
ENGR480 MANUFACTURING SYSTEMS

Spring 2015

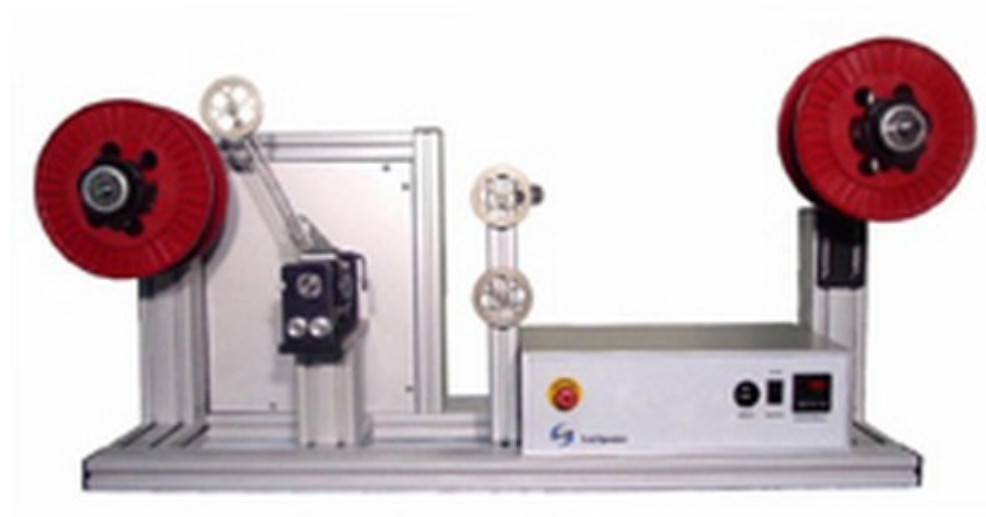
ENGR480 MANUFACTURING SYSTEMS

- Class MWF 10:00 (CSP165)
- Lab Thur 2:00 (KRH105)
- Read Syllabus for other info

THREE PROJECT CHOICES

Respooling filament

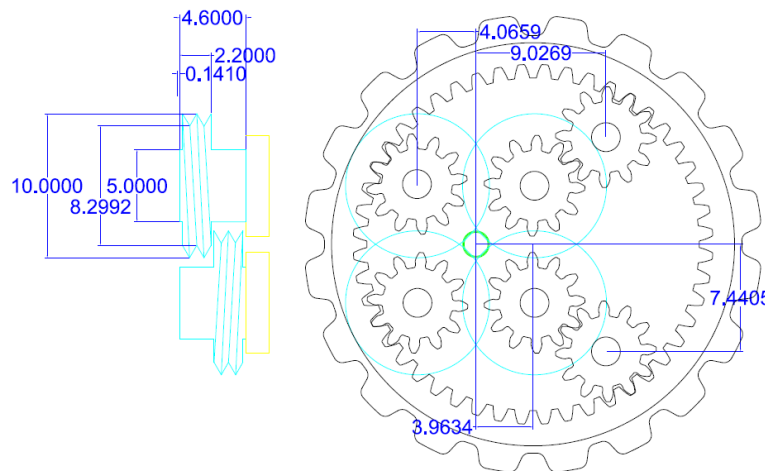
- automate the transfer of 1.75mm plastic filament from large drums to small spools, including spool changing
- spools will be a modified design for ease of feeding.



THREE PROJECT CHOICES

Assembling filament feeders

- automate the assembly of small gearboxes, consisting of a ring gear and six pinion gears, four drive screws, a base plate and a top cap.
- gears will be manufactured by casting polyurethane resin in silicone molds.



