Chip Forming Operations

- Sawing
- Drilling

Milling

– Mill

- Drill press
- Mill - Lathe
- Turning - Lathe







Turning

• Rotating work, fixed tool







Turning



Turning

• Collets • Chucks • Centers 6-12 12.

Machinability

• The enemies:



Vibration (chatter)



Vibration



Vibration

- For Max Material Removal Rate:
 - Choose highest spindle RPM
 - Tune tool length to stay in a stable lobe at top spindle RPM



Vibration



Process

- Rigidity:
 - use shortest tool and tool holder
 - deflection of tool or work causes form error
 - keep workpiece firmly clamped and supported
 - avoid speed/feed/depth combos that chatter
- Heat:
 - use coated tools when heat is a problem
 - keep chips cleared (liquid or air coolant)
 - hard chips get harder
 - soft chips stick to tool
 - don't go too fast OR too slow
- Chip load:
 - keep volume removed constant!
 - especially watch tool entry, exit, corners

Doing Vertical Milling

- Select stock
 - material, dimension
- Select workholding

 usually vice or strap clamps
- Select tools & create toolpath

 FeatureCAM for CNC, by hand for manual
- Set work and tool offsets (for CNC)
- Determine feeds, speeds, and cutting depth
 - FeatureCAM helps with this for CNC

Vertical Milling



Coordinate System



Work Offsets

 Work Offsets - G54-G59 - G54 X & Y aligned with vice step jaw left front Set G54 Z to height of top of work (type number, press F1)



Offsets



Setting Work Offset

	HORK	ZERO	OFFSET							
	G COI	DE	X		Y		Z			
	G 52		0.		8.		0.			
	G 54		-18	4071	-8.	1975	6.4515			
	G 55		-10	8788	-8.	5000	8.			
	G 56		-22.	6680	-6.	8000	8.			
	6 57		-16.	3900	-2.	6200	6.0000			
	G 58		-12.	4185	-8.	0782	5.8248			
	G 59		-18.	4871	-8.	0782	5.2285			
	G154	P1	0.		0.		8.	(G110)		
	G154	P2	8.		0.		0.	(6111)		
	G154	P3	0.		0.		0.	(G112)		
	G154	P4	0.		8.		8.	(6113)		
	G154	P5	0.		8.		8.	(G114)		
	G154	P6	0.		0.		в.	(6115)		
15 500	G154	P7	8.		0.		0.	(G116)		
States 1	G154	PB	8.		8.		0.	(6117)	10	
	4154	P9	8.		0.		0.	(6118)	A 13	
The second se	1154	P18	8.		8.		8.	(6119)		1
Maria Carrana and Anna	G154	P11	8.		0.		8.	(6128)		
17 VIA 11	G154	PIZ	8.		8.		8.	(GIZI)		P
	6.154	P13	8.		8.		8.	(6122)	4 NS [] /	1
	0154	P14	8.		0.		8.	(6123)	1 1 1 1 2 2 2	
	6154	P15	8.		8.		0.	(6124)		
	6154	P16	8.		8.		8.	(6125)	24 \ 1	
	G154	P17	8.		8.		B.	(6126)	\ ∰	
	Z POS	ITION	1 : -5.	0343	HRITE	ADD/F1	SEL/OFSEL	TOCOLL		
	RAPID 587 JOGGING Y AXIS HONDLE . 8081									
										1
	The Party of						and the second s			

Tool Offsets

- Select tool #
- Jog until touch
- Press "Tool Offset Measure"
- Subtract 2.000" (-2.0 Enter)

JOOL	POSITION	GEOMETRY	HEAR	GEOMETRY	HEAR	FLUTES
1		-16.1442	0.	0.1250	0.	2
2	a contraction of	-16.7966	0.	0.1250	0.	2
3		-16.7883	0.	0.1250	0.	2
4		-12.2747	0.	0.1000	0.	2
5		-13.9795	0.	0.3750	0.	4
5		-16.2011	0.	0.2500	0.	2
7		-14.4871	0.	0.3125	0.	2
3		-14.4289	0.	0.1250	0.	2
9		-16.9389	0.	0.0625	0.	2
10		-17.0816	0.	0.0625	0.	2
11		0.	0.	0.	0.	2
12		0.	0.	0.	0.	2
13		0.	0.	0.	0.	2
14		U	0.	0.	0.	2
15		0.	0.	0.	0.	2
6		0.	0.	0.	0.	2
17		0.	0.	0.	0.	2
8		0.	0.	0.	0.	2
19		0.	0.	0.	0.	2
8		0.	0.	0.	0.	2



CNC Programming

- Example CNC program bores a center hole and drills bolt circle
- Haas manual at: k:\class\engr\480\haas\usermanual.pdf

```
2
000100
(Maxon motor bolt circle program);
(center hole 0.256R);
T3 M06;
G00 G90 G54 X0.74 Y0.63; (Get tool T3 from toolchanger);
G00 M03; (Set spindle speed at 1100 RPM and start CW);
G43 H03 Z0.3 M08; (Compensate for tool length, Set return height);
G01 Z0 F10; (drop to surface);
G12 G91 Z0.05 I0.1 K0.256 Q0.01 L3 D03 F1.0; (Bore center hole);
G00 G90 Z1. M09; (return to 1" above surface, turn off coolant);
(bolt circle - 0.374R, peck 0.05);
G70 I0.374 J60.0 L6; (0.374R, 60deg, 6 holes);
T1 M06; (Get tool T1);
G00 G90 G54 X0.74 Y0.63; (Get tool T1);
G050 M03; (Set spindle to 1050 RPM);
G43 H01 Z1. M08; (Compensate for tool len, set ret height, coolant on);
G82 G98 Z-0.05 P1. R0.1 F5.; (Execute drill cycle for each hole);
G00 G80 Z1. M09; (Return home, turn off spindle);
G28 G91 Z0 M05; (End of program);]
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64 1 66

Loading CNC Program from Floppy

- Name program with 8 or fewer letters
- Copy to a: drive
- Put in Haas
 - press List Prog, type in name, press F3

PROGRAM (LIST PROG)
Centres (as) Paul man (9991, ncl. 1)
Other (p: Pend step2 nr1 5)
Comparts (p: Sector Prototype3\sa)
ocenter (p: Sentor Project Prototupe3 sa)
General (p: Senior Project Prototupe3\b2)
opering (p: Senior Project Prototupe3/h2)
opering (p) Sector Project (Prototume 3) h2)
opening (prosenior Project Prototupe 3/ho)
one and the Sector Project (Prototime 3)ho)
conside (p. Sentor Project (Prototime 3)h2)
condition (p) Senior Project (Proto types (hz)
control (p: Senior Project (Prototypes ne)
onese the Sentor Holder Trotordepesters
contract (a) Carley Bas (and) Bas (a totam 2) (2)
on the constant of the lect of the coupes the
veries (p: vrend steps.ncl. ()
OB1220 (CO2 Pert Dett) 2 Units
OB1238 (G83 Peck Drill, Z-Hole)
OBISST (p: scal.ncl. 1)
OB2346 (C: Documents and Settings David)
Doused IL: Documents and Settings David)
000606 (p:\manu_lab\pcd2.ncl.2)
(p: Manu_lahyplatecdrill.ncl.2)
(p: Senior Project Prototype3'sa)
(the senior Project Prototype3 sa)
PROCEARS 692 FREE (786812 BYTES)
TEL TO SEND, RECV, ERASE F1 TO DUP PROC
DISK MR, F3 DISK RD, F4 DIR RD
RAPID S82

Mil I / Turn Video

