CNC Programmer

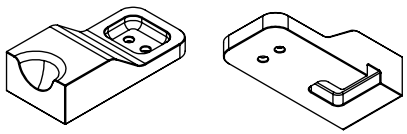
Purpose: The purpose of this competition is to evaluate each competitor's skills to independently plan and program jobs and provide instructions for 3-Axis Computer Numerical Control (CNC) milling machine and turning center operators to execute. The competition also seeks to recognize outstanding students for excellence and professionalism.

On-Site/Off-Site	▪ On-Site
Contest Date	▪ 4/9/2024
Contest Location	▪ Convention Center ▪ C-Hall
Early/Normal Start Time	▪ Normal Start Time ▪ Registration will open at 8:00am. Please report to B-Hall Show Office for Registration. Competition will begin at 10:00am.
Contest Open/Closed	▪ Open ▪ Exhibit Halls do not open to observers until 12:00pm.
Eligibility	▪ **This contest has a Regional Qualifier Contest.** The top three (3) candidates from the Regional Qualifiers will proceed to the State Championship Contest.
Competition Clothing (To be worn on Day 1)	Work/School Attire: ▪ Field specific work clothing required for the work environment or that matches the service conditions for the contest. ▪ This may include jeans if they are clean and professional looking and are accepted in the respective field (no holes or overly soiled pants). ▪ Shoes or work boots with a hard sole and anti-slip properties. ▪ Clothing should be as such that it will not get caught in moving equipment or power tools.

	▪ Professional attire worn in the classroom (school uniforms) such as a criminal justice uniform, chef attire, health scrubs, or cosmetology scrubs etc. may be worn if they meet the above requirements. ▪ Note: School identifiers and contestant names must be covered.
Safety Equipment Required	▪ N/A
Awards Ceremony Attire **(To be worn on Day 2)**	SkillsUSA Official Attire: ▪ Official SkillsUSA red blazer ▪ Button-up, collared, white dress shirt (accompanied by a plain, solid black tie or SkillsUSA black tie), or white shirt (collarless or small-collared), with any collar not to extend into the lapel area of the blazer ▪ Black dress slacks or black dress skirt (knee-length at minimum) ▪ Black closed-toe dress shoes ▪ Note: Wearing socks or hose is no longer required. If worn, socks must be black dress socks, and hose must be either black or skin-tone and seamless/nonpattern Or, Business Dress: ▪ Blazer, sports coat, or dress ▪ Button-up, collared, white dress shirt (accompanied by a plain, solid black tie or SkillsUSA black tie), or white shirt (collarless or small-collared), with any collar not to extend into the lapel area of the blazer ▪ Dress slacks or dress skirt (knee-length at minimum) ▪ Closed-toe dress shoes ▪ Note: Wearing socks or hose is no longer required. If worn, socks must be black dress socks, and hose must be either black or skin-tone and seamless/nonpattern
Testing	▪ **NOTE: There are two parts to this contest. Part one will be completed at your facility. All information including prints this year was made available prior to the contest. This was to allow the contestant to complete the required programming and be familiar with the new Format prior to the day of**

	competition. A flash drive with all required information MUST BE turned in the morning prior to the contest. ▪ **Part Two: Day of Contest will be additional skills test to perform.** ▪ Students should be prepared to take a written knowledge test. ▪ Students should prepare to take a Validation Programming test which will require the use of one of the following options. Mastercam, Fusion 360, Haas Controller, or Notepad or text editor that can be saved to a Flash Drive. ▪ Student should prepare to Measure some features on a part provided. ▪ Presentation for the Milling portion should contain the actual Machined Part, Actual NC Program ran on Machine for Mill & Turning, Cam Program and a Process Plan for both Mill and Turning.
Provided by Contestant (Tool List)	▪ Contestants will be required to bring their own Laptop, or computer with access to Mastercam or Fusion 360. Computer should contain a text editor i.e., Notepad or Word Pad. Free Mastercam and Fusion 360 can be provided on the Contestants standalone Computer. See Competitor Resourse Document to free access to Mastercam or Fusion 360. If you would like to bring your own Haas Simulator for an option you can. ▪ (Required) Pen or pencil for notes, or written calculations ▪ (Optional) Basic calculator ▪ (Required) – Contestant should bring a FlashDrive that contains the Actual Cam Program used for both Milling & Turning programming, All actual NC Programs, all actual Setup Sheets and all Process Plans must be in a Digital format and placed on the Flashdrive. ▪ Contestant should plan to provide actual machined part from the Milling Protion of the contest. ▪ Contestant **does not** need provide actual Turned Part. (See Special Notes) ▪ Contestants should verify that all hardware and software is in working order prior to the contest.

