

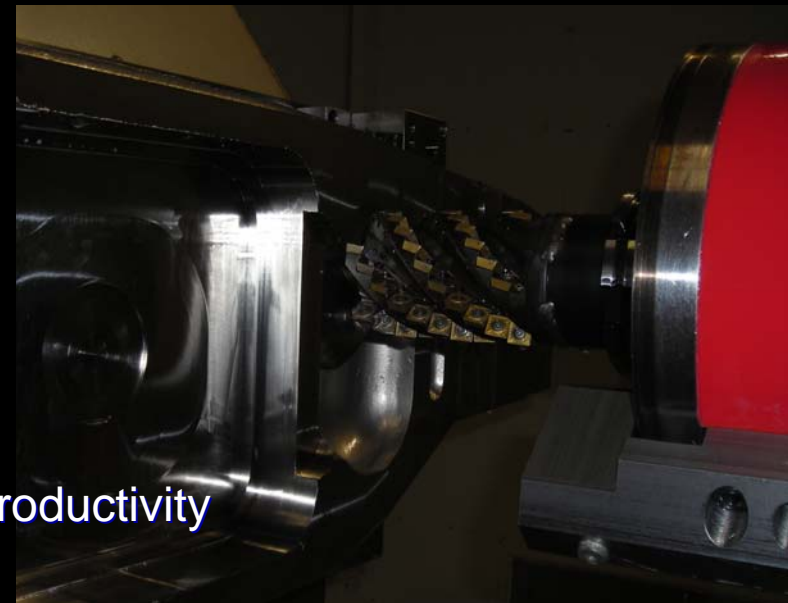
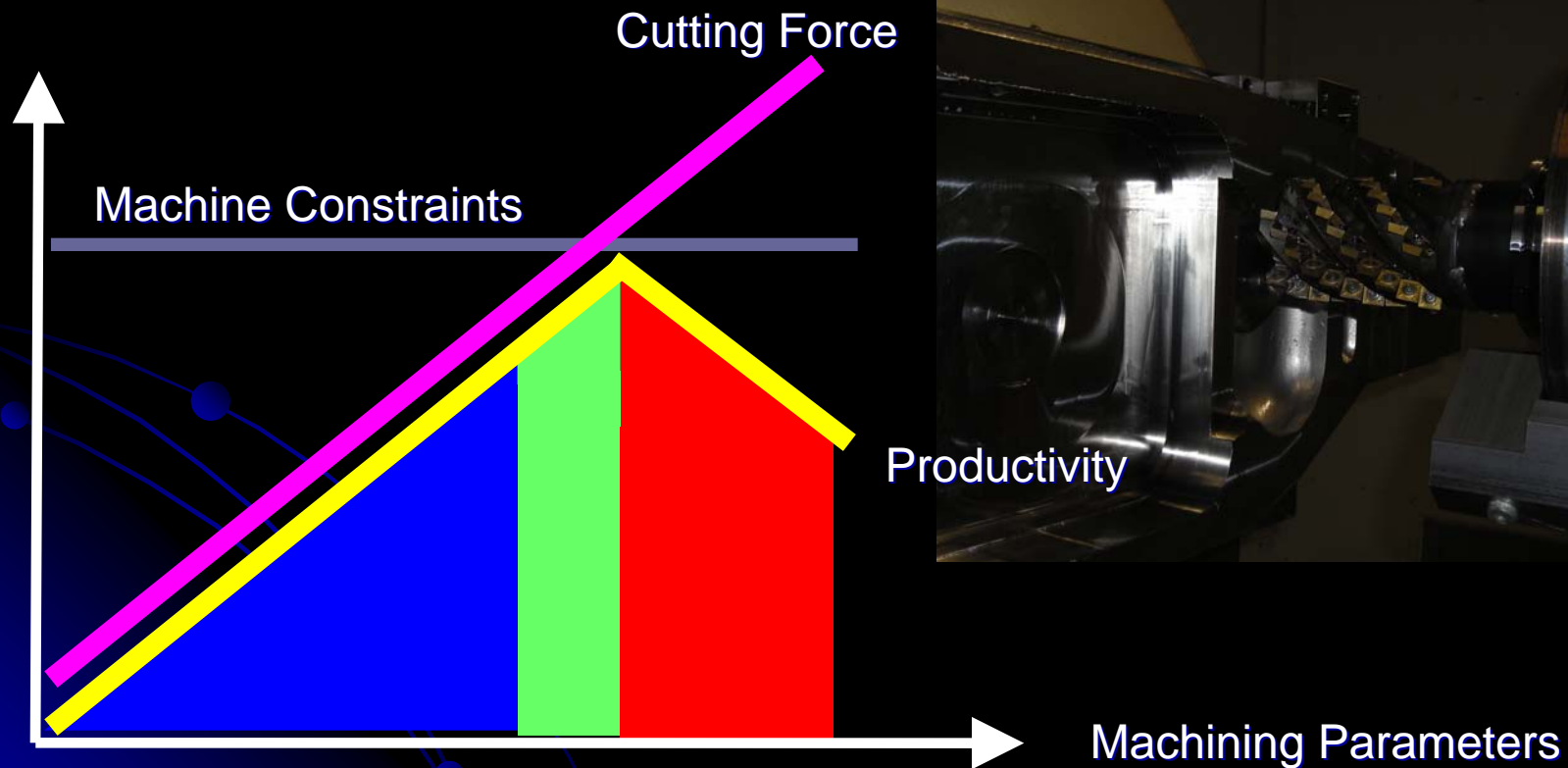


Machining Process Optimization with ISO 10303-238

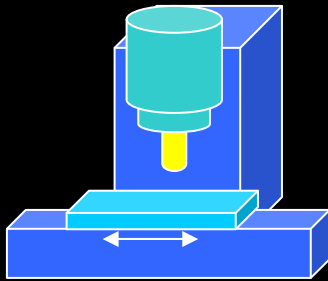
Leon Xu

The Boeing Company

Machining Process Optimization

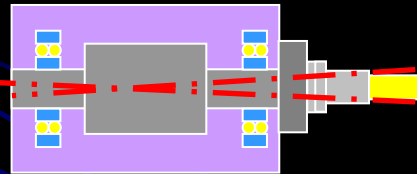


Machining System Constraints



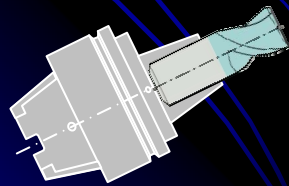
Machine/spindle capability

- Spindle power, torque and speed
- Spindle bearings
- Tool holder
- Axis torque and speed



