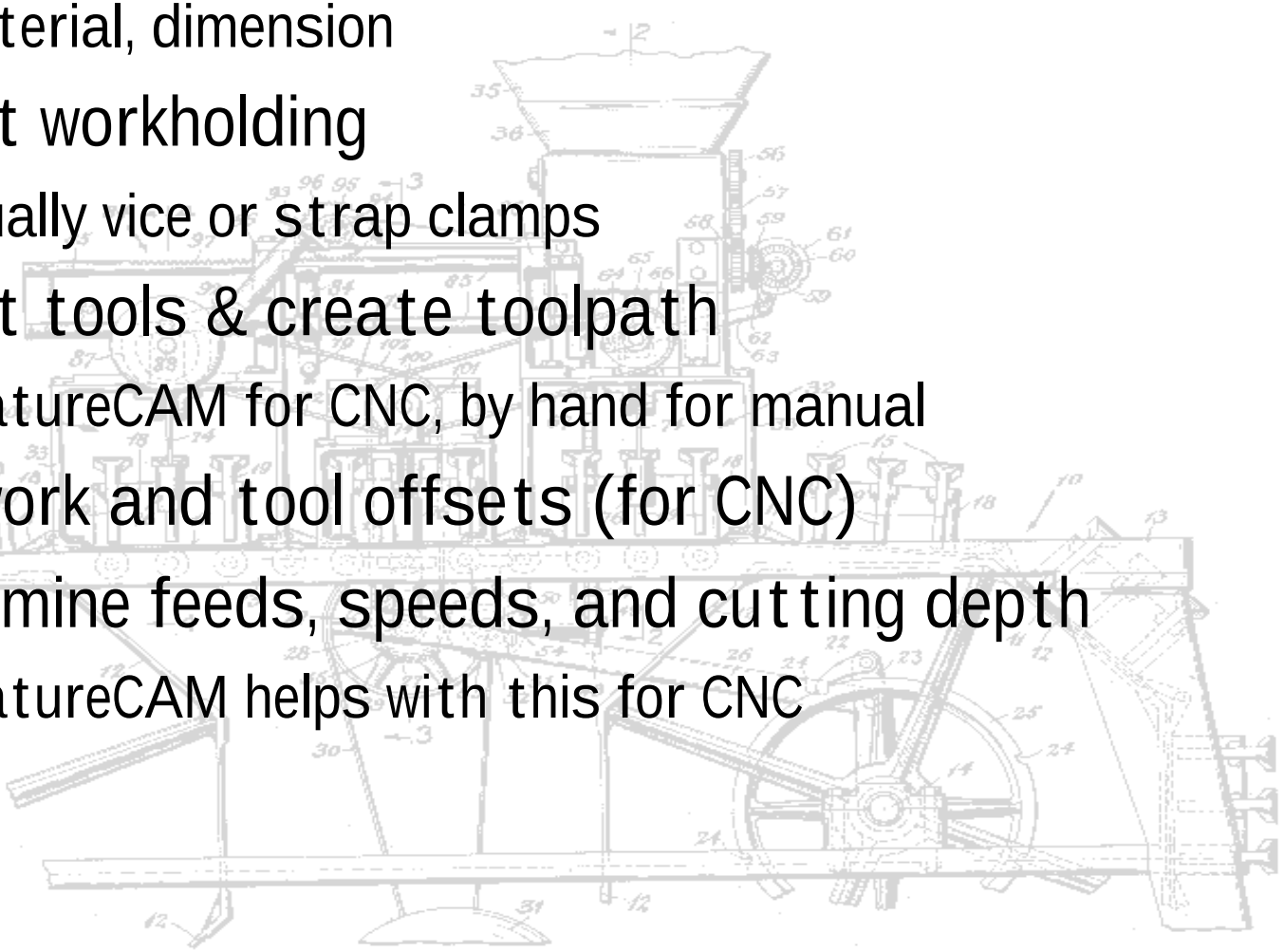