Contest Notes, Themes, & Deadlines	▪ For the ***Turning portion*** of the Contest the **actual** part ***will not*** need to be provided. In consideration was the size, cost and other factors that were based in this decision. ▪ Be aware of the Competitor Document software that was provided for the contestants for Skills. Be sure that the software license is working prior to the contest.
Special Notes	▪ Starting in 2024, all State Contests will begin to add a scenario-based component. ▪ Contact with Contest Coordinators is prohibited. Contact with Contest Coordinators outside of the SkillsUSA Ohio office may result in contestant disqualification. ▪ All safety requirements will be heavily enforced. Violation may result in contestant disqualification. ▪ No smart watches and/or phones are permitted during the contest and/or in contest. ▪ No contact with anyone outside of the contest area once the contest begins. ▪ No inappropriate communication between contestants such as verbally degrading another contest. ▪ No cheating on any portion of the contest such as informing another contestant of the skills/test prior to competing. ▪ Starting in 2024, Wi-Fi is provided for contests where it is required for contest success.
National Technical Standards	▪ Please refer to the 2023-2024 National Technical Standards for all contests. Any and all standards included may be tested in any competition. ▪ In conjunction with National Standards, violations may result in student loss of contest.
Resume/Interview Requirement	▪ All SkillsUSA Ohio State Championship Contests will require a short interview component. Students should be prepared with basic job interview skills. ▪ All contestants must have a hard copy of a one (1) page personal resume.



ISOMETRIC VIEWS

SECTION A–A

DETAIL B
SCALE 1 : 1

DIMS IN INCHES BREAK EDGES 0.015
LATHE FINISH 63 uINCH MILL FINISH 125 uINCH
90° CSINK TAPPED HOLES 0.016R OVER MAJOR∅
TOLERANCES– UNLESS OTHERWISE SPECIFIED
X/X ±0.06 X.X ±0.06 X.XX ±0.02 X.XXX ±0.005
ANGLES ±1° X.XXX DIAMETERS ◎ 0.005 TIR
X.XXXDIA & SURFACES // & ⊥ 0.001 INCH/INCH

Skills USA

HAAS AUTOMATION, INC.

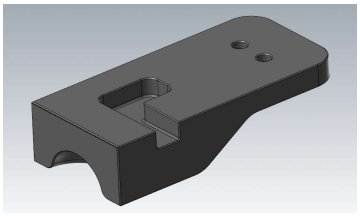
APPROVALS	DATE
DRAWN REID NOFER	12–11–23
CHECKED	
ENGINEER	

MILLING STATE COMPETITION

MATERIAL	FINISH	SIZE	SCALE	DWG	REV
6061–T6	NONE	A	1:2	2024–3	

SkillsUSA 2023 Process Plan_3X Milling_State

Part Name: Mill State Competitoin	DRW:	Rev: B	Student Name:	Date:



Program # O20001	
Operation: First	
WCS: G54	
WCS Location:	Top center of stock
Work Holding	6" Vise
Stock	X4.00, Y2.00, Z1.25
Part location:	XY Centered, Z.020 below top of stock
Notes: Place stock centered in vise. Use parallels or step cut vise jaw to hold .25 of the stock bottom. WCS is at the top center of stock	

Tooling:

Tool #	Tool Type	Diameter	# of Flutes	Flute Length	Stickout	Holder Type	Starting Chip Load	Max SFM
1	Face Mill	2	5	n/a	n/a	CAT 40 - Shell Mill Arbor	0.0025	3000
2	Bull Endmill .06R	0.5	3	1.25	1.5"	CAT 40 - ER 32	0.003	1000
3	Spot Drill 120Deg	0.5	2	0.500"	2"	CAT 40 - ER 32	0.007	300
4	Cobalt Drill 118Deg	0.201	2	1.750"	2"	CAT 40 - ER 32	0.005	300
5	1/4-20 Tap 2.5 Lead	0.25	1	.750"	2"	CAT 40 - ER 32	0.05	150
6	Ball Endmill	0.25	3	0.5	1.5	CAT 40 - ER 32	0.002	1000
7	Bull Endmill .03R	0.25	3	0.5	1.5"	CAT 40 - ER 32	0.001	1000
8	Chamfer Mill 90Deg	0.25	4	.250"	1.5"	CAT 40 - ER 32	0.0015	1000

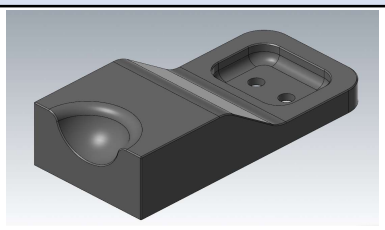
Operatoin:	Tool #	Radial DOC	Axial DOC	Notes
Face Part	1	75% Tool Dia	.175 Max/ .03 Fin	Rough and finish to model top
Rough part	2	30% Tool Dia	3X Tool Dia Max	Rough Part as needed .010 stock to leave
Finish floor and walls	2	N/A	N/A	Use wear cutter comp
Rough and Finish Slot	7	30% Tool Dia	2X Tool Dia Max	Rough and Finish Slot
Spot drill holes	3	N/A	N/A	
Drill holes	4	N/A	N/A	Peck at 2X dia, Hole depth= 3x Pitch past thread depth
Tap Holes	5	N/A	N/A	Tap full thread past print depth
Chamfer part	8	N/A	N/A	

