Machining-3
Cutting Fluid and Chatter

Cutting Fluids - Effects

- Reduce friction and wear
  - improve tool life, surface finish
- Cool cutting zone
  - reduce temperature and distortion
- Wash chips away
- Prevent corrosion
- Reduces forces and energy consumption

Cutting Fluids - Types

- Water based
  - contain salts or soluble oils
- Mineral-oil based
- Synthetic

- Bio-degradable
- Bio-resistant
- Soaps
- Defoamers
- Sulphur
- Chlorinated

Cutting Fluids - Application Methods

- Brush
  - manual
- Mist
  - mostly water based coolants
- Flood

Coolant or Lubricant?

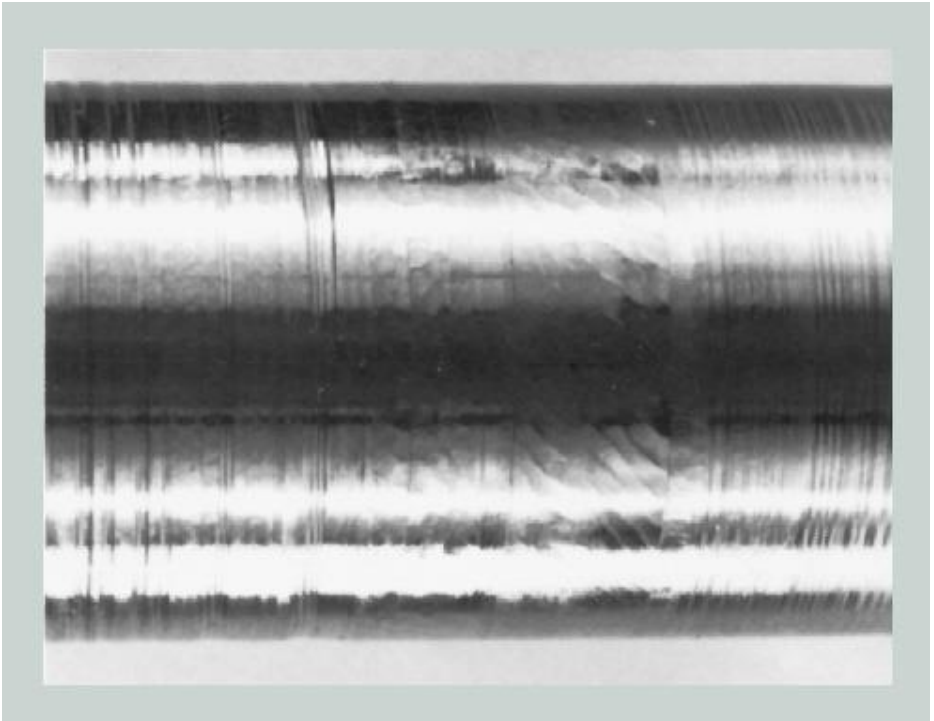
- Temperature
- Cutting speed
- Type of machining operation
- Method of application
  - brush (manual)
  - mist
  - flood

Vibration

- Forced
  - periodic applied force
    - from a motor or gear drive
- Self-excited
  - interaction of dynamics of chip removal process and structural dynamics of machine tool

Chatter

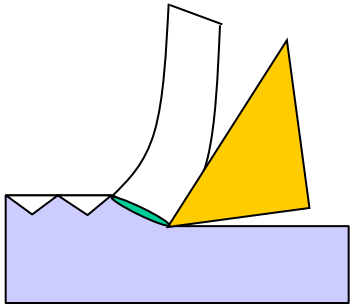
- Results from vibration
- Tool bounces in and out of the workpiece



Glacial Chatter

Chatter Types

- Regenerative (f < 1000 Hz)
  - when a surface undulation previously produced causes a cutting force variation



- Coupling (f < 1000 Hz)
  - two modes of tool or machine vibration are coupled (x and y directions)