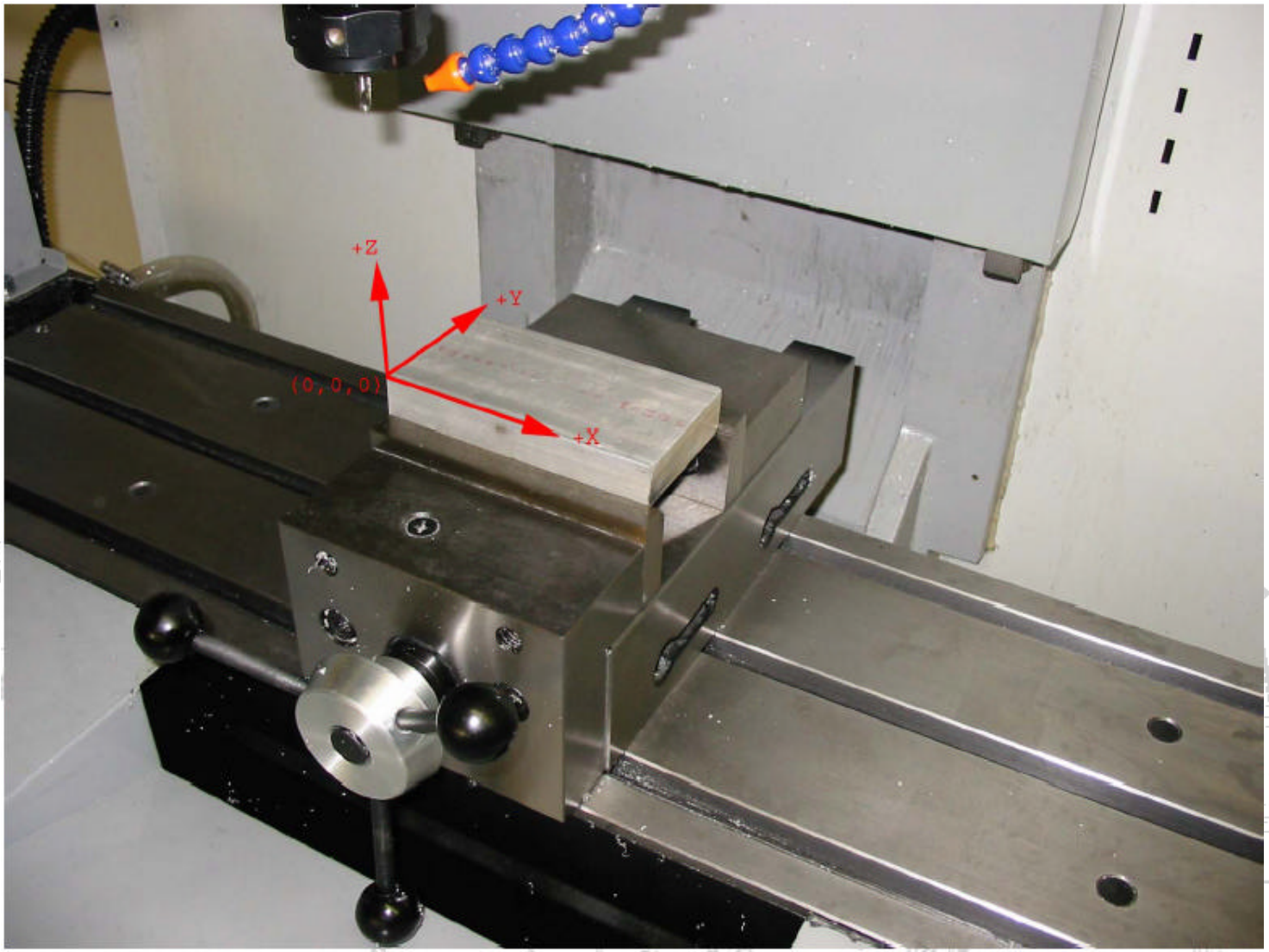
Doing Vertical Milling