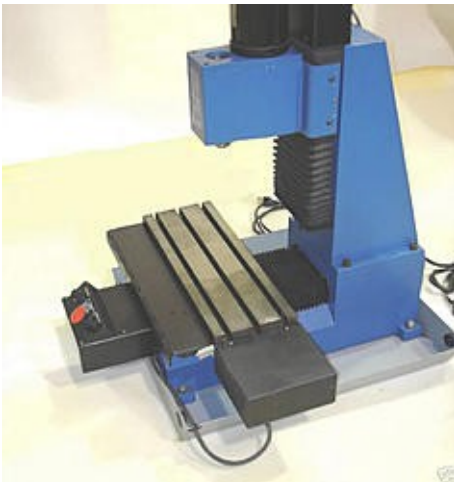
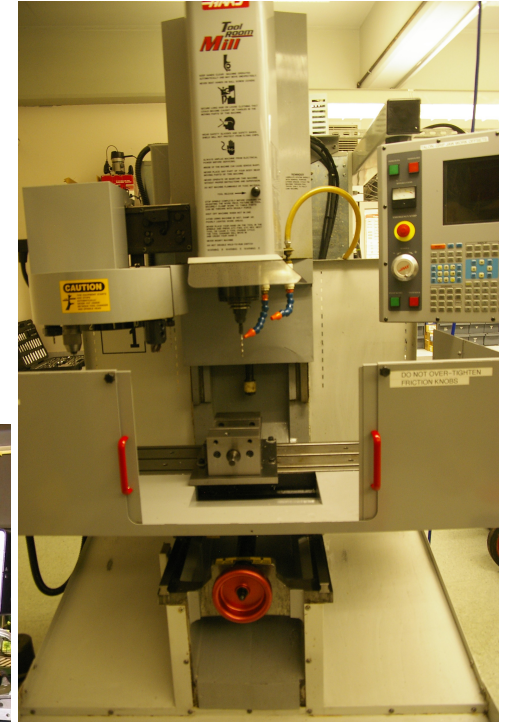
THREE PROJECT CHOICES

Assembling Gear Cases

- automate the assembly of cell phone cases that include several interlocking gears and mechanisms.
- parts will be manufactured by casting polyurethane resin in silicone molds.