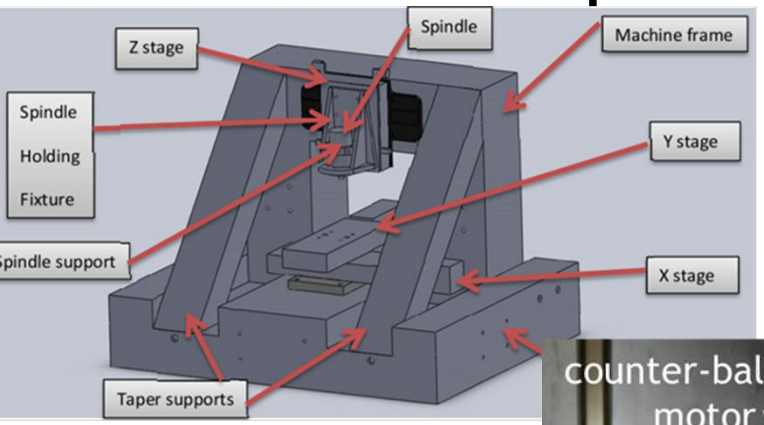
Chatter Types

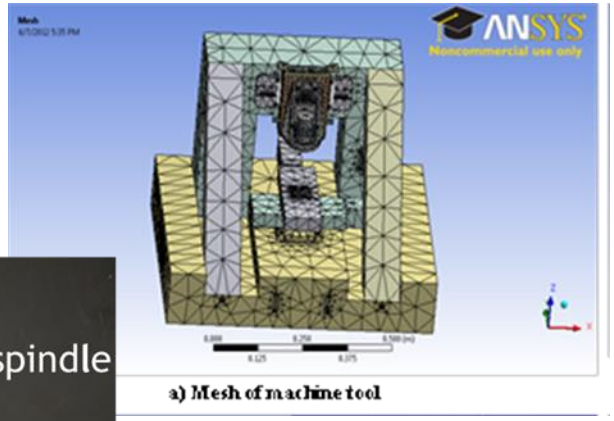
- Self-excited vibration (1000 < f < 10,000 Hz)
  - negative slope of the shear-stress vs. temperature (τ vs. θ) relationship
  - force components provide positive instead of negative damping

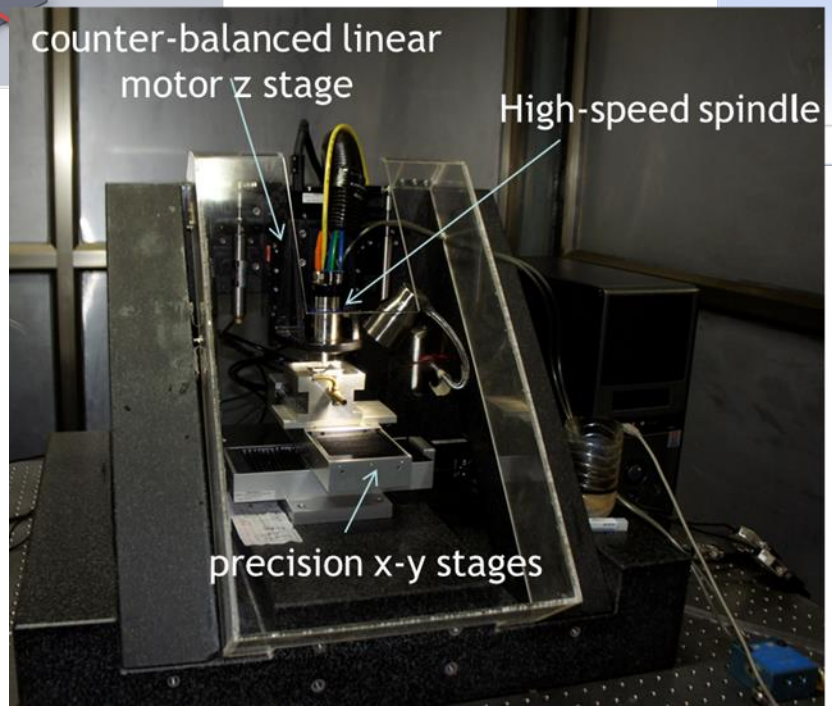
Vibration Elimination

- Stiffer machines
- Tuned dampers
- Active control
- Support workpiece rigidly
- Minimize cutter overhang
- Modify tool and cutter geometry
- Change process parameters
  - speed, feed, depth of cut, cutting fluid