Student notes:

Judge notes:

SkillsUSA 2023 Process Plan_3X Milling_State

Part Name: Mill State Competition	DRW:	Rev: B	Student Name:	Date:



Program # O20002	
Operation: Second	
WCS: G55	
WCS Location:	Top center of stock
Work Holding	6" Vise
Stock	X4.00, Y2.00, Z1.25 - Front Previous Op
Part location:	XYZ Centered
Notes: Place stock in vise with stock at stop on left. Use parallels or step cut vise jaw to hold 0.250 of part machined in pervious OP. WCS is at the Z parallel surface, Y against the fixed jaw, X against the stop	

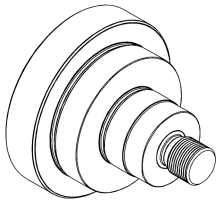
Tooling:

Tool #	Tool Type	Diameter	# of Flutes	Flute Length	Stickout	Holder Type	Starting Chip Load	Max SFM
1	Face Mill	2	5	n/a	n/a	CAT 40 - Shell Mill Arbor	0.0025	3000
2	Bull Endmill .06R	0.5	3	1.25	1.5"	CAT 40 - ER 32	0.003	1000
3	Spot Drill 120Deg	0.5	2	0.500"	2"	CAT 40 - ER 32	0.007	300
4	Cobalt Drill 118Deg	0.201	2	1.750"	2"	CAT 40 - ER 32	0.005	300
5	1/4-20 Tap 2.5 Lead	0.25	1	.750"	2"	CAT 40 - ER 32	0.05	150
6	Ball Endmill	0.25	3	0.5	1.5	CAT 40 - ER 32	0.002	1000
7	Bull Endmill .03R	0.25	3	0.5	1.5"	CAT 40 - ER 32	0.001	1000
8	Chamfer Mill 90Deg	0.25	4	.250"	1.5"	CAT 40 - ER 32	0.0015	1000

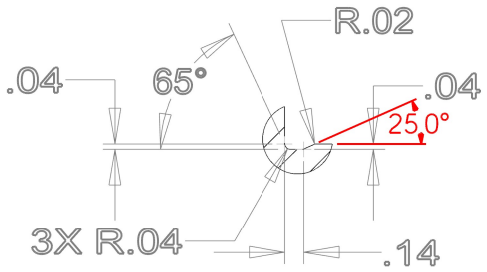
Operation:	Tool #	Radial DOC	Axial DOC	Notes
Rough part	2	30% Tool Dia	3X Tool Dia Max	Rough Part as needed, .030 stock to leave
Finish as needed	2	N/A	N/A	
Finish as needed	6	N/A	N/A	.0005 Scallop height
Rough as needed	7	30% Tool Dia	3X Tool Dia Max	5Deg Max helix angle if needed, .010 stock to leave
Finish as needed	7	N/A	N/A	
Chamfer part	8	N/A	N/A	

Student notes:

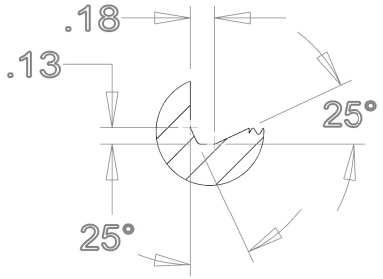
Judge notes:



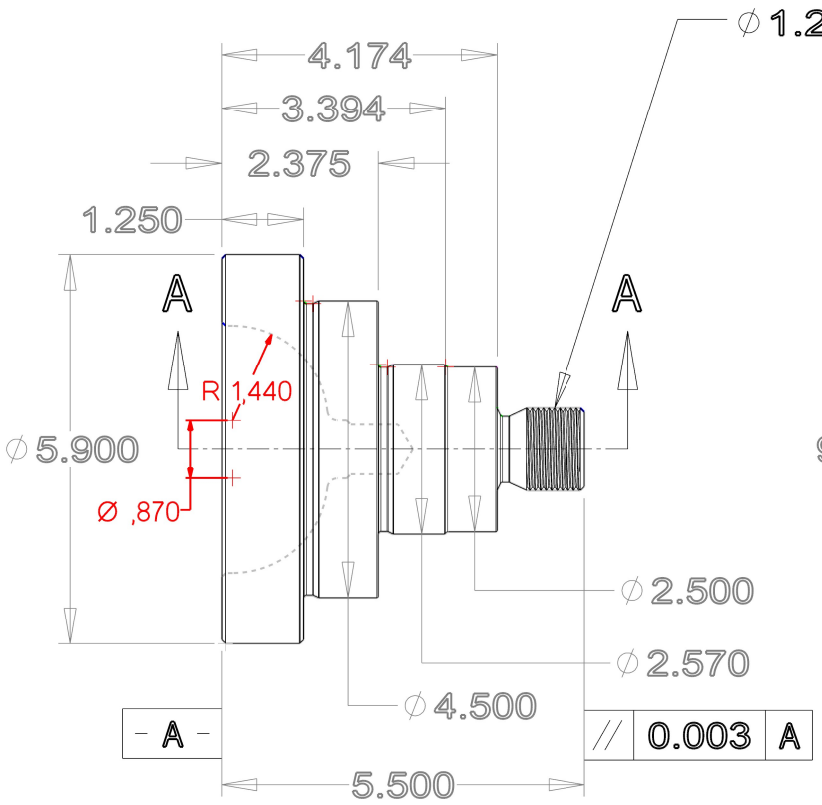
ISOMETRIC VIEW

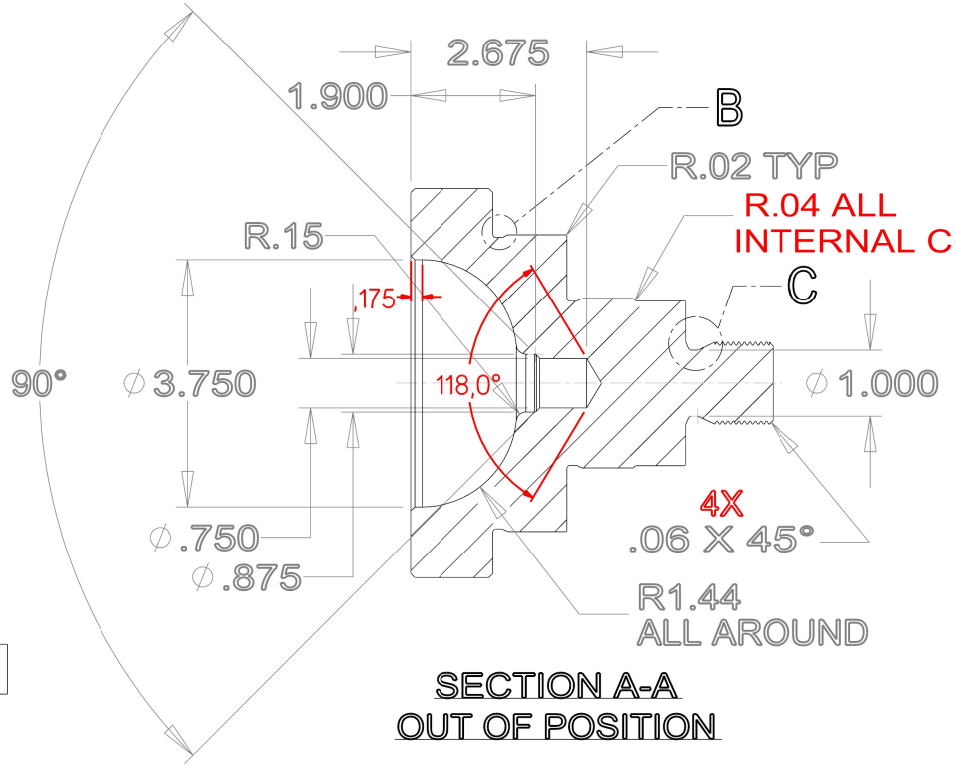


2X DETAIL B
SCALE 2 : 3



DETAIL C
SCALE 2 : 3





SECTION A-A
OUT OF POSITION

DIMS IN INCHES BREAK EDGES 0.015
LATHE FINISH 63 uINCH MILL FINISH 125 uINCH
90° CSINK TAPPED HOLES 0.016R OVER MAJOR ⌀
TOLERANCES- UNLESS OTHERWISE SPECIFIED
X/X ±0.06 X.X ±0.06 X.XX ±0.02 X.XXX ±0.005
ANGLES ±1° X.XXX DIAMETERS ◎ 0.005 TIR
X.XXXDIA & SURFACES // & ⊥ 0.001 INCH/INCH

Skills USA

HAAS AUTOMATION, INC.

TURNING STATE COMPETITION

APPROVALS	DATE
DRAWN REID NOFER	12-11-23
CHECKED	
ENGINEER	

added dimnesion

MATERIAL	FINISH	SIZE	SCALE	DWG	REV
6061-T6	NONE	A	1:2	2024-4	

1.8269 in

SkillsUSA 2024 Process Plan_Turning_State

Part Name: SkillsUSA 2024 Process Plan_Turning_State	DRW:	Rev: N/A	Student Name:	Date:

Program # O20001	
Operation: First	
WCS: G54	
WCS Location	Front face of part
Work Holding	8" 3 Jaw Chuck, with pocket cut to 6" Dia x 2.225 Deep
Stock	6 Dia, cut to 5.7"
Part location:	Centered in stock axially and radially
Notes: Finish machine part on first op to include the chamfer on the large OD in front of the jaws without cutting the jaws. CAD Model includes 3 bodies: Part, 1stOpJaws, 2ndOpJaws	

