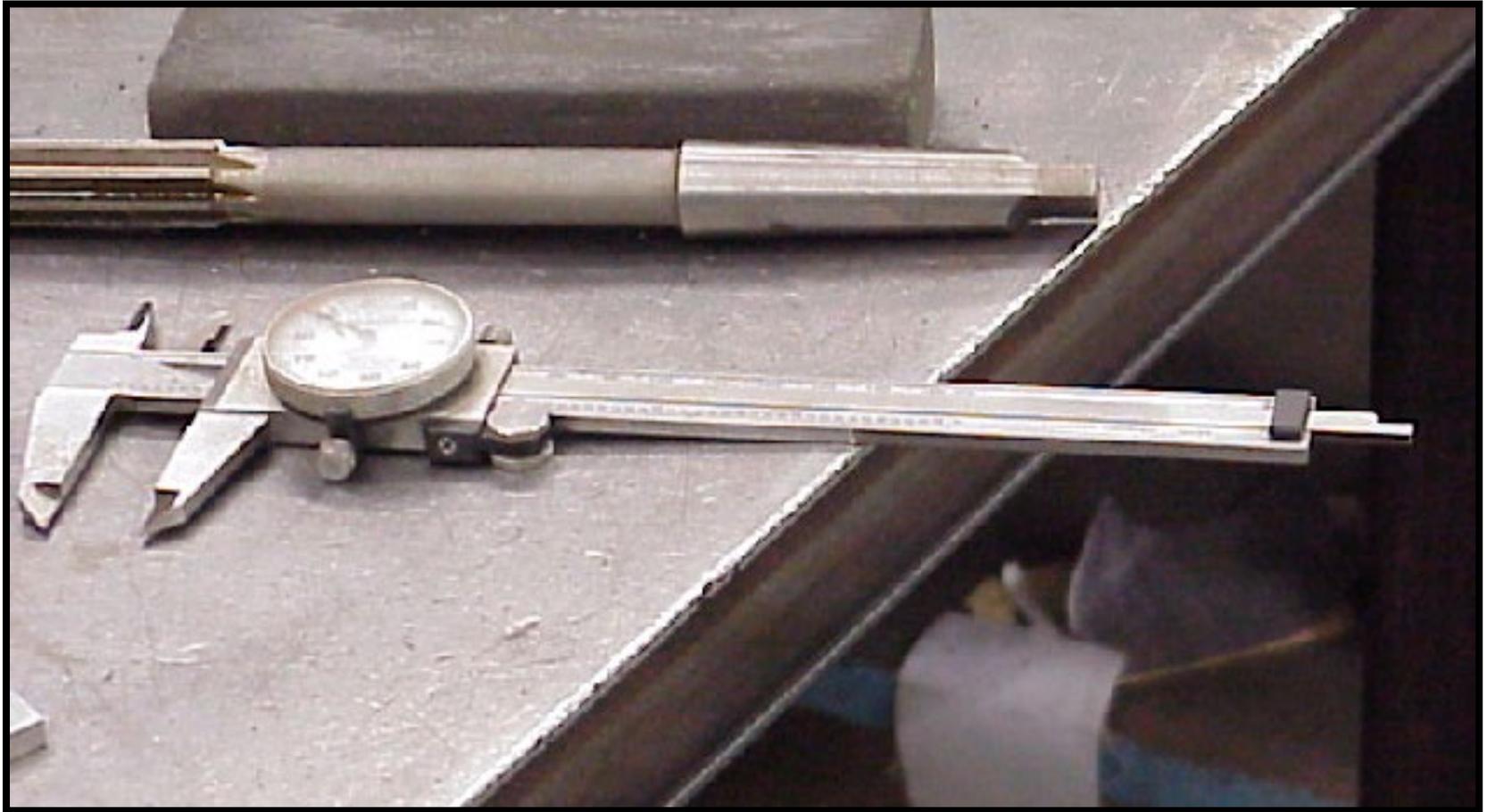
31

# Caliper Practice #4





# Caliper Safety

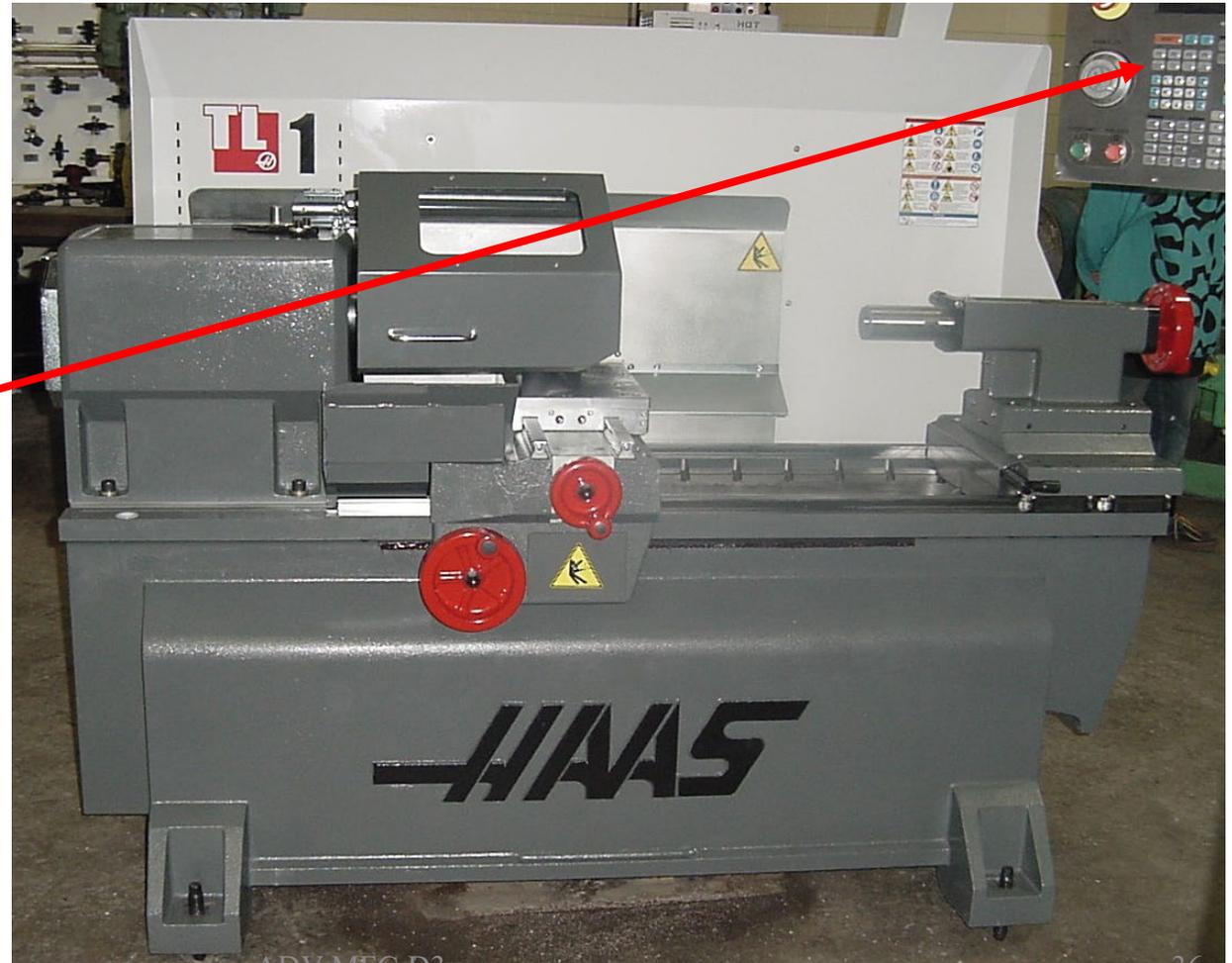


**Is this safe to the caliper?**



# Hass TL-1 CNC Lathe

- **Manual/CNC lathe**
- **Power up, make sure Tail Stock is at the far right**
- **Hold Pendant**



# Manual Mode

- Move table by hand
- Read the screen

EDIT: IPS JOG IPS

MANUAL JIP #FER & FACE FER & RADIUS L & TAP ADING AD RE-CUT /ING

MDI N00000000

S1200 M03 ;

X AND Z AXES  
THE AXES CAN BE ELECTRONICALLY LOCKED AND UNLOCKED. THIS IS SHOWN BY XZ-MAN DISPLAYED AT THE BOTTOM OF THE SCREEN. IN THIS MODE BOTH THE X AND Z AXES ARE UNLOCKED AND CAN BE POSITIONED USING THE MANUAL HAND WHEELS. PRESSING [SHIFT] AND EITHER [+X] OR [-X], [+Z], OR [-Z] WILL ELECTRONICALLY LOCK THAT AXIS. PRESSING [SHIFT] AND THE SAME BUTTON A SECOND TIME WILL UNLOCK THE AXIS.