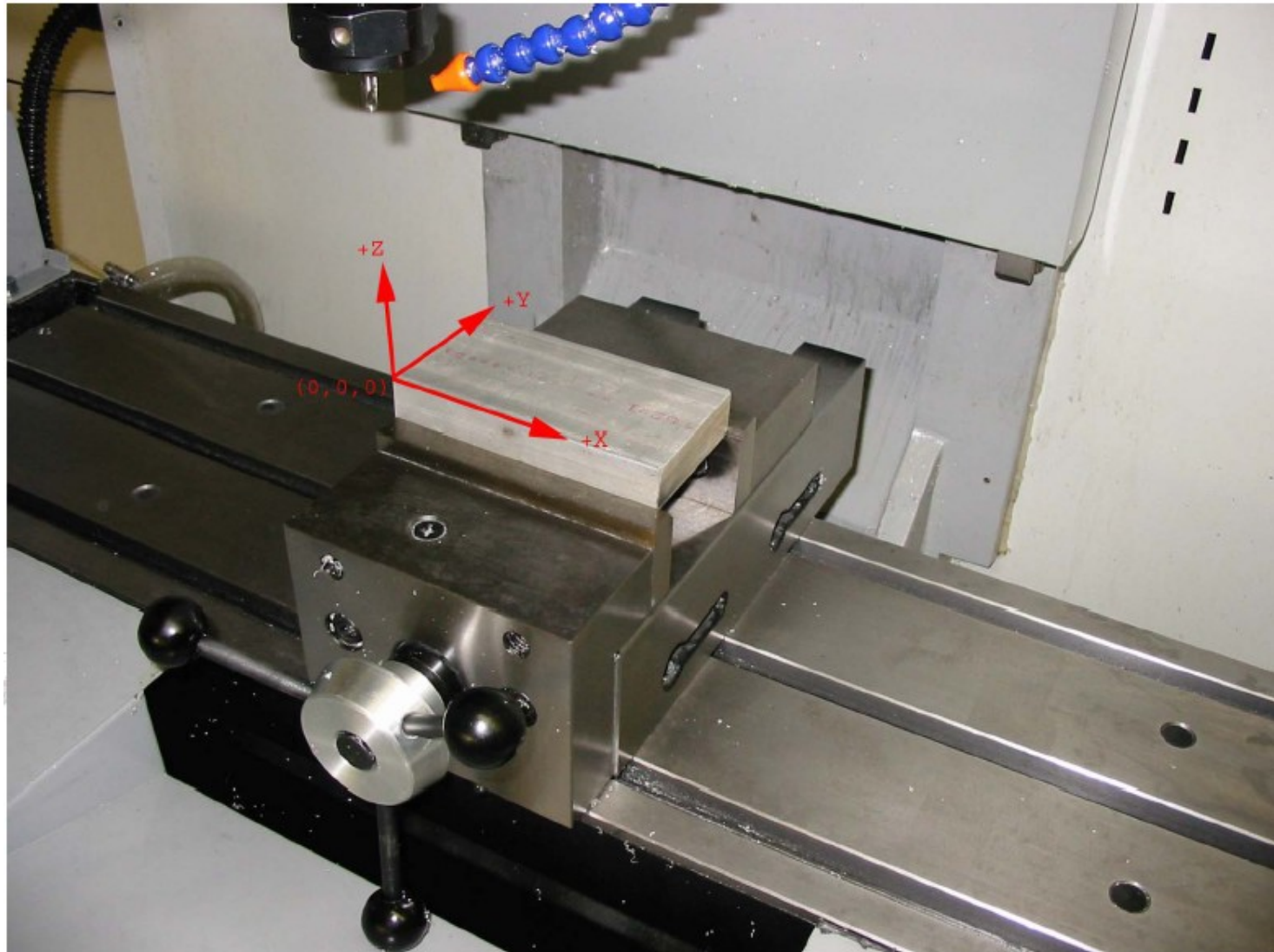
VERTICAL MILLING



DOING VERTICAL MILLING

- *Select stock*
 - material, dimension
- *Select workholding*
 - usually vice or strap clamps
- *Select tools & create toolpath*
 - Esprit, FeatureCAM, Creo or hand-edited G-code for CNC, by hand for manual
- *Set work and tool offsets (for CNC)*
- *Determine feeds, speeds, and cutting depth*
 - Esprit and FeatureCAM help with this for CNC

COORDINATE SYSTEM



EXAMPLE PROGRAM

%

O01001

(DRILL 1/4IN HOLES)

(DRILL EXAMPLE - 2013-04-05)

(OP1- TOP SIDE)

(STOCK- 2IN X 2IN X 1/4IN)

(G54 ZERO- LEFT FRONT TOP)

G54

G00 G40 G90 G17 G20

(SPOT DRILL HOLES)

T7 M6

G43 H7

S2000 M3

M8

G0 X0.50 Y0.50 Z0.1

G81 Z-0.1 R0.1 F10.; (CANNED DRILL CYCLE)

X0.50 Y1.00

X1.00 Y1.00

X1.00 Y0.50

G80 G00 Z0.1;(CANCEL CANNED CYCLE)

M9

M5

T9 M6

G43 H9

S2000 M3

M8

G0 X0.50 Y0.50 Z0.1

G83 Z-0.35 Q0.1 R0.1 F10.0

X0.50 Y1.00

X1.00 Y1.00

X1.00 Y0.50

G80 G00 Z0.1

G00 Z6.0

M9

M5

M30

%

G-CODES FOR MILLING

G00	Rapid positioning
G01	Linear interpolation (feeding)
G02	CW Circular interpolation
G03	CCW Circular interpolation
G04	Dwell
G20	Inch system
G21	Metric system
G28	Return to reference point
G43	Tool Length Compensation