Case study of vibration control in High Speed Micromachining







Best Configuration selection

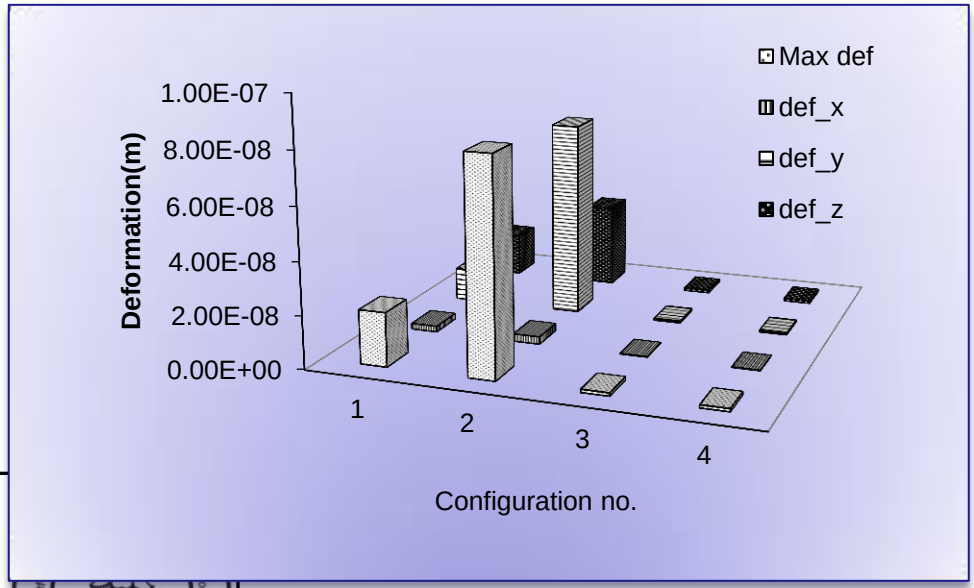
- Goal: To find most stiff configuration
- Approach:-

Model : Machine base with frame

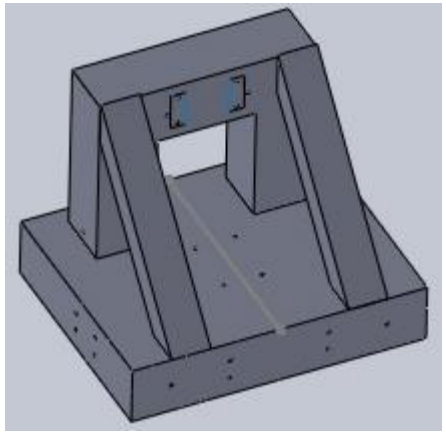
BC: Bottom of base fixed

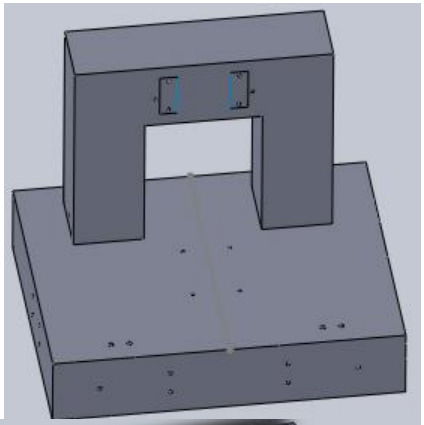
Load : Force of magnitude 60 N applied at the middle of bridge