System structural dynamics

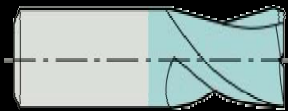
- Machine/spindle/fixture
- Cutting tool/holder/spindle



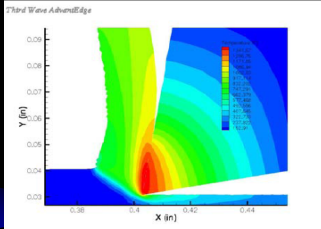
Cutting tools

- Edge rigidity
- Surface velocity
- Rotational speed
- Wear

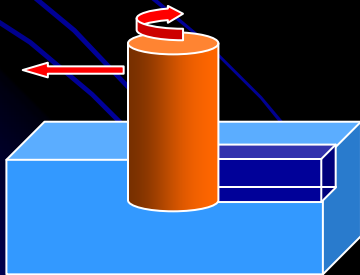
Affecting Factors



Cutting tool dimensions

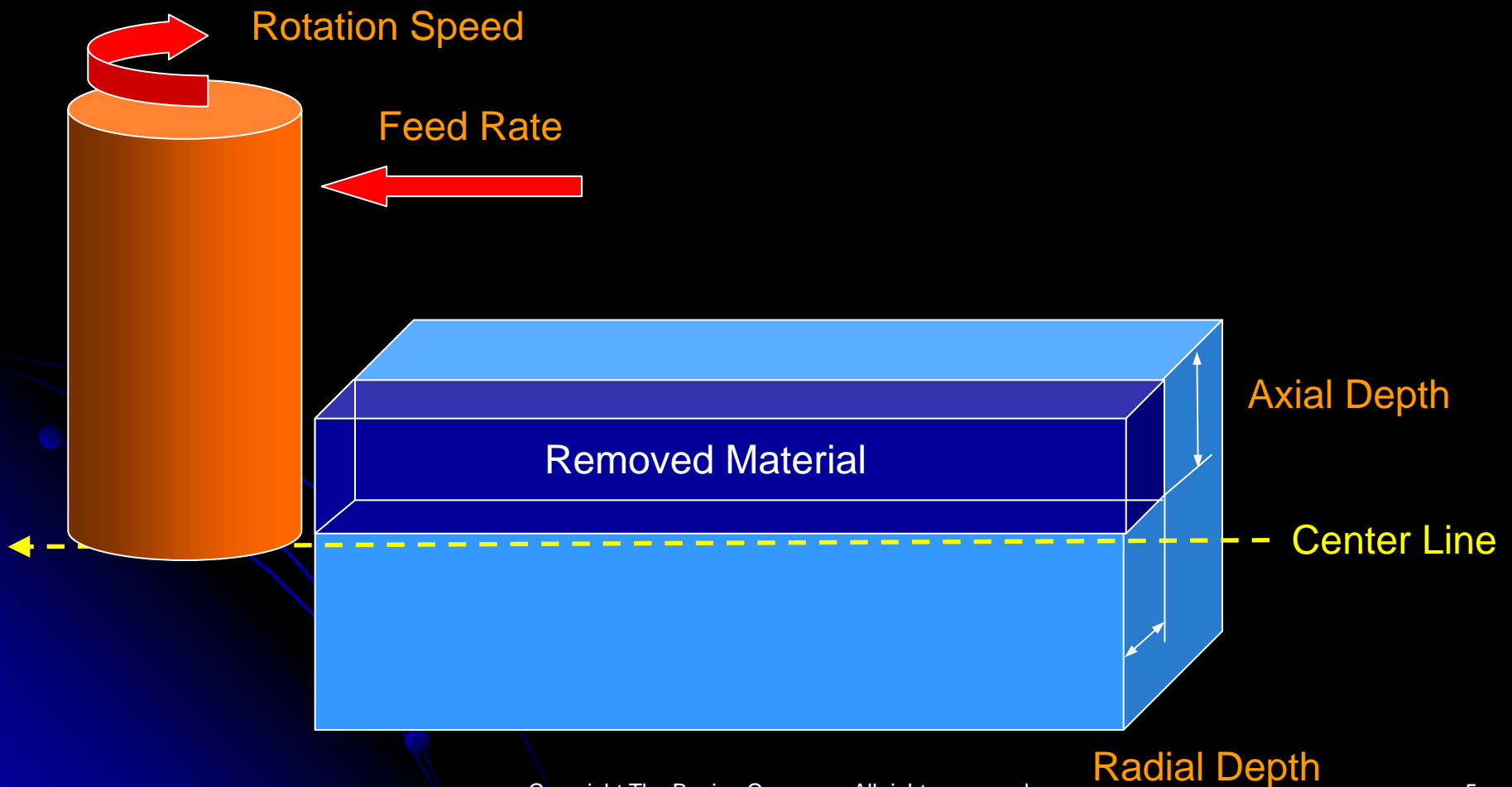


Material properties

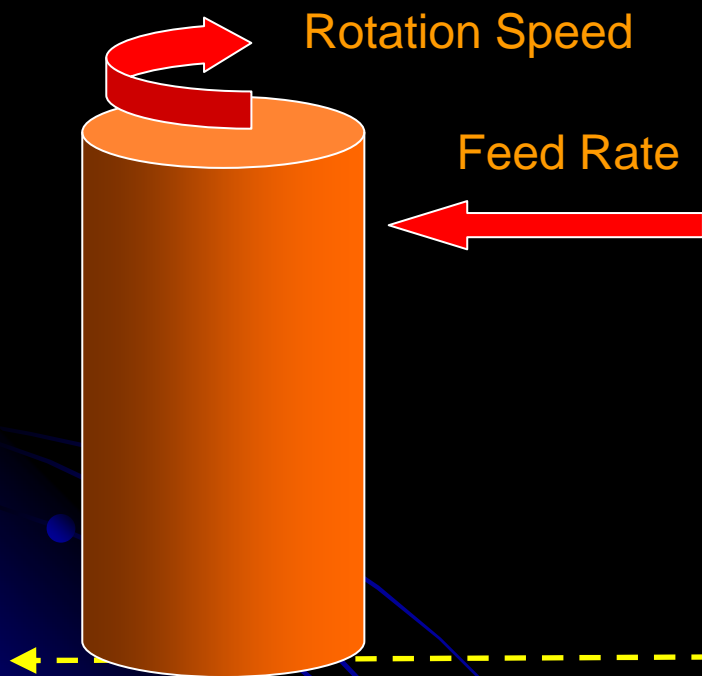


Machining parameters