G-CODES FOR MILLING

G54-G59	Select work coord system
G65	Macro call
G70	Bolt circle cycle
G81	Drill canned cycle
G83	Peck drill canned cycle
G84	Tapping canned cycle
G90	Absolute coordinates
G91	Incremental coordinates
G98	Initial point return

M-CODES FOR MILLING

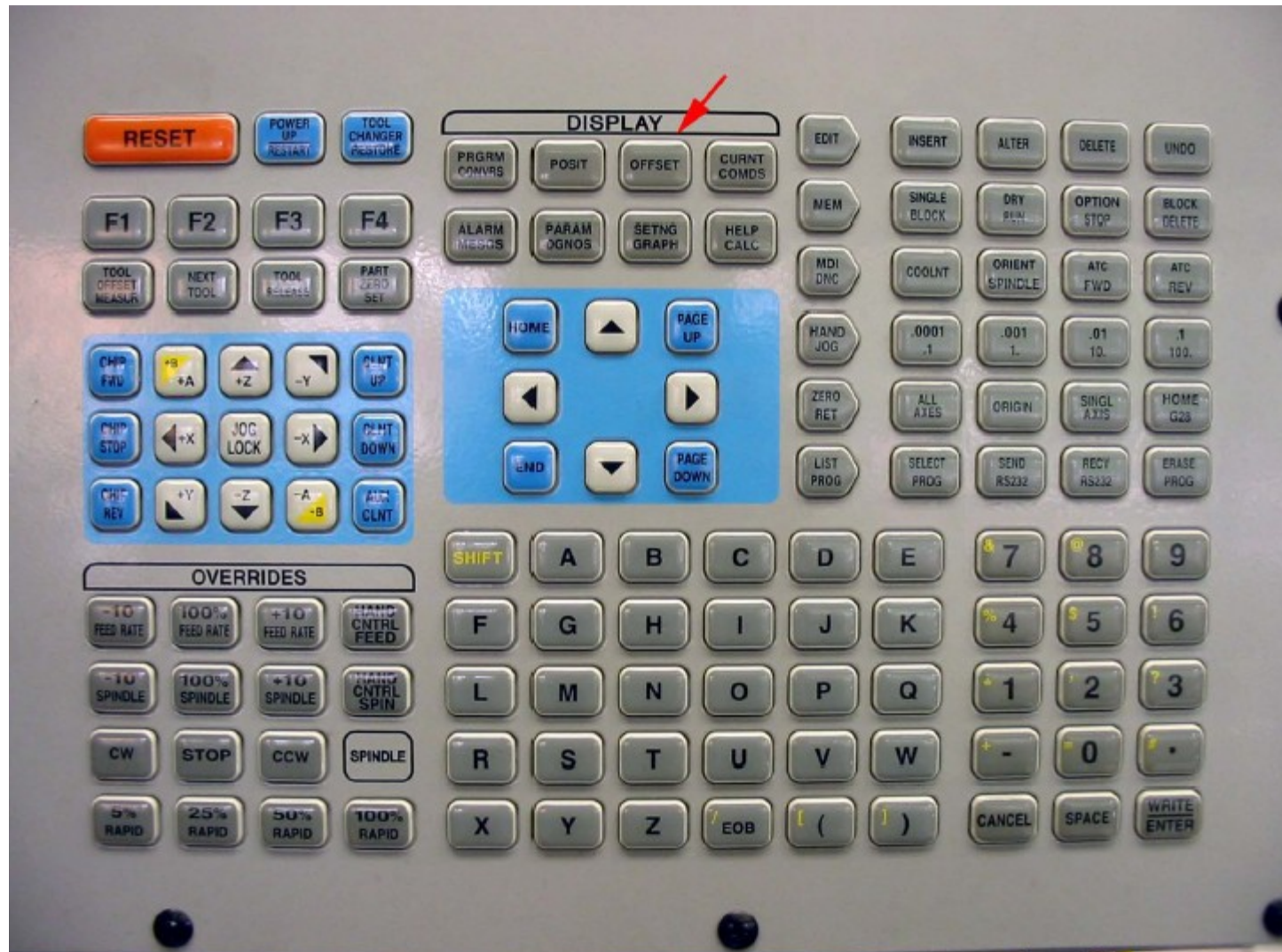
M00	Program Stop
M01	Opt. Program Stop (panel controlled)
M03	Start spindle (normal rotation)
M04	Start spindle (reverse rotation)
M05	Stop spindle
M06	Tool change
M08	Start coolant
M09	Stop coolant
M30	Program end