Tooling:

Tool #	Tool Type	Shank	Head Length	Overall Length	Cutting Width	Holder Type	Starting Chip Load (Rough/Finish	Max SFM
1	Haas 80Deg CNMG 432-HUM HTP15 02-0541	0.75	1.2	4.5	1	MCLP-R (-5Deg)	.012/.006	1200
2	Haas 55Deg DCGT3251-HAL HTSU10 02-0341	0.75	0.945	4.5	1	SDJC-R (-3Deg)	.010/.003	1600
3	3/4" 118Deg Drill, 3.75"LOC, 4"LBH	0.75				CAT 40 - ER 32	0.012	300
4	12TPI Threading Stick tool	0.75	1.28	5	2"	Streight Thread		500RPM
5	Haas CCGT 3251-HAL HTSU10 02-0341	0.625	1.28	6	0.406	SCLC-R, Boring (.77Min Bore)	.010/.003	1000

Operation:	Tool #	Stepover	Stock to leave	Notes
Face	1	0.05	0	.010 Finish pass at .006 chip load
Rough	1	0.065	0.01	Horizontal rough front to back.
Rest machine	2	0.025	0.01	Rest machine areas that T2 didn't reach
Finish machine	2	0.01	0	Finsih front to back.
Thread 3/4-12	4	N/A	0	5 passes, plus single spring pass

Student notes:

Judge notes:

SkillsUSA 2024 Process Plan_Turning_State

Part Name: SkillsUSA 2024 Process Plan_Turning_State	DRW:	Rev: N/A	Student Name:	Date:

Program # O20002	
Operation: Second	
WCS: G54	
WCS Location	Front face of part
Work Holding	8" 3 Jaw Chuck, with 2.57" through bore
Stock	6 Dia, cut to 5.7"
Part location:	Centered in stock axially and radially
Notes: Continue machining after first operation. Part is held by the 2.57" Diameter and stopped against the shoulder of the 4.5" Diameter. Finish machine uncut features from the first operation. CAD Model includes 3	

Tooling:

Tool #	Tool Type	Shank	Head Length	Overall Length	Cutting Width	Holder Type	Starting Chip Load (Rough/Finish	Max SFM
1	Haas 80Deg CNMG 432-HUM HTP15 02-0541	0.75	1.2	4.5	1	MCLP-R (-5Deg)	.012/.006	1200
2	Haas 55Deg DCGT3251-HAL HTSU10 02-0341	0.75	0.945	4.5	1	SDJC-R (-3Deg)	.010/.003	1600
3	3/4" 118Deg Drill, 3.75"LOC, 4"LBH	0.75				CAT 40 - ER 32	0.012	300
4	12TPI Threading Stick tool	0.75	1.28	5	2"	Streight Thread		500RPM
5	Haas CCGT 3251-HAL HTSU10 02-0341	0.625	1.28	6	0.406	SCLC-R, Boring (.77Min Bore)	.010/.003	1000

Operation:	Tool #	Stepover	Stock to leave	Notes
Face	1	0.05	0	.010 Finish pass at .006 chip load
Rough	1	0.065	0.01	Horizontal rough remaining part
Drill	3			Drill to bottom of hole. Max Peck= 25% of the tool Dia
Rough bore	5	0.05	0.005	Rough remaining ID features
Finish bore	5	0.005	0	Finish remaining ID features

Student notes:

Judge notes:

COMPETITOR RESOURCE

Haas Automation is a sponsor of the 2024 SkillsUSA CNC Machining Competitions. We are committed to providing materials for Regional and State competitions throughout the United States for the 2024 CNC Machining Competitions.

In addition, we are providing a list of resources to help prepare students to enter the CNC Machining competitions and the workforce of our industry, feeling well-equipped for success. Please see the following pages for resources or visit our website at haascnc.com.

For Regional and State level SkillsUSA testing materials, please contact the SkillsUSA State Director in your state.

About the Competition:

Haas Automation, Inc. | 2800 Sturgis Rd. Oxnard, CA 93030
Sponsor of SkillsUSA CNC Competitions
CNC Programmer | CNC 2-Axis Turning | CNC 3-Axis Milling | CNC 5-Axis Milling Programmer

Regional and State-level CNC Milling Programmer, CNC 2-Axis Turning, CNN 3-Axis Milling, and State CNC 5-Axis Milling Programmer competitions will test two major skills areas (1) a CNC theory test and (2) CAM programming and Oral Professional Development Assessment.

CNC Theory Test:

The CNC theory test is a set of multiple-choice questions closely related to the CNC subject area of focus for the competition, i.e., milling or turning. Competitors must select the best answer that applies, reading each question carefully before choosing an answer. Contestant numbers must be written on the test in the space provided on each page, or the competitor will receive 0 points.