Cutting Parameters and Path Geometry



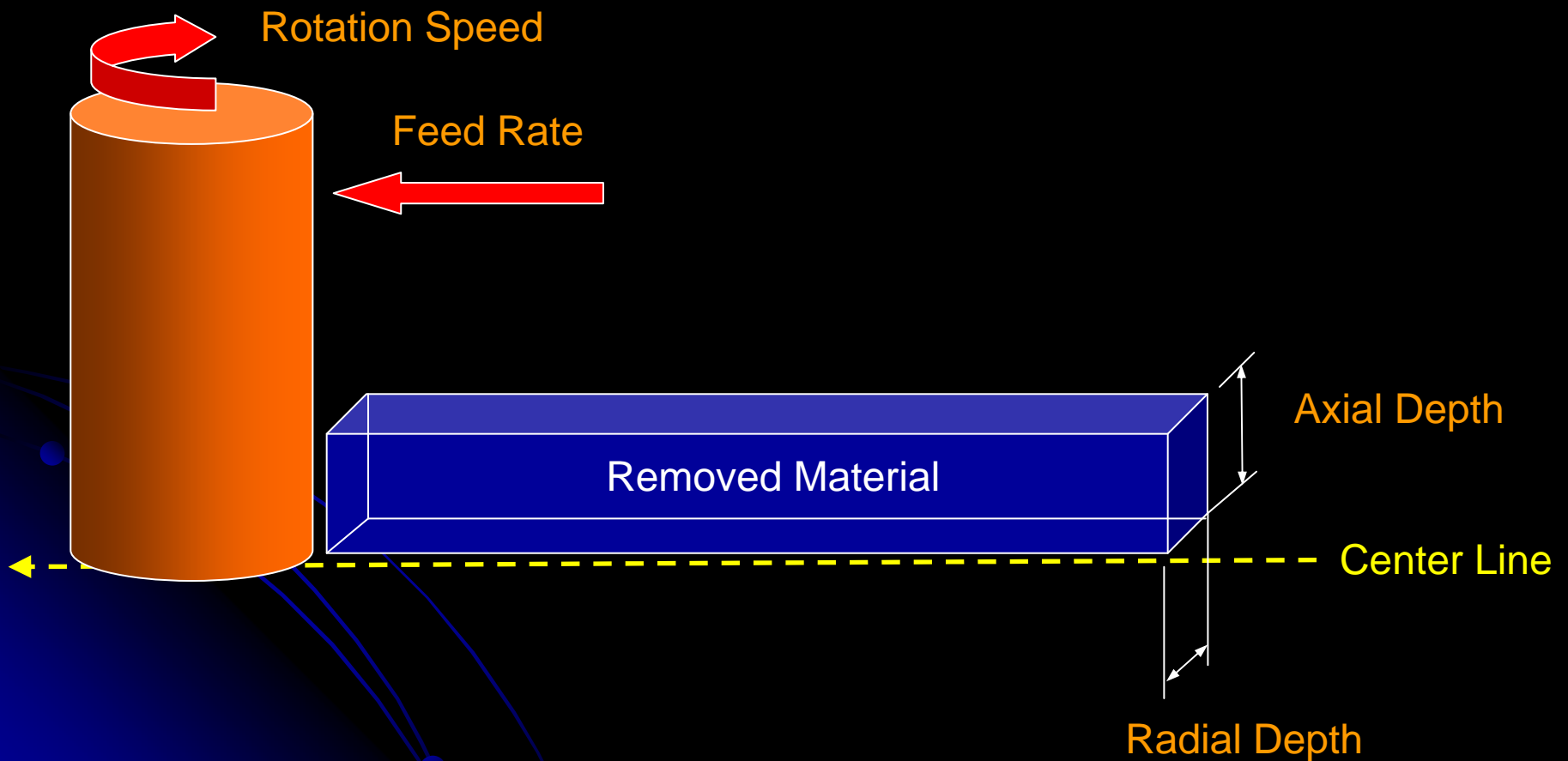
Information in M-G Code (ISO 6983)



```
N1 G49  
N2 T10M6  
N3 G90  
N4 G43.5H10I0J0K1  
N5 M3S7958  
N6 G1X0Y0Z30F0  
N7 X99.8497Y-149.3009Z10  
N8 G0Z4  
N9 Z-2  
N10 G1Z-4F8355.9  
N11 X89.8497Y-165.6804  
N12 X88.6399Y-167.6621  
N13 X84.5787Y-173.9364  
N14 X79.9216Y-180.683  
N15 X75.4355Y-186.7118  
N16 X69.814Y-193.8761  
N17 X65.1231Y-199.3388  
N18 X62.8337Y-201.9142  
N19 X53.9447Y-211.9142
```