WORK OFFSETS

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



OFFSETS



SETTING WORK OFFSET

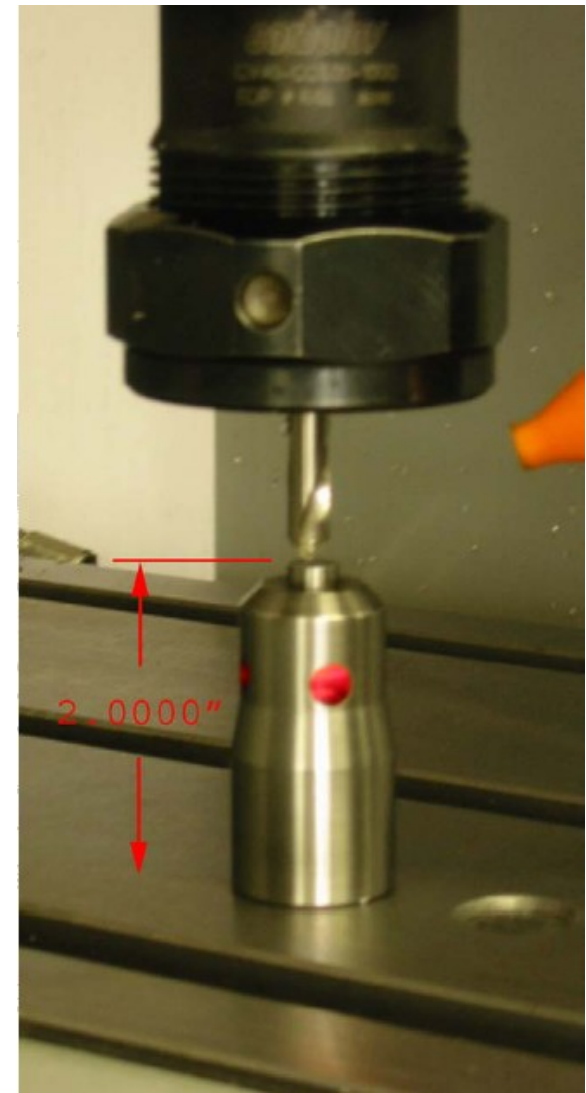
WORK ZERO OFFSET			
G CODE	X	Y	Z
G 52	0.	0.	0.
G 54	-18.4871	-8.1975	6.4515
G 55	-18.8788	-8.5888	0.
G 56	-22.6688	-6.8888	0.
G 57	-16.3988	-2.6288	6.8888
G 58	-12.4185	-8.8782	5.8248
G 59	-18.4871	-8.8782	5.2285
G154 P1	0.	0.	0. (G118)
G154 P2	0.	0.	0. (G111)
G154 P3	0.	0.	0. (G112)
G154 P4	0.	0.	0. (G113)
G154 P5	0.	0.	0. (G114)
G154 P6	0.	0.	0. (G115)
G154 P7	0.	0.	0. (G116)
G154 P8	0.	0.	0. (G117)
G154 P9	0.	0.	0. (G118)
G154 P10	0.	0.	0. (G119)
G154 P11	0.	0.	0. (G120)
G154 P12	0.	0.	0. (G121)
G154 P13	0.	0.	0. (G122)
G154 P14	0.	0.	0. (G123)
G154 P15	0.	0.	0. (G124)
G154 P16	0.	0.	0. (G125)
G154 P17	0.	0.	0. (G126)
Z POSITION : -5.8343 WRITE ADD/F1 SET/OFSET TOGGLE			
RAPID 58%			
JOGGING Y AXIS HANDLE .0001			
-18.4871			