- 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

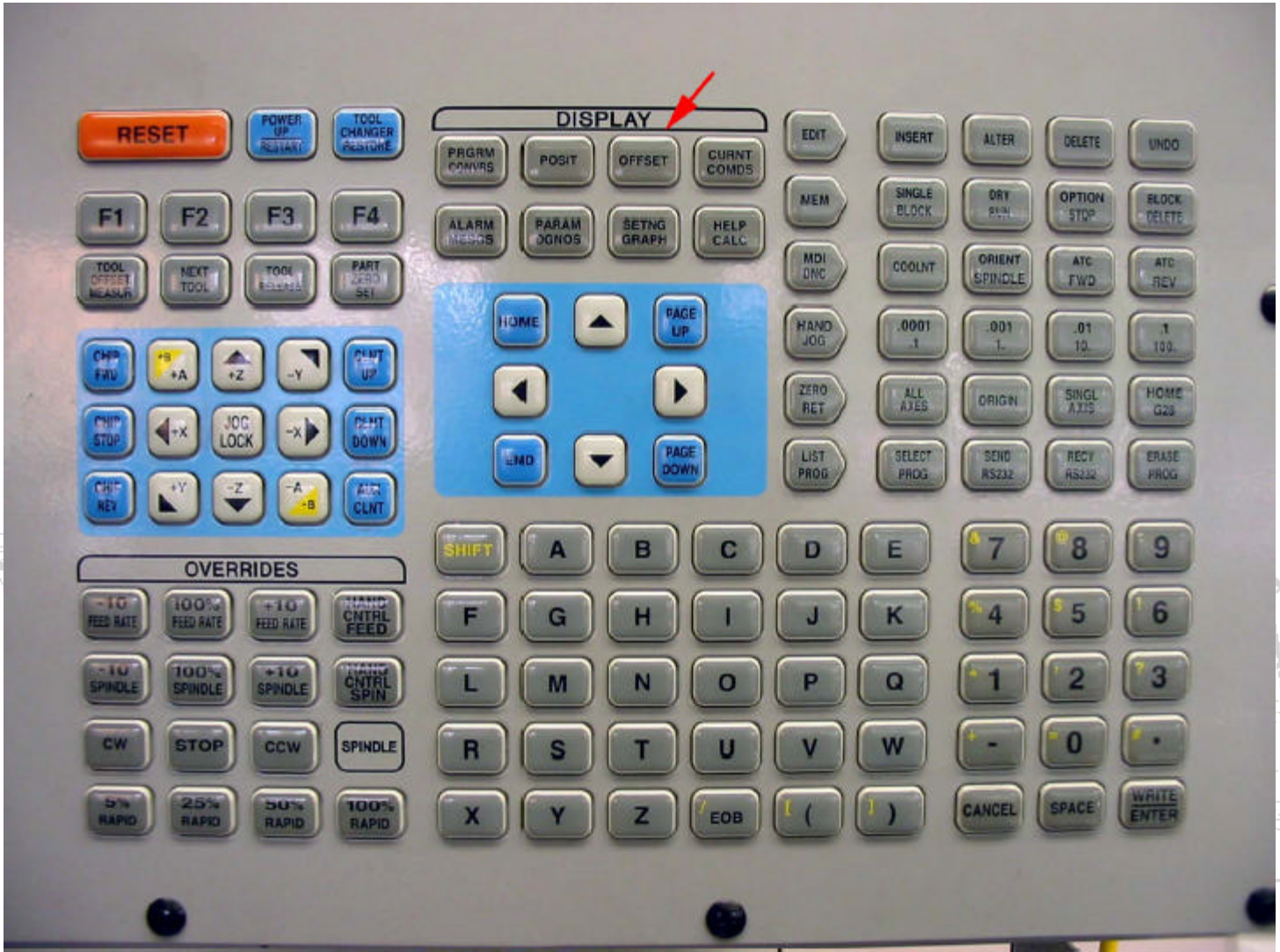
Coordinate System



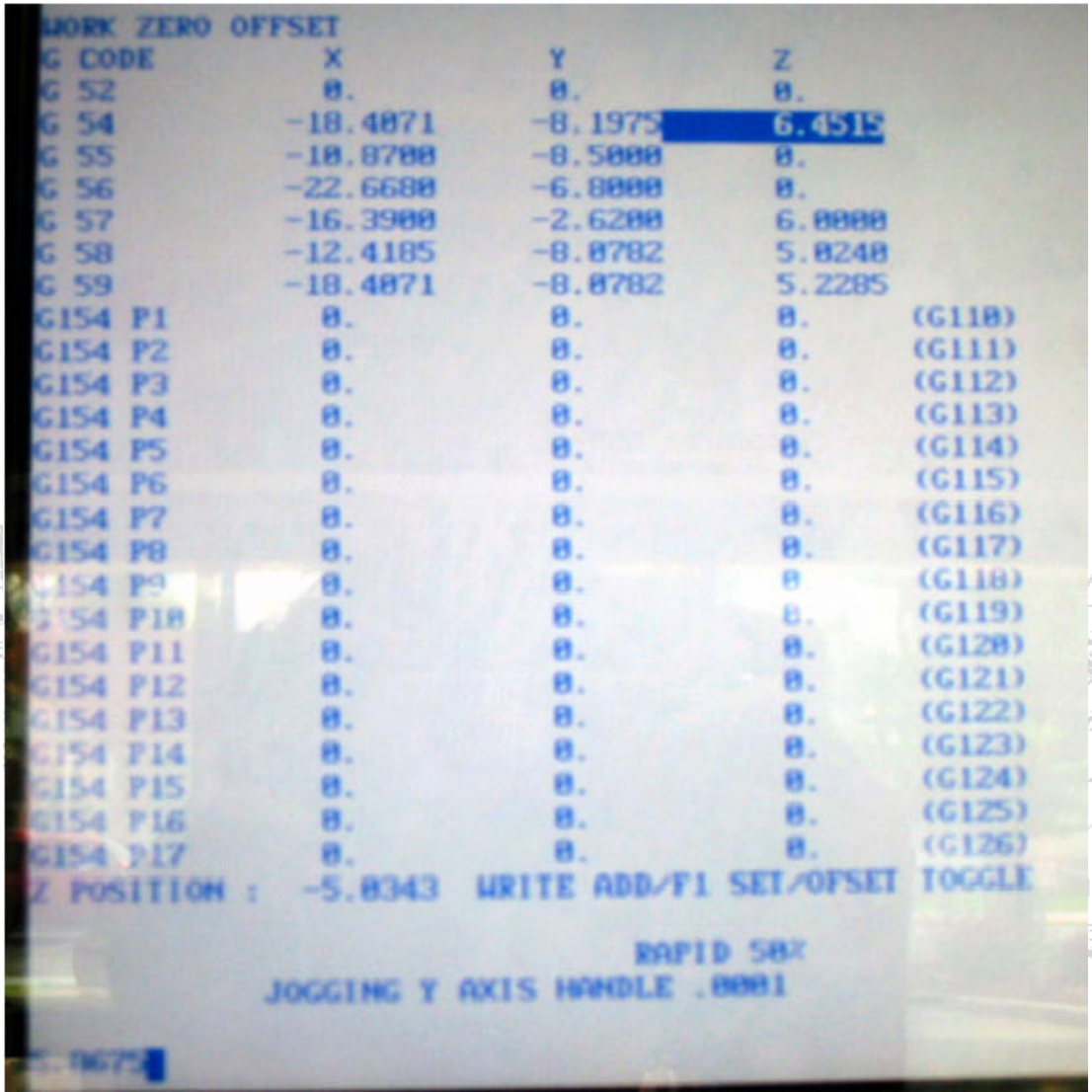
Work Offsets

- 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


RESET
POWER UP RESTART
TOOL CHANGER RESTORE
DISPLAY
PRGRM CONVRS
POSIT
OFFSET
CURNT COMDS
ALARM MESGS
PARAM DGNOS
SETNG GRAPH
HELP CALC
F1
F2
F3
F4
TOOL OFFSET MEASUR
NEXT TOOL
TOOL RELEASE
PART ZERO SET
HOME
PAGE UP
END
PAGE DOWN
JOG LOCK
EDIT
MEM
MDI DNC
HAND JOG
ZERO RET
LIST PROG
INSERT
ALTER
DELETE
UNDO
SINGLE BLOCK
DRY RUN
OPTION STOP
BLOCK DELETE
COOLNT
ORIENT SPINDLE
ATC FWD
ATC REV
.0001
.001
.01
.1
ALL AXES
ORIGIN
SINGL AXIS
HOME G28
SELECT PROG
SEND RS232
RECV RS232
ERASE PROG
OVERRIDES
FEED RATE
CNTRL FEED
SPINDLE
CNTRL SPIN
CW
STOP
CCW
SPINDLE
RAPID
25% RAPID
50% RAPID
100% RAPID
SHIFT
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
Z
EOB
CANCEL
SPACE
WRITE ENTER