.....
----- Center Line

Information in ISO 10303-238



Cross-Sectional Area in ISO 10303-238

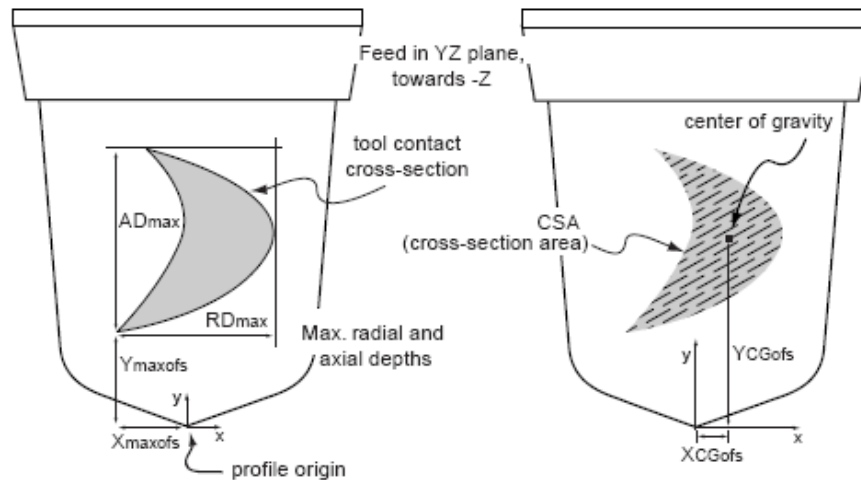


Figure 34 - Cross-section parameters for milling

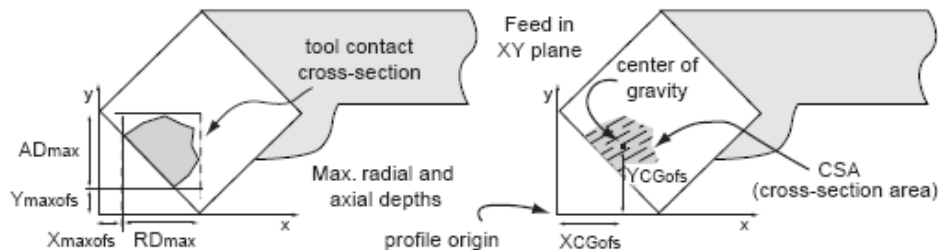
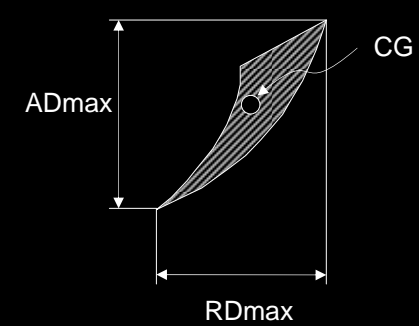
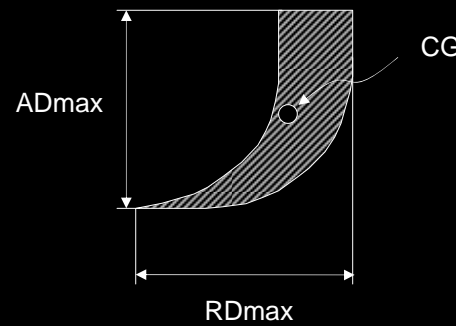
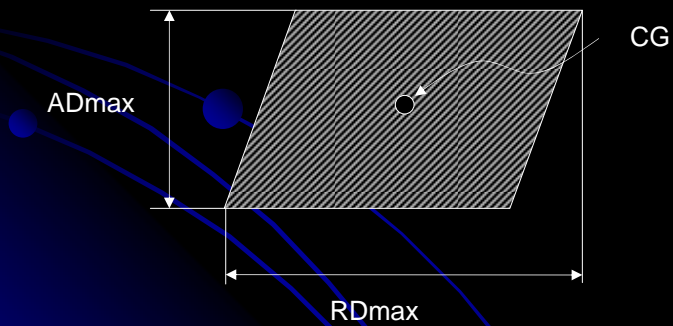
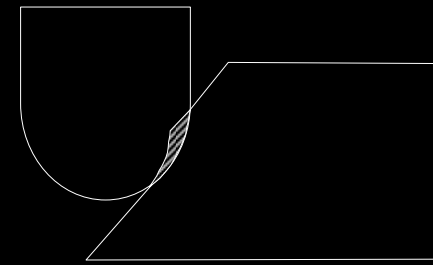
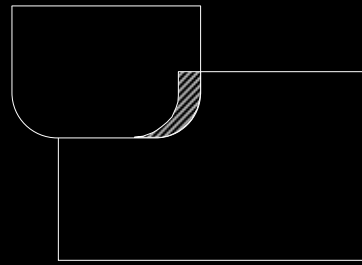
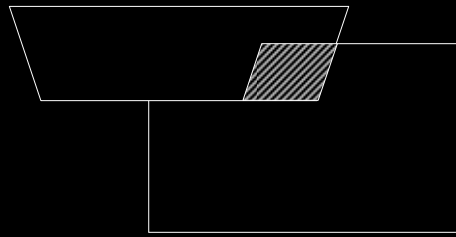
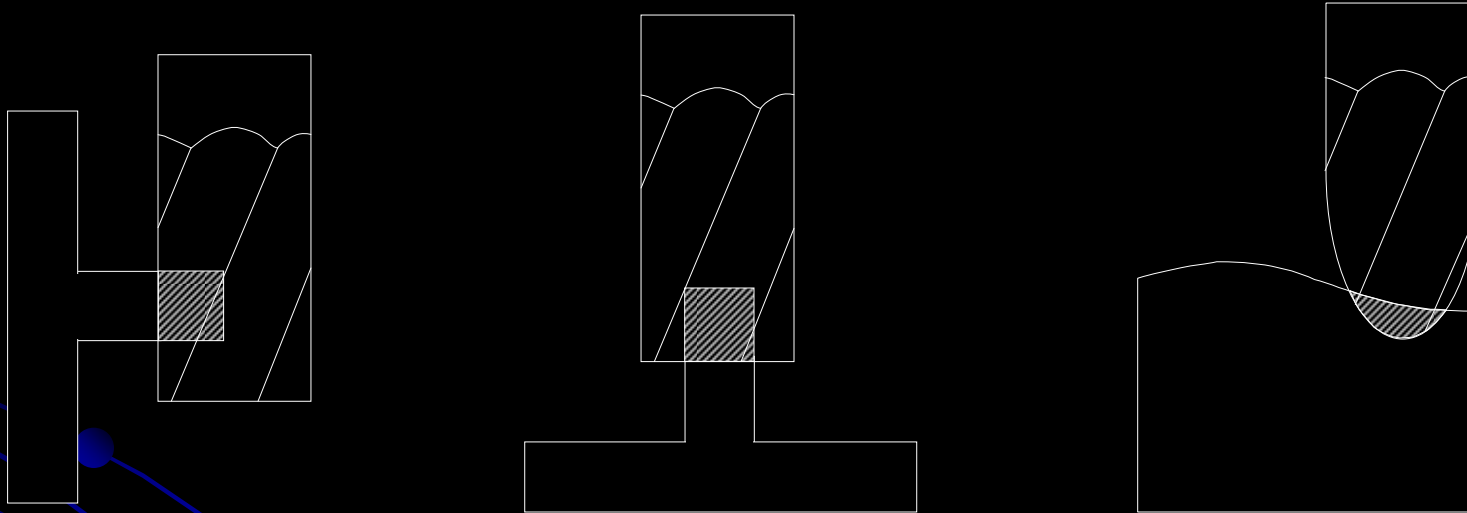