TOOL OFFSETS

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

TOOL	POSITION	GEOMETRY	WEAR	GEOMETRY	WEAR	FLUTES
1		-16.1442	0.	0.1250	0.	2
2		-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
6		-16.2011	0.	0.2500	0.	2
7		-14.4871	0.	0.3125	0.	2
8		-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		0.	0.	0.	0.	2
15		0.	0.	0.	0.	2
16		0.	0.	0.	0.	2
17		0.	0.	0.	0.	2
18		0.	0.	0.	0.	2
19		0.	0.	0.	0.	2
20		0.	0.	0.	0.	2

2 POSITION : -14.1442 WRITE ADD/F1 SET/OFFSET TOGGLE



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 carbide 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

SETTING FEEDS & SPEEDS

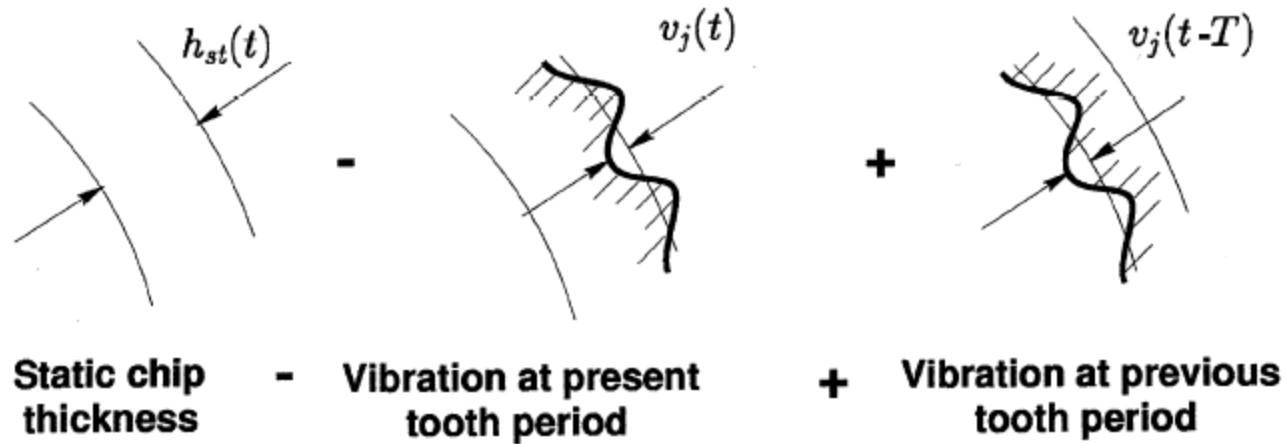
<u>Aluminum (6061, 2024, 7075)</u>				
SFM	Chipload Per Tooth			
<u>2, 3, & 4 Flute</u>	<u>up to .125 dia.</u>	<u>.125-.250 dia.</u>	<u>.250-.500 dia.</u>	<u>.500-1.0 dia.</u>
300-500	.0008-.0020	0015-.0040	0020-.0060	0030-.0090

<u>Tool Steels <30 RC (4140, 4340, A2, D2, O1, S7, P2,H13)</u>				
SFM	Chipload Per Tooth			
<u>2, 3, & 4 Flute</u>	<u>up to .125 dia.</u>	<u>.125-.250 dia.</u>	<u>.250-.500 dia.</u>	<u>.500-1.0 dia.</u>
150-225	.0005-.0010	0008-.0020	0010-.0030	0020-.0040