Setting Work Offset

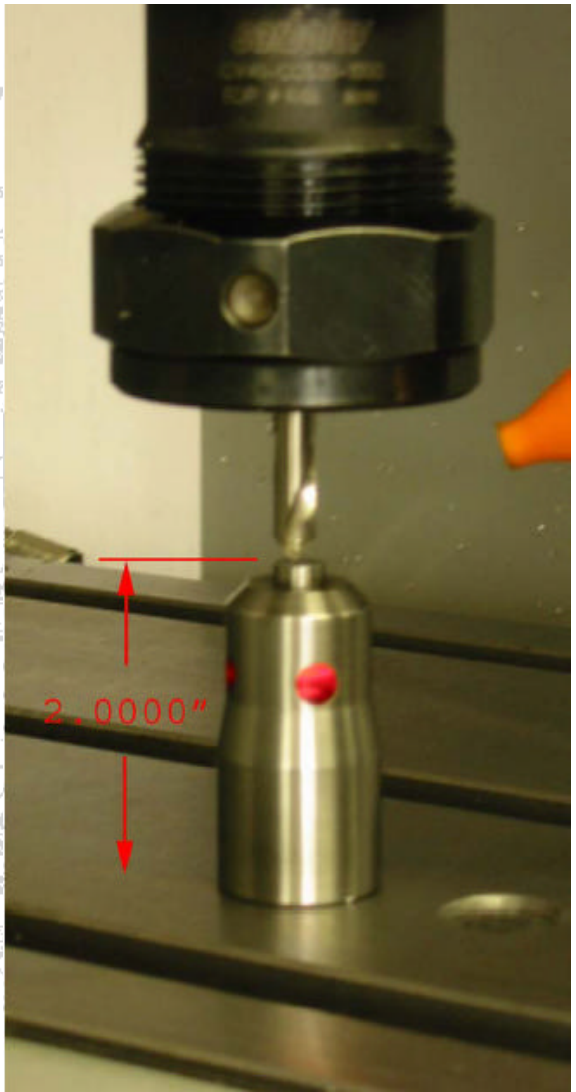


Tool Offsets

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

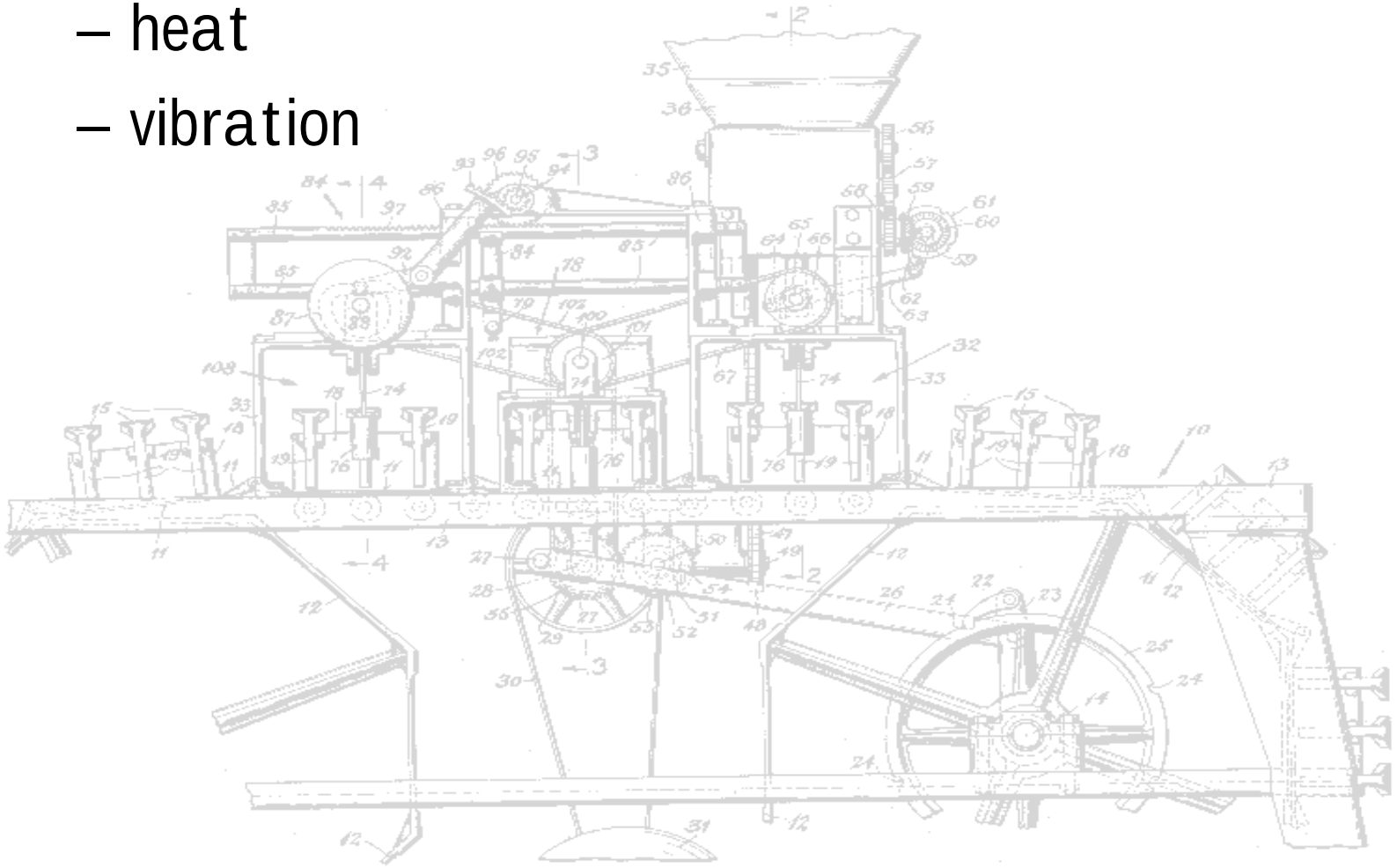
TOOL	POSITION	GEOMETRY	WEAR	GEOMETRY	WEAR	FLUTES
1		-16.1442	0.	0.1250	0.	2
2		-16.7966	0.	0.1250	0.	2
3		-16.7883	0.	0.1250	0.	2
4		-12.2747	0.	0.1000	0.	2
5		-13.9795	0.	0.3750	0.	4
6		-16.2011	0.	0.2500	0.	2
7		-14.4871	0.	0.3125	0.	2
8		-14.4289	0.	0.1250	0.	2
9		-16.9389	0.	0.0625	0.	2
10		-17.0816	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