Figure 35 - Cross-section parameters for turning

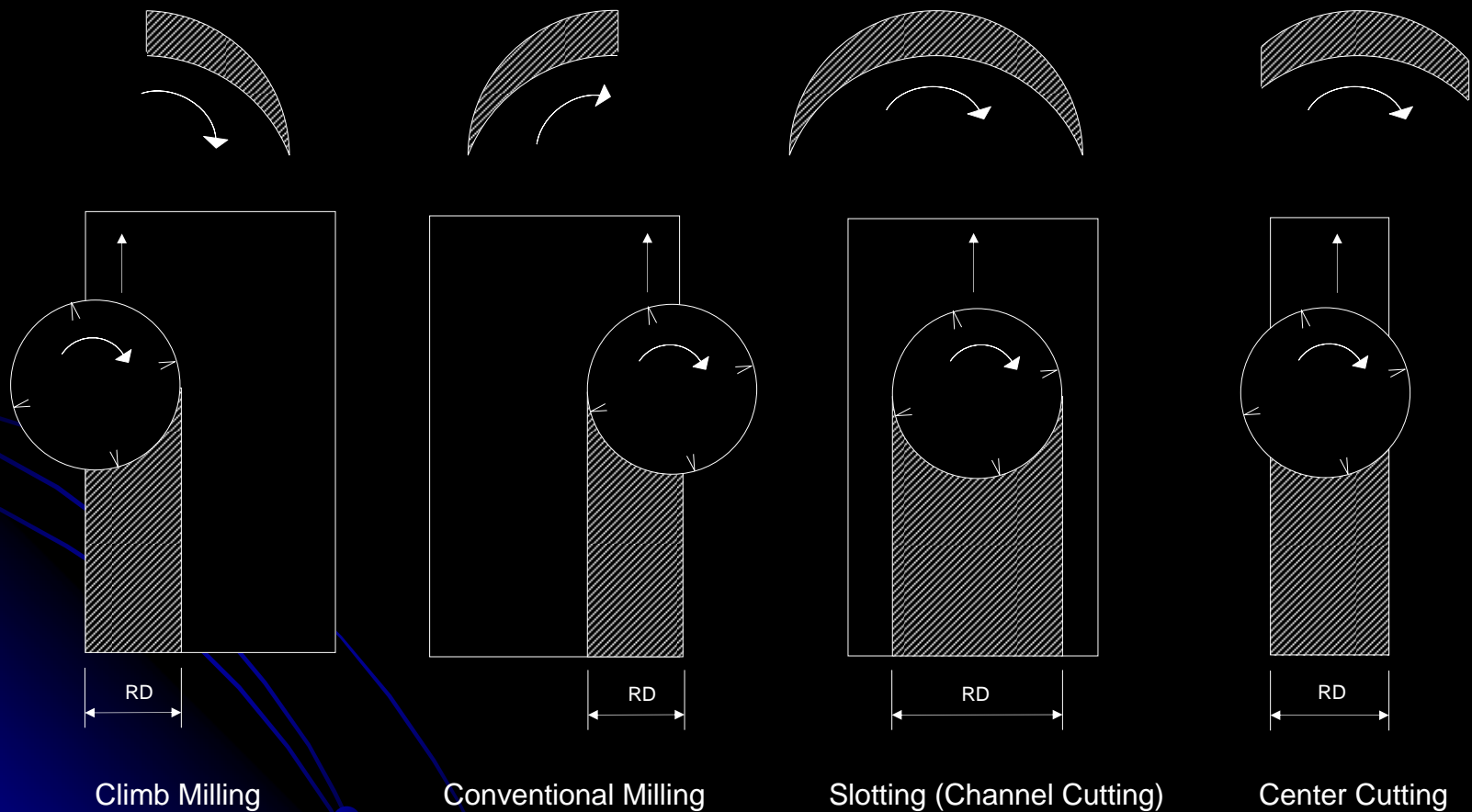
Examples of Cross-Sectional Area



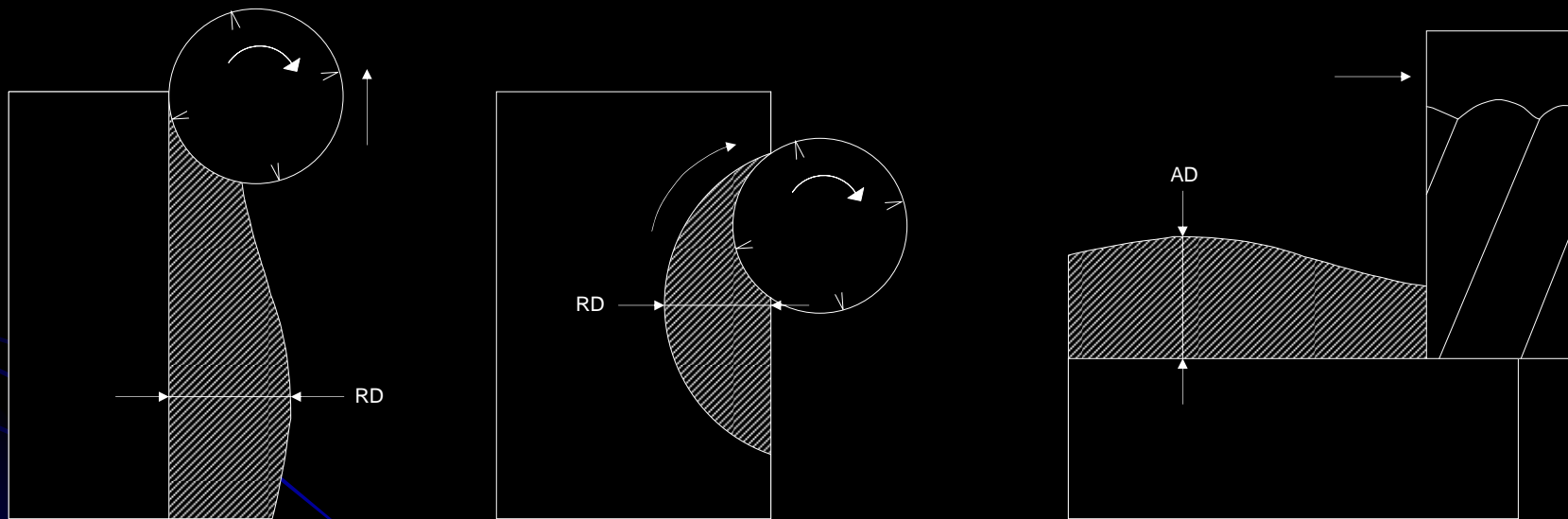
Engagement Locations



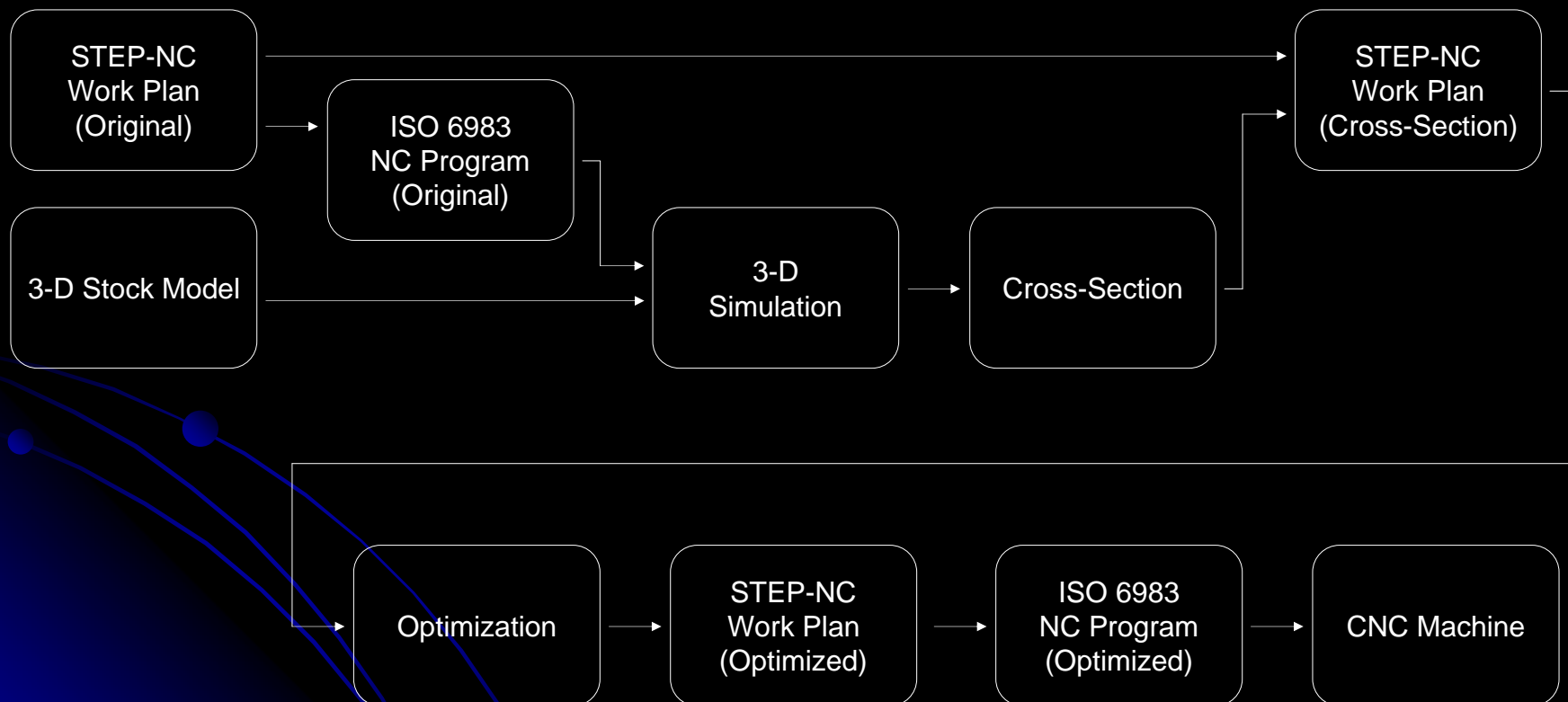
Engagement Start-End Conditions



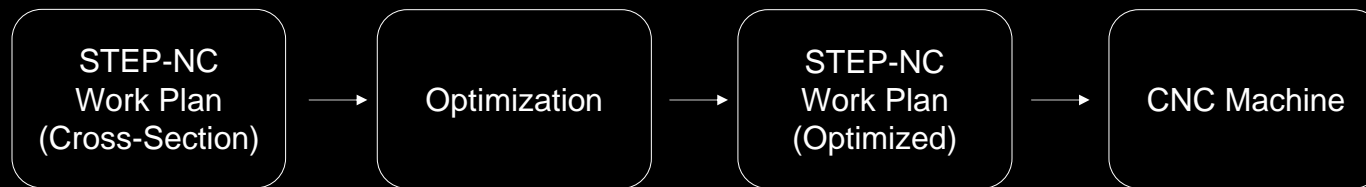