<u>Carbon Steels <35 RC (A36, 1000's, 1100's, 1300's)</u>				
SFM	Chipload Per Tooth			
<u>2, 3, & 4 Flute</u>	<u>up to .125 dia.</u>	<u>.125-.250 dia.</u>	<u>.250-.500 dia.</u>	<u>.500-1.0 dia.</u>
175-250	.0006-.0015	0010-.0025	0015-.0040	0020-.0050

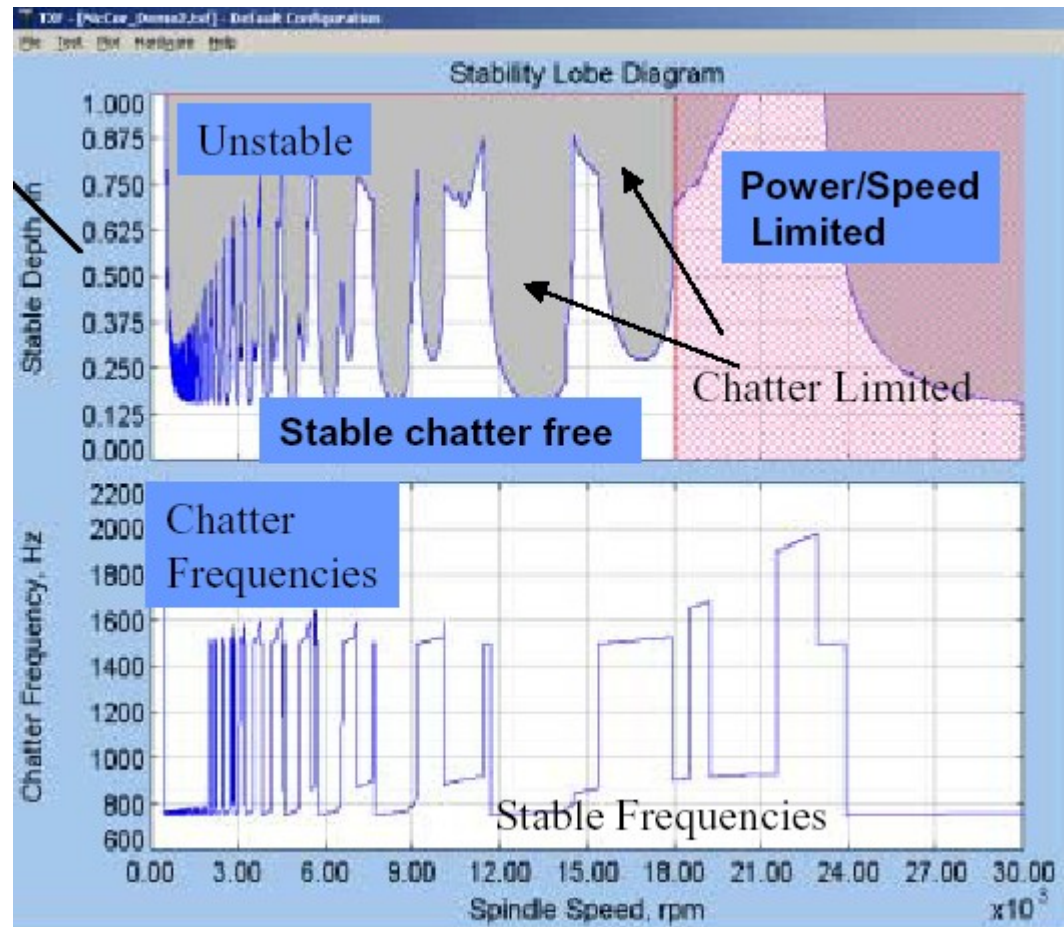
- <http://www.custompartnet.com/calculator/milling-speed-and-feed>

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

Stability Lobes for Bull Nose Cutter and Al7075