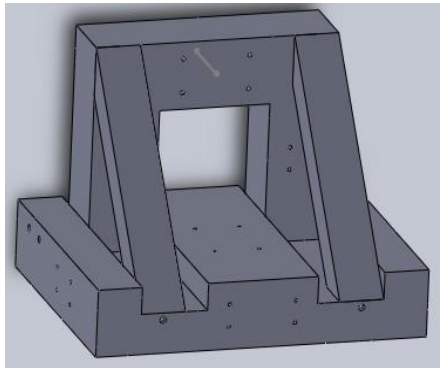
components	Ribs	No ribs
No slot	Configuration-1	Configuration-2
Slot	Configuration-3	Configuration-4

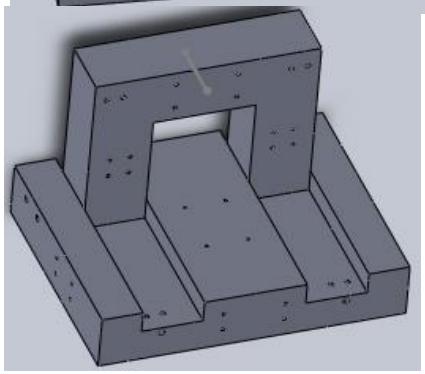


Different configurations



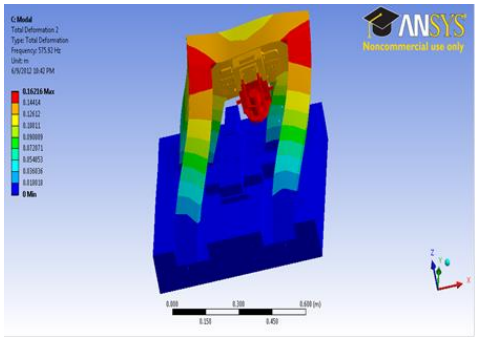




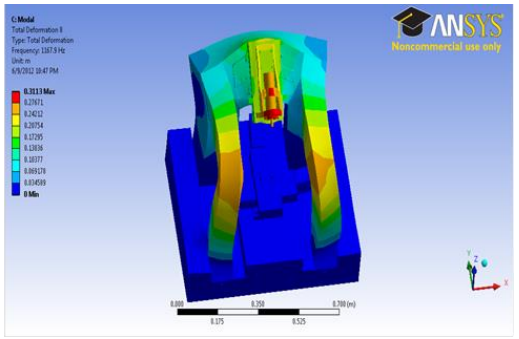


Configuration 3&4 better

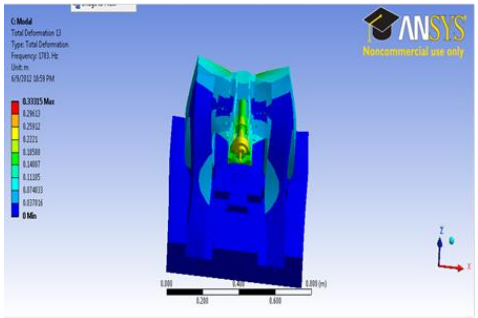
Modes of High Speed Micromachine Tool



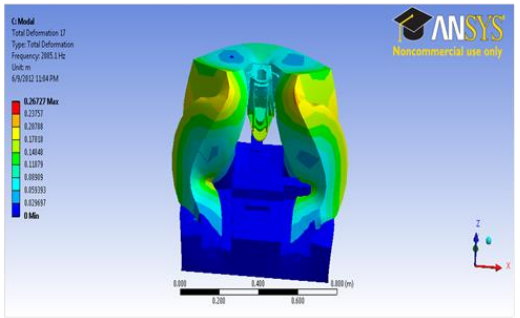
a) 2nd mode (576 Hz)



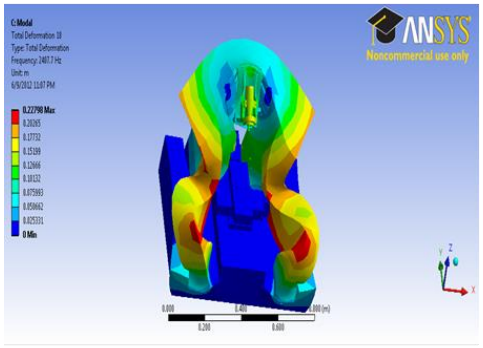
b) 8th mode (1168 Hz)