Maximum Engagement Conditions



Current Optimization Process



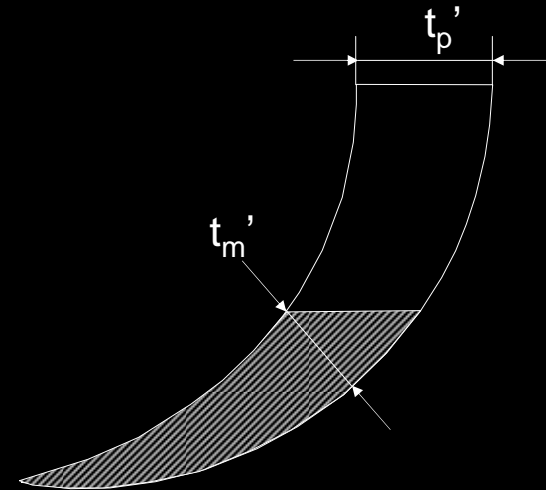
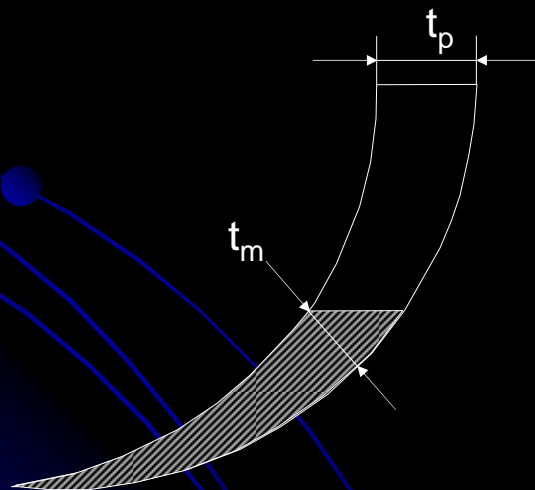
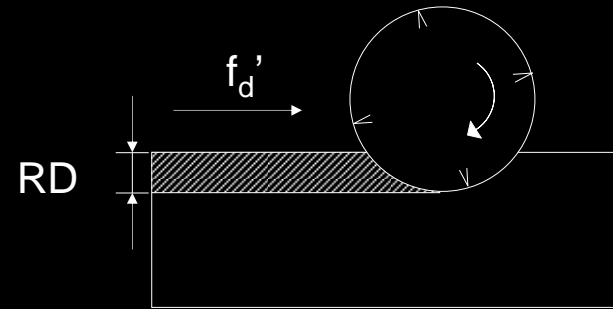
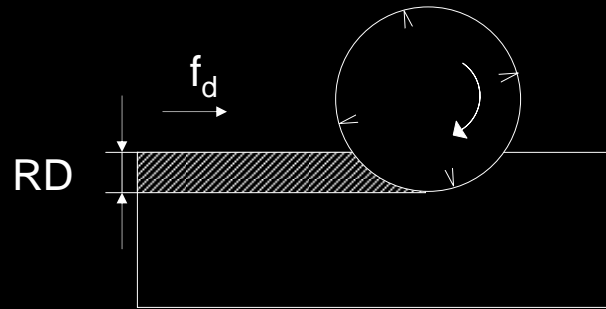
Future Optimization Process



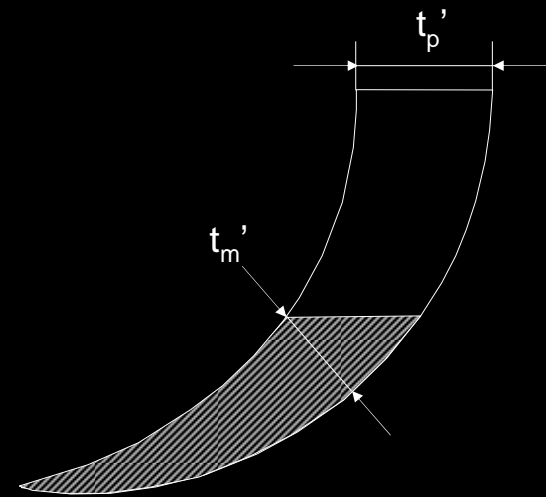