Programming:

The programming portion of the competition will provide competitors with access to a part drawing, STEP model, and Process Plan. It is the competitor's job to use the provided documents to complete a CAM program. If run, the program would produce a machined part that is in accordance with the Process Plan, collision-free, and accurate to the part drawing provided. The drawing will be complete with multiple views making it easy for competitors to visualize the part and understand its geometry. The Process Plan will provide setup instructions, a sequence of operations, and tool data. Contestant numbers must be used as the name for the CAM file. If this step is missed, the competitor will receive 0 points. Remember, save early, save often.

Competitors will be provided with all testing documents mentioned above, but **competitors must provide the following items to compete successfully.**

- (Required) Laptop or PC with access to CAM software (Mastercam or Autodesk Fusion)
- (Required) Pen or pencil for notes or written calculations.
- (Optional) Basic calculator

NOTE: Judges have access to a Theory Test Key and Programming Score Card, which can be used to calculate the appropriate points for the SkillsUSA Regional/State Score Card.

Recommended Competitor Preparation

Set yourself up for success by committing to continuous learning. Haas Automation, and other supporting partners, offer an array of opportunities for everyone to learn about the principles of CNC machining. Get ahead by preparing yourself as a competitor before and after competitions.

Haas Certification Program

These online courses are designed to provide the basic knowledge necessary to get started as a CNC machine operator or CNC machinist. They introduce basic CNC machine operation, proper machine safety, and fundamental machining processes. For more information and to sign-up for the free online courses, visit: https://www.learn.haascnc.com

Haas Programming Workbooks

These programming workbooks provide the basic principles to program Haas Mills and Haas Lathes. Numerous exercises throughout the workbook enable users to build their skills at their own pace. Answer Books are also available. To download, visit the Haas Learning Resources webpage:
https://www.haascnc.com/myhaas/Haas_Learning_Resources.htm

Haas Video Library

The Haas Video Library gives you access to thousands of videos recorded specifically to help Haas CNC users everywhere to grow their skills and understanding of CNC machining to maximize their abilities. Access videos directly from the Haas Video Library via the Haas YouTube channel or using the Quick Picklist of the Haas Learning Resources page, which organizes a handful of entry- to advanced-level videos to help get you started. For the complete Video Library, visit:
https://www.haascnc.com/video.html Or, for the shortened Quick Picklist, visit:
https://www.haascnc.com/myhaas/Haas_Learning_Resources.html

CAM Programming Training and Software

Partners **Mastercam** and Autodesk Fusion provide access to software and video training programs. Please visit the links below for information on accessing software and training resources.

Mastercam is a proud National Partner of SkillsUSA and a member of the Technical Committee for the CNC Competitions at the Regional, State and National levels.

We are pleased to assist in providing an Educational Mastercam seat **free of charge** for any Skills Competition competitor and the instructor. If in **Ohio** Please contact Scott Harding for more information.
scotth@fastechinc.net

Be sure to utilize some of the links provided below for all software for practice and further examples.

Mastercam Learning Content: https://my.mastercam.com/hubs/learning/
Sign up for a free myMastercam account to gain access to free Courses in Core, 2D Mill, 3D Mill, Lathe, Multiaxis, and more.
Free Acoustic Amplifier Project-Based Tutorial: https://signup.mastercam.com/project-part-series-1-amplifier
Mastercam Software Access for SkillsUSA: https://www.mastercam.com/skillsusa/
Contact Email: education@mastercam.com

Autodesk is a proud National Partner of SkillsUSA and a member of the Technical Committee for the CNC Competitions at the Regional, State and National levels. Autodesk is excited to be a part of the 2024 CNC Competition and wish all competitors the best of luck!

Autodesk and SkillsUSA:
Information on how Autodesk can support you in SkillsUSA Manufacturing competitions.
https://www.autodesk.in/campaigns/education/skillsusa
**If the page doesn't load, please check back soon for updates.*

Download Autodesk Fusion:
Autodesk Fusion is an all-in-one integrated CAD/CAM/CAE software that is **free for students and educators**. Available on Mac, PC, and Chromebook.
https://www.autodesk.com/campaigns/education/fusion-360

Autodesk Fusion Learning Resources:
Extend your skills with our free courses, featuring self-paced courses, tutorials, and learning modules.
https://www.autodesk.com/certification/learn/catalog/product/Fusion%20360

If you have questions or would like additional support, please reach out to amy.shapiro@autodesk.com

Competitor Instruction:

Theory Test:

Add your contestant number in the space provided. If printed, add the contestant number on each page. For each multiple-choice question, select the best answer that applies. Be sure to read each question carefully before choosing the answer. Write neatly. Make sure your contestant number is on the test before submitting. Questions without an answer receive zero points.