Z POSITION : -14.1442 WRITE ADD/F1 SET/OFSET TOGGLE

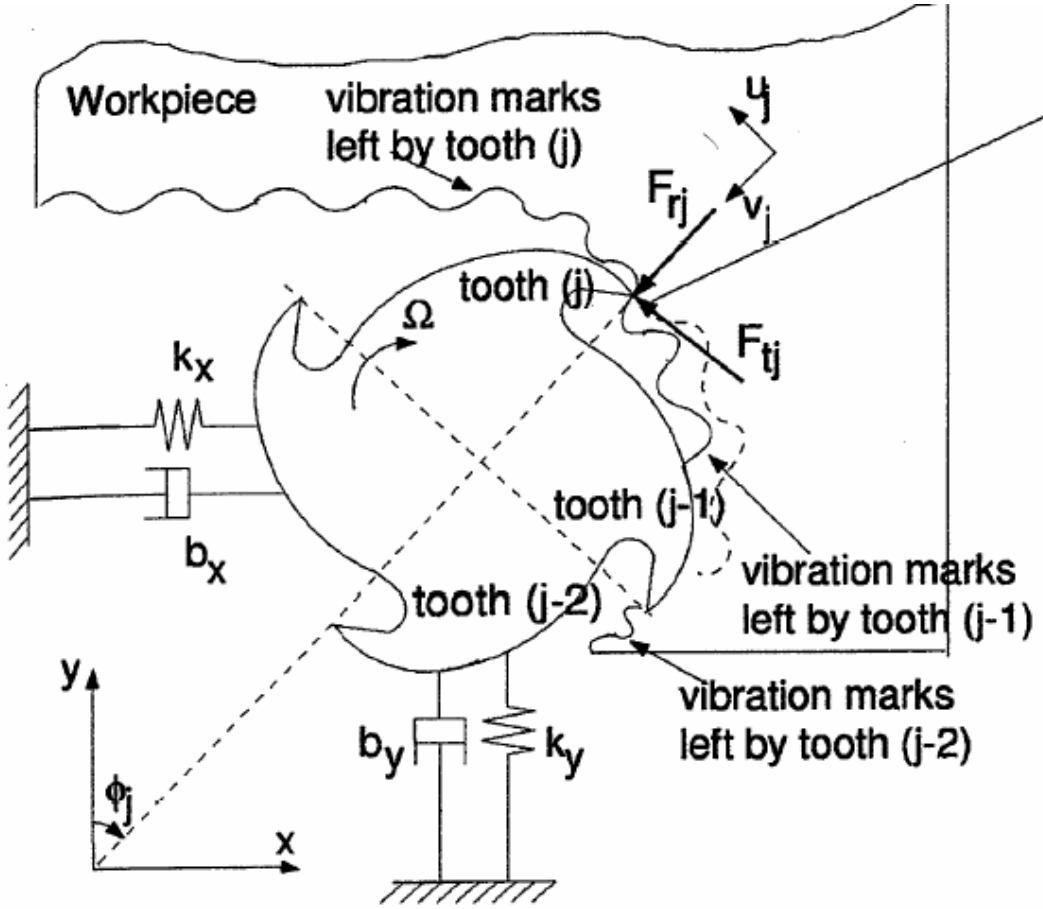


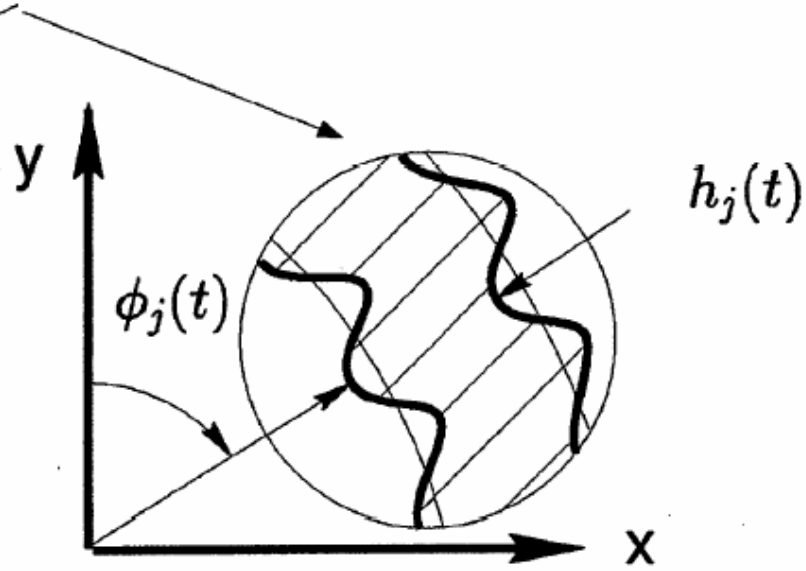
Machinability

- The enemies:
  - heat
  - vibration



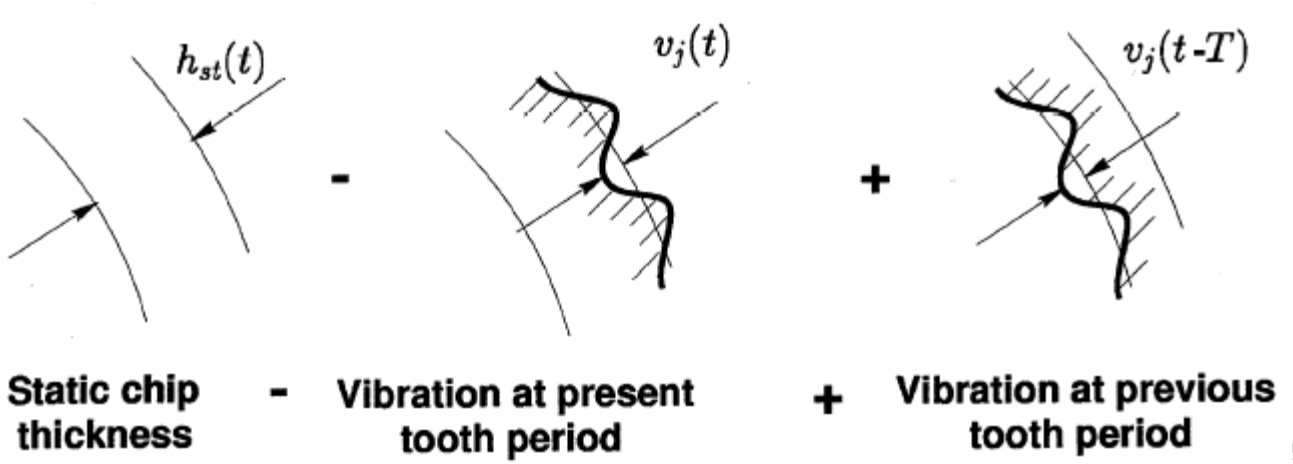
Vibration (chatter)