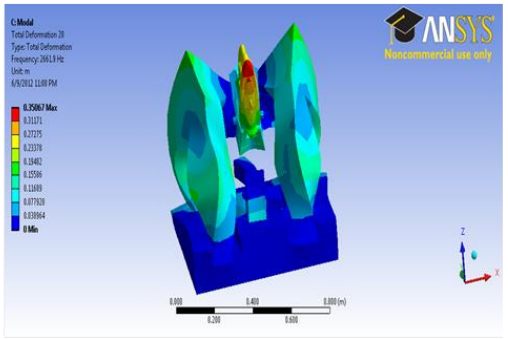
c) 13th mode (1783 Hz)



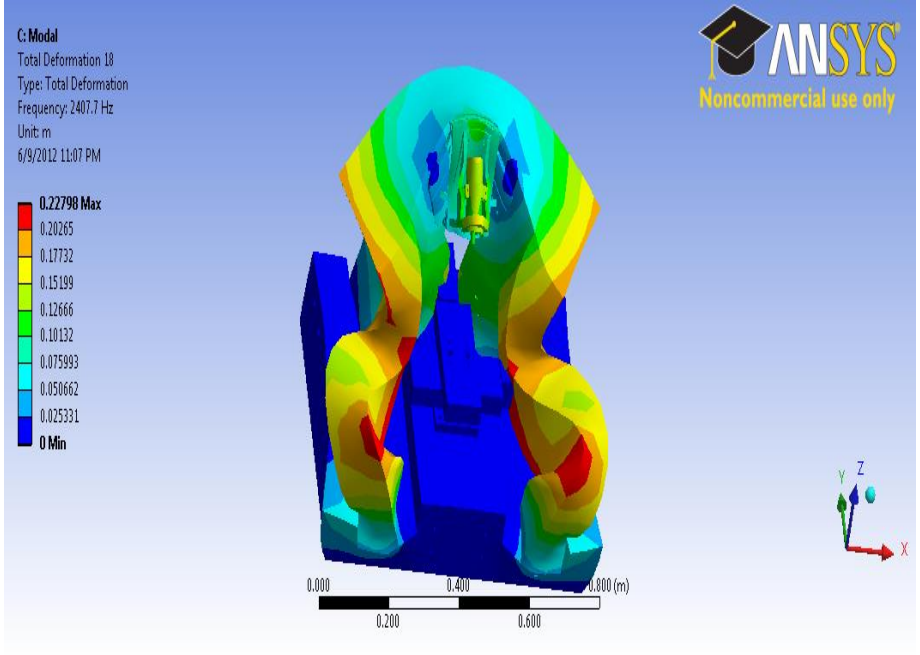
d) 17th mode (2085 Hz)