Programming:

Open the STEP model in your CAM software of choice. Save the file using your contestant number in the file name. Use the provided documents (Drawing and Process Plan) to program the model using the information provided (Ex. Stock Setup, Operation Sequence, Tool Data, Feed and Speeds, and WCS). **Save OFTEN.** When done, check the entire program from start to finish, and save. The judged file should resemble a perfect program, which, if run on a machine, would produce a machined part that is accurate to the print and collision-free. Submit your completed program via USB flash drive.

Decimal Equivalent Chart .0059 – .0980

Decimal Equiv.	Drill Size	mm	Tap Sizes	Decimal Equiv.	Drill Size	mm	Tap Sizes
.0059	97	0.150		.0320	67	0.813	
.0063	96	0.160		.0330	66	0.838	
.0067	95	0.170		.0350	65	0.889	
.0071	94	0.180		.0360	64	0.914	
.0075	93	0.191		.0370	63	0.940	
.0079	92	0.201		.0380	62	0.965	
.0083	91	0.211		.0390	61	0.991	
.0087	90	0.221		.0400	60	1.016	
.0091	89	0.231		.0410	59	1.041	
.0095	88	0.241		.0420	58	1.067	
.0100	87	0.254		.0430	57	1.092	
.0105	86	0.267		.0465	56	1.181	
.0110	85	0.279		.0469	3/64	1.191	#0-80
.0115	84	0.292		.0520	55	1.321	
.0120	83	0.305		.0550	54	1.397	
.0125	82	0.318		.0595	53	1.511	#1-64 · #1-72
.0130	81	0.330		.0625	1/16	1.588	
.0135	80	0.343		.0635	52	1.613	
.0145	79	0.368		.0670	51	1.702	
.0156	1/64	0.397		.0700	50	1.778	#2-56 · #2-64
.0160	78	0.406		.0730	49	1.854	
.0180	77	0.457		.0760	48	1.930	
.0200	76	0.508		.0781	5/64	1.984	
.0210	75	0.533		.0785	47	1.994	#3-48
.0225	74	0.572		.0810	46	2.057	
.0240	73	0.610		.0820	45	2.083	#3-56
.0250	72	0.635		.0860	44	2.184	
.0260	71	0.660		.0890	43	2.261	#4-40
.0280	70	0.711		.0935	42	2.375	#4-48
.0292	69	0.742		.0938	3/32	2.381	
.0310	68	0.787		.0960	41	2.438	
.0313	1/32	0.794		.0980	40	2.489	

Tap drill sizes above based on approximately 75% full thread
Tap # Sizes #0 = .060 #1 = .073 #2 = .086 #3 = .099 #4 = .112
Tap # x .013 + .060 = Thread # OD

Decimal Equivalent Chart .0995 – .2969

Decimal Equiv.	Drill Size	mm	Tap Sizes	Decimal Equiv.	Drill Size	mm	Tap Sizes
.0995	39	2.527		.1875	3/16	4.763	#12-32
.1015	38	2.578	#5-40	.1890	12	4.801	
.1040	37	2.642	#5-44	.1910	11	4.851	
.1065	36	2.705	#6-32	.1935	10	4.915	
.1094	7/64	2.778		.1960	9	4.978	
.1100	35	2.794		.1990	8	5.055	
.1110	34	2.819		.2010	7	5.105	1/4-20
.1130	33	2.870	#6-40	.2031	13/64	5.159	
.1160	32	2.946		.2040	6	5.182	
.1200	31	3.048		.2055	5	5.220	
.1250	1/8	3.175		.2090	4	5.309	
.1285	30	3.264		.2130	3	5.410	1/4-28
.1360	29	3.454	~~#8-32 · #8-36~~	.2188	7/32	5.556	1/4-32
.1405	28	3.569		.2210	2	5.613	
.1406	9/64	3.572		.2280	1	5.791	
.1440	27	3.658		.2340	A	5.944	
.1470	26	3.734		.2344	15/64	5.953	
.1495	25	3.797	#10-24	.2380	B	6.045	
.1520	24	3.861		.2420	C	6.147	
.1540	23	3.912		.2460	D	6.248	
.1563	5/32	3.969		.2500	1/4&E	6.350	
.1570	22	3.988		.2570	F	6.528	5/16-18
.1590	21	4.039	#10-32	.2610	G	6.629	
.1610	20	4.089		.2656	17/64	6.747	
.1660	19	4.216		.2660	H	6.756	
.1695	18	4.305		.2720	I	6.909	5/16-24
.1719	11/64	4.366		.2770	J	7.036	
.1730	17	4.394		.2810	K	7.137	
.1770	16	4.496	#12-24	.2813	9/32	7.144	5/16-32
.1800	15	4.572		.2900	L	7.366	
.1820	14	4.623	#12-28	.2950	M	7.493	
.1850	13	4.699		.2969	19/64	7.541	