SPINDLE  
THE SPINDLE IS COMMANDED BY ENTERING A VALUE FOR THE SPINDLE SPEED AND PRESSING EITHER THE [FWD] OR [REV] BUTTONS. THE SPINDLE SPEED OVERRIDE KEYS (+/-10% ) CAN BE USED TO ADJUST THE COMMANDED SPEED.

Use the [LEFT / RIGHT] cursor keys to navigate between tabs. Press [WRITE / ENTER] to activate mode. Press CANCEL to exit current mode

MAIN SPINDLE

SPINDLE SPEED: 0 RPM  
SPINDLE LOAD: 0.0 KW  
PROGRAM RPM: 0 RPM  
COMMANDED RPM: 0 RPM  
FEED RATE: 0.0000  
ACTIVE FEED: 0.0000

OVERRIDES  
FEED: 100%  
SPINDLE: 100%  
RAPID: 50%

SPINDLE LOAD(%)  0%

POSITION: MACHINE

(IN) LOAD

X -1.3490  0%

Z -3.0755  0%

ACTIVE TOOL

TOOL 1 OFFSET 1  
LOAD 0 LIFE 100%

INPUT: |  |  |

# MDI (Manual Data Input)

- Answer questions
- Generate code
- Run machine

The screenshot displays a CNC control interface with the following sections:

- EDIT: MDI PROGRAM**: Shows the MDI input window with a red border containing the following G-code:
 

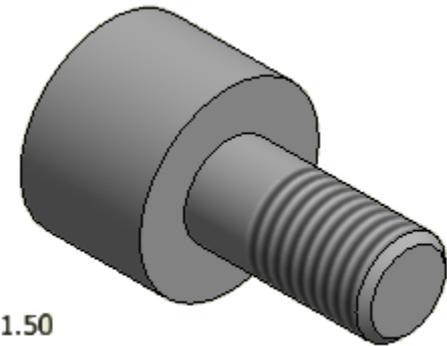
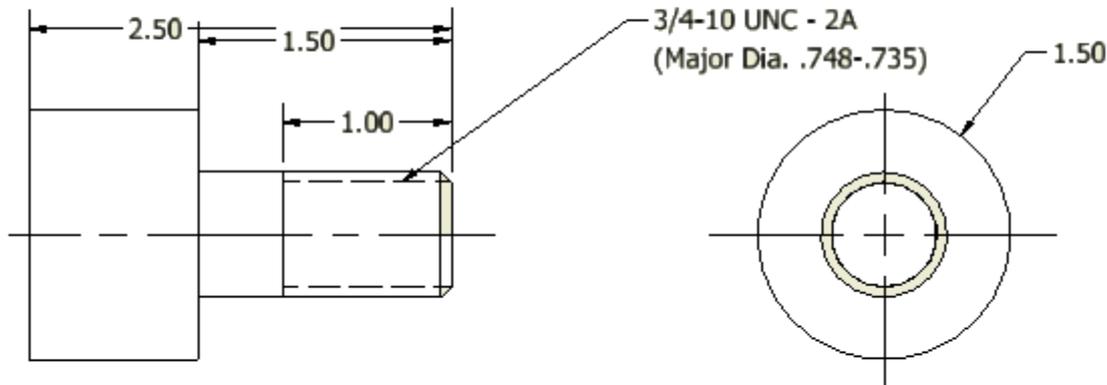
```

      (ID THREAD) ;
      T505 ;
      G54 ;
      G97 S500 M03 ;
      G00 X0.83 ;
      Z0.475 ;
      G04 P1. ;
      M09 ;
      M24 ;
      G76 X1. Z-0.9 K0.08 I0. D0.015 F0.125 ;
      G00 X0.83 Z0.475 ;
      Z5. ;
      M09 ;
      M30 ;
      ;
      
```
- THREADING**: A sub-menu with various parameters:
  - TOOL NUMBER: 5
  - MINOR: 0.8800 in
  - SPINDLE RPM: 400
  - WORK OFFSET: 54
  - MAJOR: 1.0000 in
  - TAPER: 0.0000 in
  - Z START PT: 0.1000 in
  - TPI: 8.000
  - THREAD DIR: RIGHT
  - THREAD LENGTH: 1.0000 in
  - DEPTH OF CUT: 0.0150 in
  - CHAMFER: OFF
  - COOLANT: OFF
- MAIN SPINDLE**:
  - STOP button
  - OVERRIDES: FEED: 100%, SPINDLE: 100%, RAPID: 50%
  - SPINDLE SPEED: 0 RPM
  - SPINDLE LOAD: 0.0 KW
  - PROGRAM RPM: 500 RPM
  - COMMAND RPM: 500 RPM
  - FEED RATE: 0.1250
  - ACTIVE FEED: 0.1250
  - SPINDLE LOAD(%): 0%
- POSITION: MACHINE**:
  - (IN)
  - X: -14.0589 (14% LOAD)
  - Z: -16.3623 (12% LOAD)
- ACTIVE TOOL**:
  - TOOL 5 OFFSET 5
  - LOAD 0 LIFE 100%
- Bottom Bar**:
  - INPUT: EDIT PROG
  - Lock icon
  - Home icon