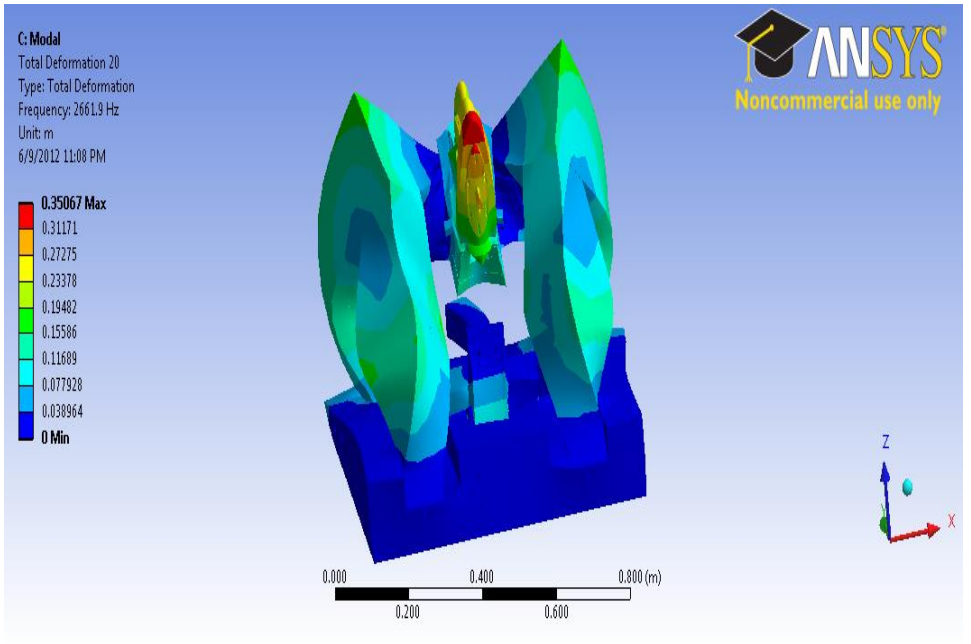


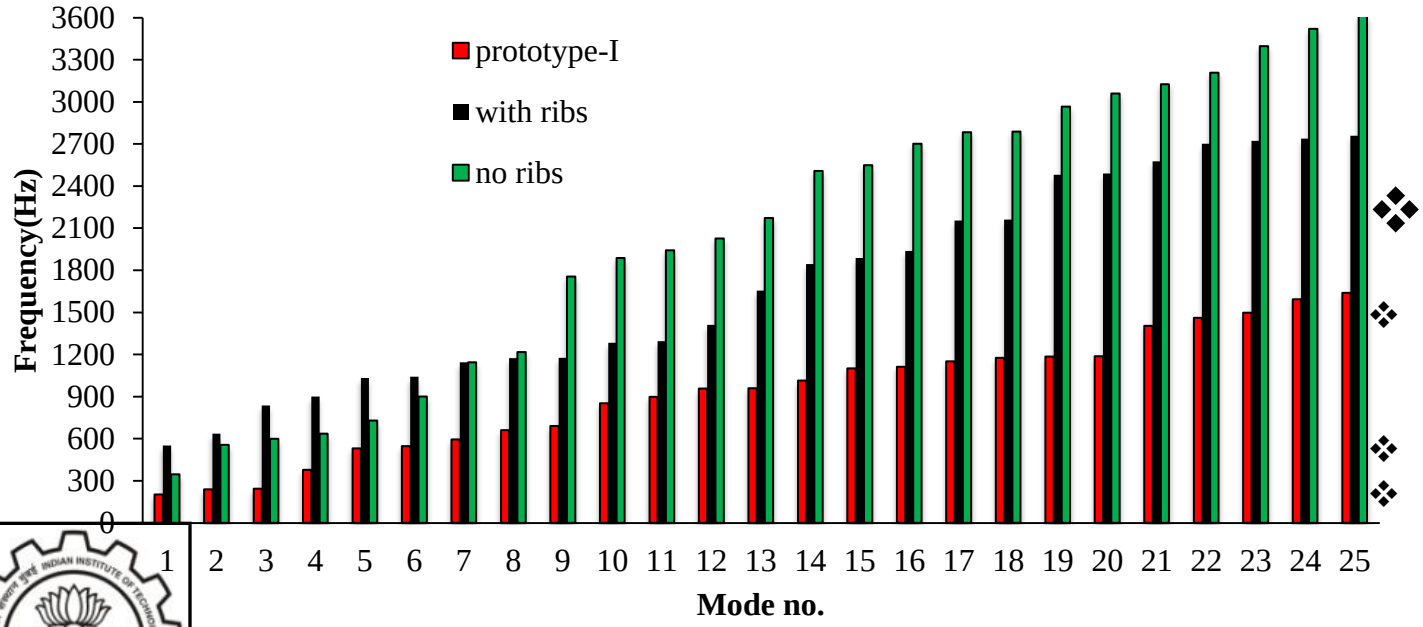
e) 18th mode (2408 Hz)



f) 20th mode (2662 Hz)