Tap drill sizes above based on approximately 75% full thread
Tap # Sizes #5 = .125 #6 = .138 #8 = .164 #10 = .190 #12 = .216
Tap # x .013 + .060 = Thread # OD

Decimal Equivalent Chart .3020 – 1.000

Decimal Equiv.	Drill Size	mm	Tap Sizes	Decimal Equiv.	Drill Size	mm	Tap Sizes
.3020	N	7.671		.5625	9/16	14.288	5/8-18
.3125	5/16	7.938	3/8-16	.5781	37/64	14.684	5/8-24
.3160	O	8.026		.5938	19/32	15.081	
.3230	P	8.204		.6094	39/64	15.478	11/16-12
.3281	21/64	8.334		.6250	5/8	15.875	
.3320	Q	8.433	3/8-24	.6406	41/64	16.272	11/16-20 . 11/16-24
.3390	R	8.611		.6563	21/32	16.669	3/4-10
.3438	11/32	8.731	3/8-32	.6719	43/64	17.066	
.3480	S	8.839		.6875	11/16	17.462	3/4-16
.3580	T	9.093		.7031	45/64	17.859	3/4-20
.3594	23/64	9.128		.7188	23/32	18.256	
.3680	U	9.347	7/16-14	.7344	47/64	18.653	13/16-12
.3750	3/8	9.525		.7500	3/4	19.050	13/16-16
.3770	V	9.576		.7656	49/64	19.447	13/16-20 . 7/8-9
.3860	W	9.804		.7813	25/32	19.844	
.3906	25/64	9.922	7/16-20	.7969	51/64	20.241	7/8-14
.3970	X	10.084		.8125	13/16	20.637	
.4040	Y	10.262	7/16-28	.8281	53/64	21.034	7/8-20
.4063	13/32	10.319		.8438	27/32	21.431	
.4130	Z	10.490		.8594	55/64	21.828	15/16-12
.4219	27/64	10.716	1/2-13	.8750	7/8	22.225	15/16-16 . 1.0-8
.4375	7/16	11.113		.8906	57/64	22.622	15/16-20
.4531	29/64	11.509	1/2-20	.9063	29/32	23.019	
.4688	15/32	11.906	1/2-28	.9219	59/64	23.416	1.0-12
.4844	31/64	12.303	9/16-12	.9375	15/16	23.813	
.5000	1/2	12.700	9/16-18	.9531	61/64	24.209	1.0-20
.5156	33/64	13.097	9/16-24	.9688	31/32	24.606	
.5313	17/32	13.494	5/8-11	.9844	63/64	25.003	
.5469	35/64	13.891		1.000	1	25.400	

Tap drill sizes above based on approximately 75% full thread
A decimal equivalent chart can be displayed on a Haas control by pressing the HELP/CALC button, and then selecting the Drill Table tab. Use the jog handle or cursor keys to scroll through the chart.

Mill and Lathe Formulas

Cutting Speed (surface feet/min.)
SFM = 0.262 x DIA x RPM

Revolutions Per Minute
RPM = 3.82 x SFM ÷ DIA

Feed Rate (in/min.)
IPM = FPT x T x RPM

Feed Per Revolution
FPR = IPM ÷ RPM

Feed Per Tooth (in)
FPT = IPM ÷ (RPM x T)

Metal Removal Rate
MRR = W x d x F

Converting IPR to IPM
IPM = IPR x RPM

Converting IPM to IPR
IPR = IPM ÷ RPM

Converting SFM to SMPM
SMPM = SFM x .3048

Converting IPR to MMPR
MMPR = IPR x 25.40

Distance over Time (in minutes)
L = IPM x TCm

Time Cutting over Distance (Mill) (minutes)
TCm = L ÷ IPM

Time Cutting over Distance (Mill) (seconds)
TCs = L ÷ IPM x 60

INCH METRIC CONVERSION

mm x 0.03937 = in.	in. x 25.4 = mm
m x 39.37 = in.	in. x 0.0254 = m
m x 3.2808 = ft	ft x 0.3048 = m
m x 1.0936 = yd	yd x 0.9144 = m
km x 0.621 = mi	mi x 1.6093 = km
Celsius to Fahrenheit (°C x 1.8) + 32 = °F	Fahrenheit to Celsius (°F - 32) ÷ 1.8 = °C

Drill Point Depth & Countersink Diameter Formulas

To calculate drill tip depth for a chamfer diameter,
or drill point depth for a required drilling depth:

Drill Point Angle (DPA)	Factor
60˚	0.866 x Dia. = Point Depth
82˚	0.575 x Dia. = Point Depth
90˚	0.500 x Dia. = Point Depth
118˚	0.300 x Dia. = Point Depth
120˚	0.288 x Dia. = Point Depth
135˚	0.207 x Dia. = Point Depth

Example: To calculate for a 118-degree drill tip depth, multiply the dia. by 0.3

i.e., 0.250 drill diameter x .3 = 0.075 drill tip depth