Dynamic chip thickness

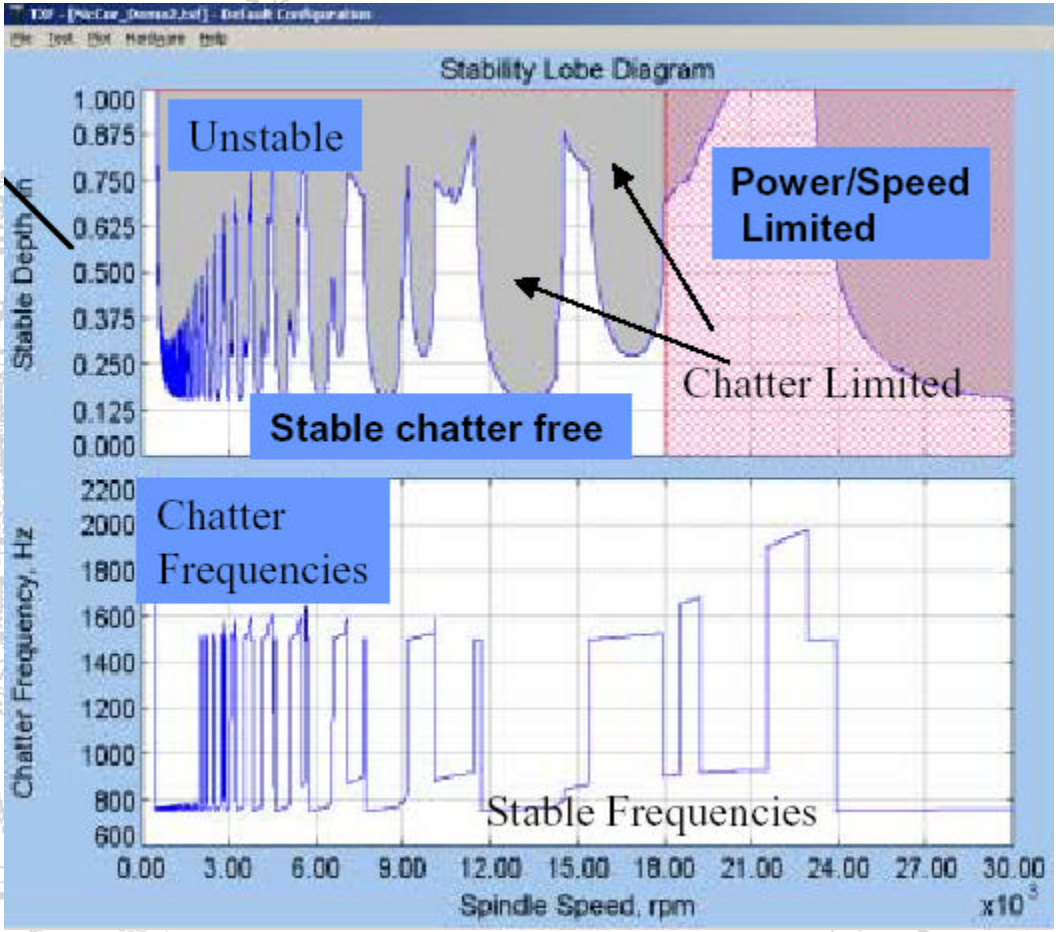
Vibration



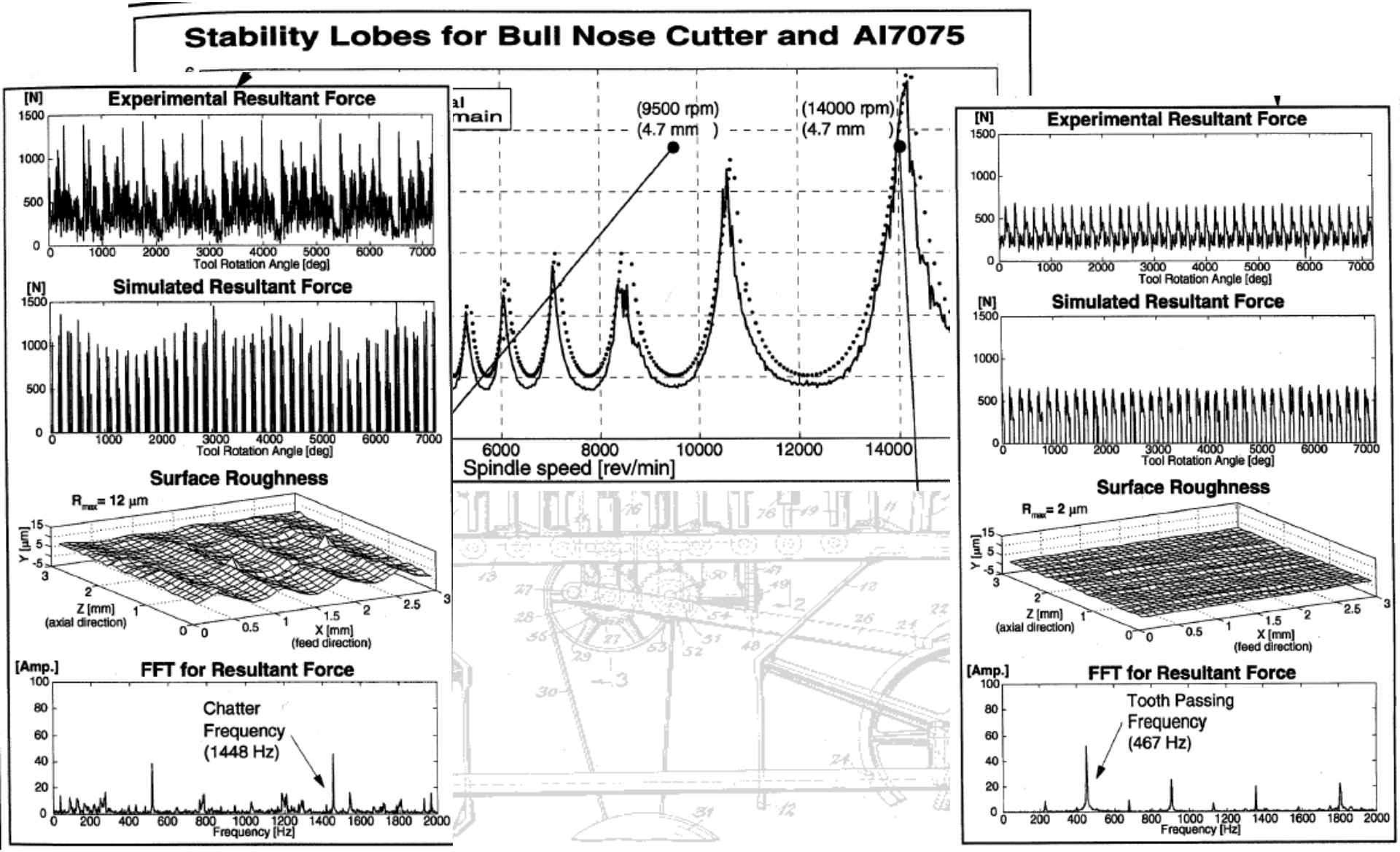
Static chip thickness - **Vibration at present tooth period** + **Vibration at previous tooth period**

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
(9500 rpm)
(4.7 mm)
(14000 rpm)
(4.7 mm)
6000
8000
10000
12000
14000
Spindle speed [rev/min]
[N]
Experimental Resultant Force
Tool Rotation Angle [deg]
Simulated Resultant Force
Surface Roughness
R_max= 12 µm
Z [mm]
(axial direction)
X [mm]
(feed direction)
[Amp.]
FFT for Resultant Force
Chatter
Frequency
(1448 Hz)
Frequency [Hz]
R_max= 2 µm
Tooth Passing
Frequency
(467 Hz)

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