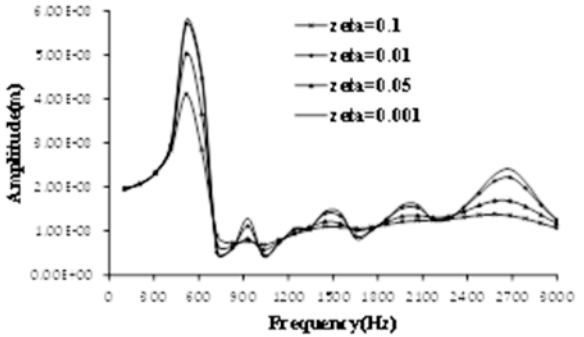




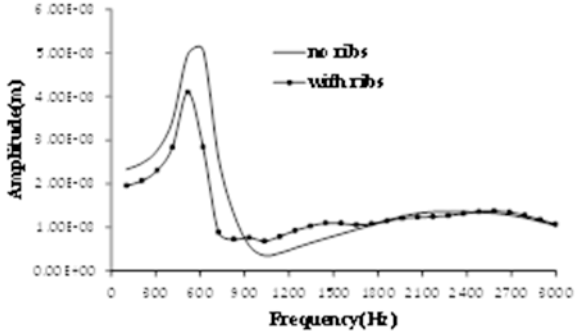


- Prototype-II frequency more than prototype-I
- No ribs case higher frequency more than with ribs case
- first 6 modes critical
- With ribs case better than others, supported by frequency response curve