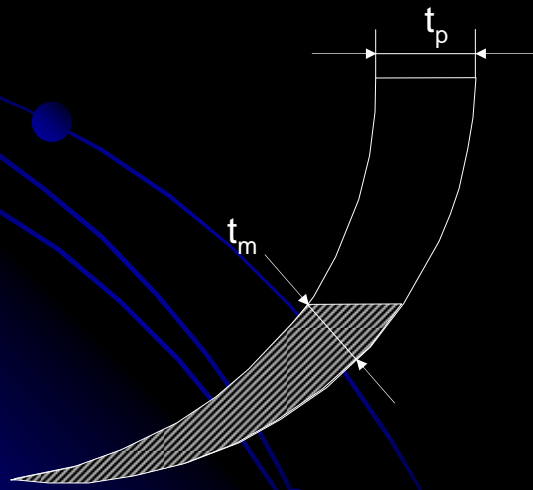
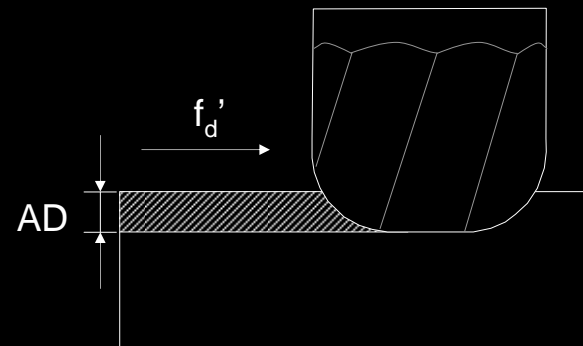
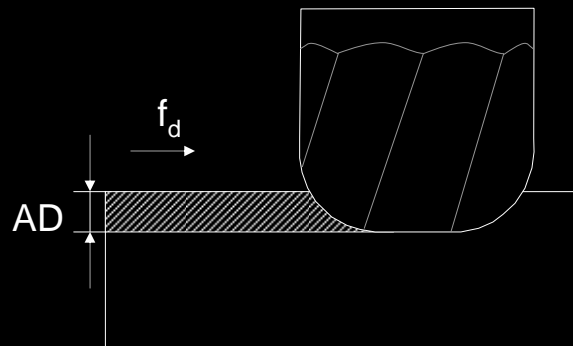
Optimization Methods

- Volume Based Optimization
- Force Based Optimization
- Tool Wear Optimization
- Constant Chip Optimization
- User-defined Optimization