Press PRGRM/CONVRS to Activate the VQC/IPS tab(s)

# Projects

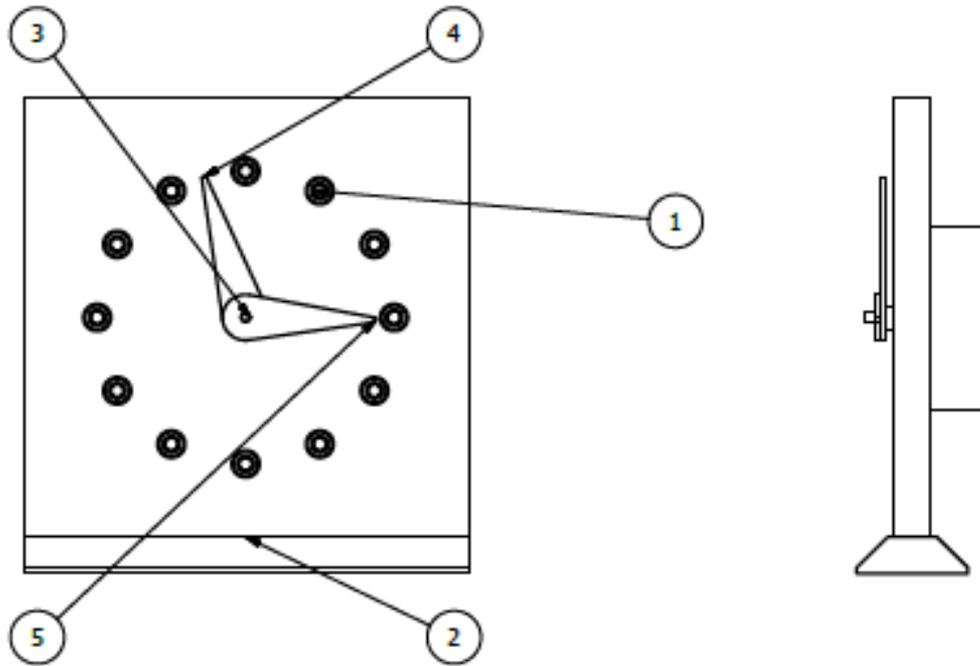
- Split in 2 groups, then switch
  - CNC lathe part
  - Cut, Mill & Drill clock
    - CNC mill/engrave face
    - Assemble clock



- 1) cut stock 2 5/8" long
- 2) load in 3 jaw chuck 1 3/4" from front of chuck jaw.
- 3) use Tool #1 to face and turn major diameter
- 4) use tool #3 to machine threads

# Clock

- Cut & prep material for CNC mill



# ACC Grant Information

“CAD/CAM CNC Powerpoint” by Bob Tosch, Building Career Pathways in the STEM Cluster: Closing the Skill Gaps in Northeast Michigan, Alpena Community College is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>.

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