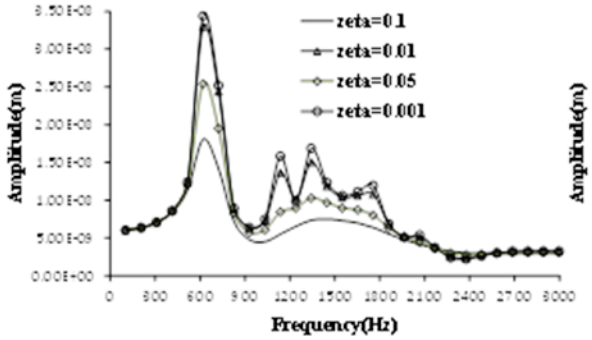
Frequency Response Analysis



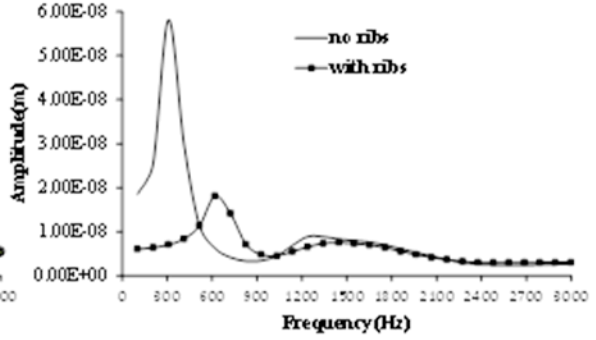
a) X axis



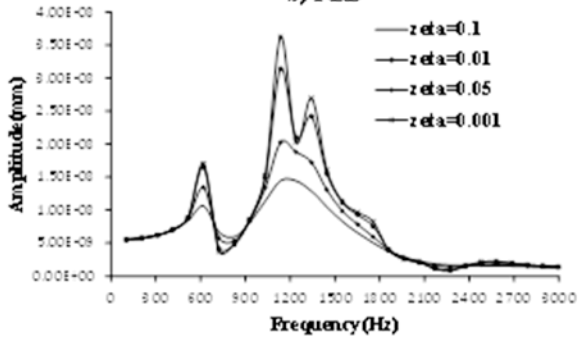
d) X axis



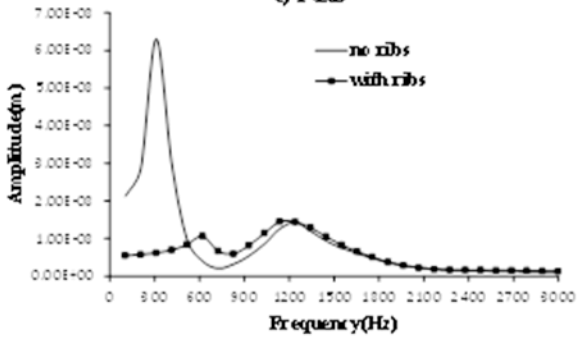
b) Y axis



e) Y axis

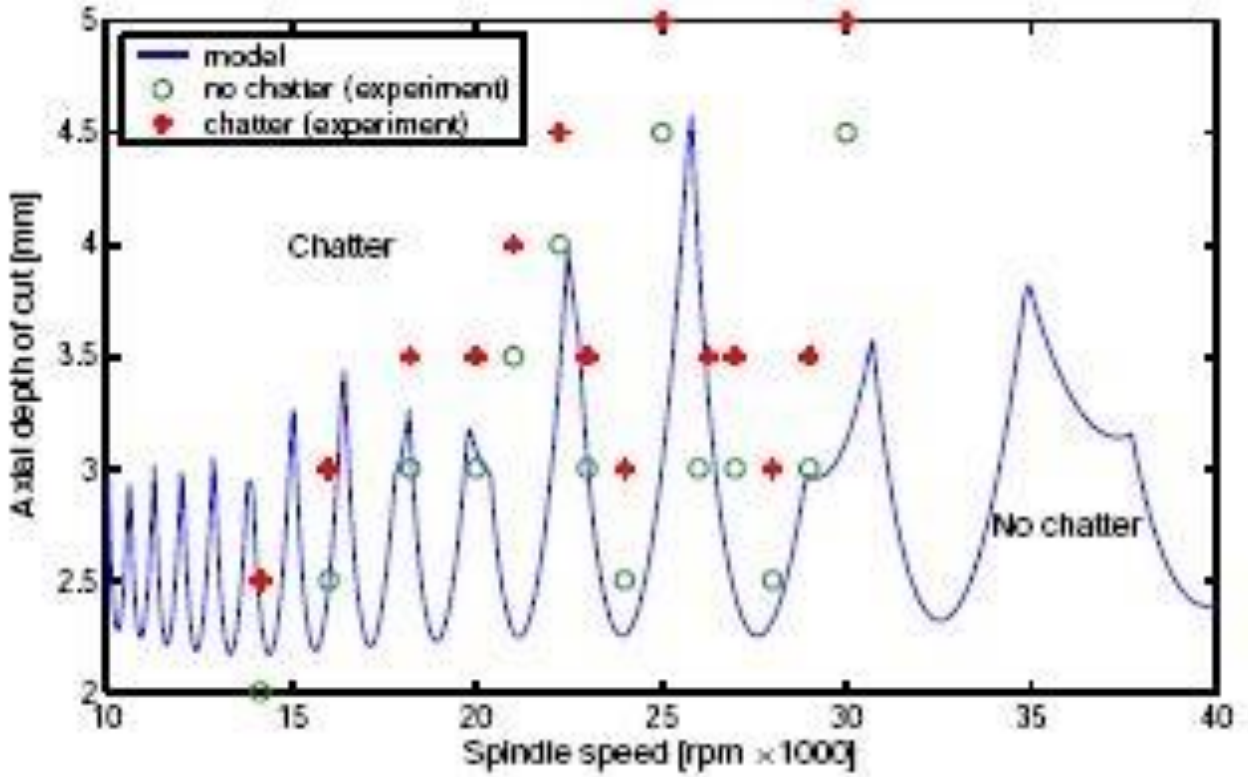


c) Z axis



f) Z axis

Stability Lobes (Process Controlled)
Axial depth of chip width



Summary

- Chip formation process
- Cutting fluids
- Vibration and chatter