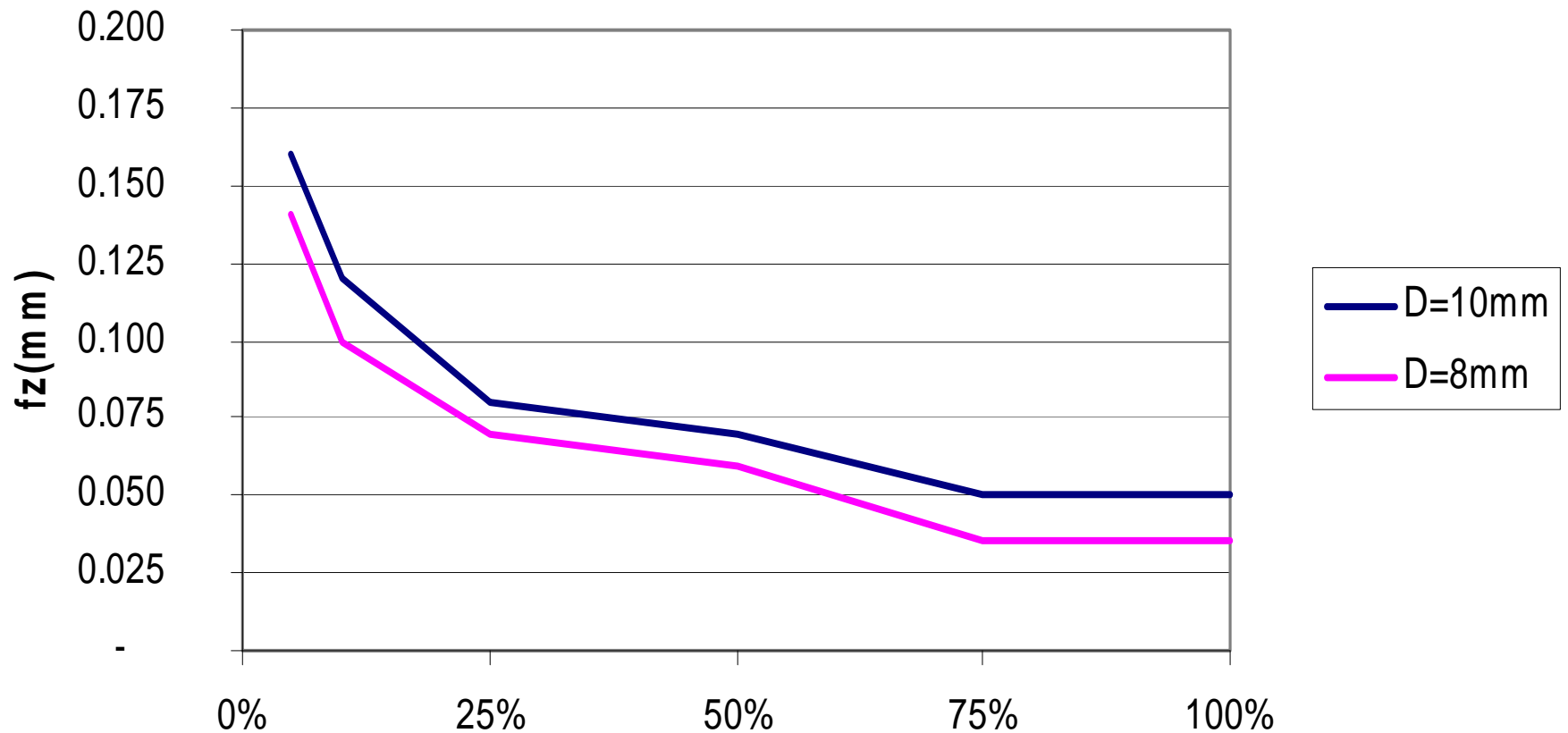
Radial Chip-Thinning Compensation



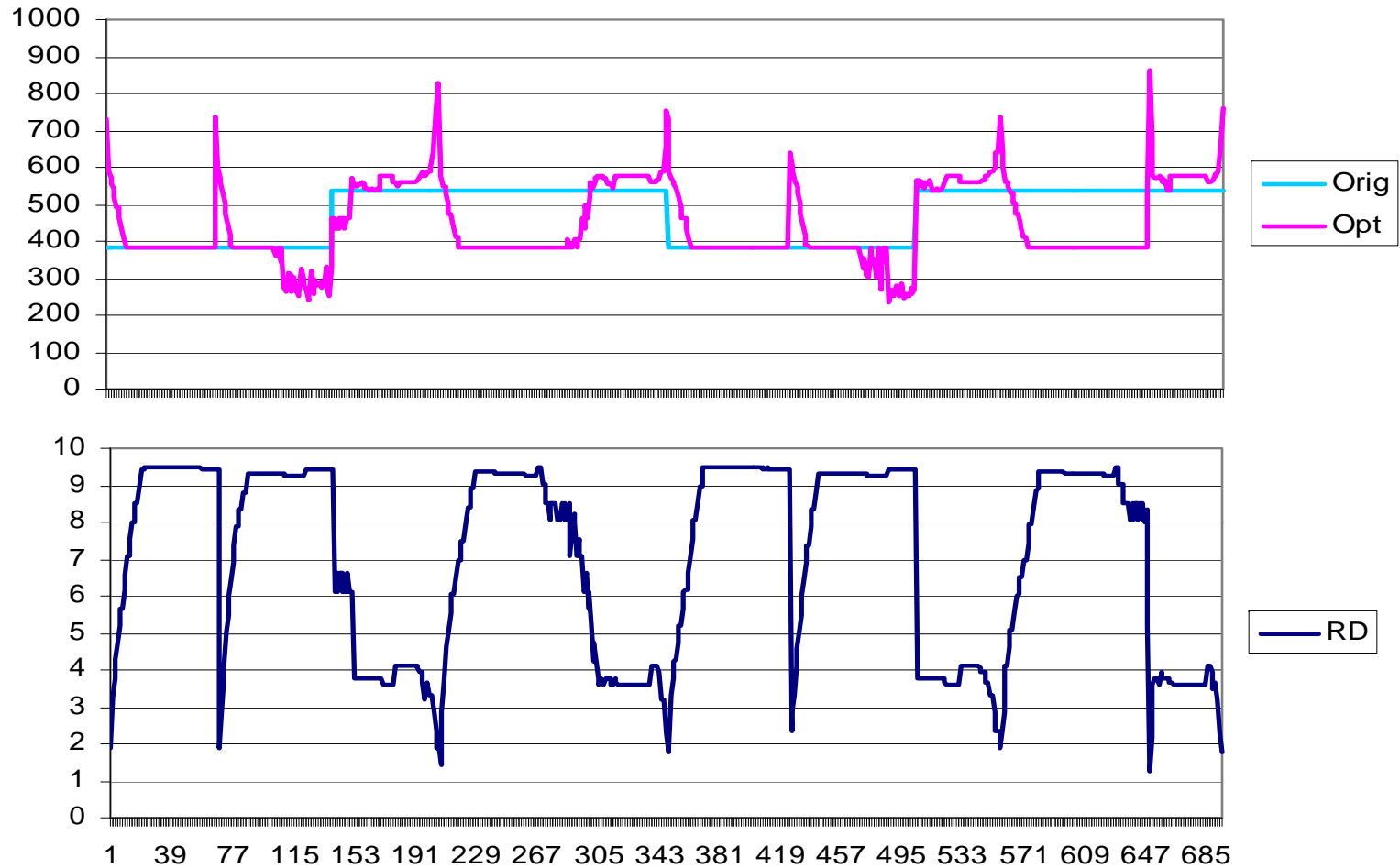
Axial Chip-Thinning Compensation



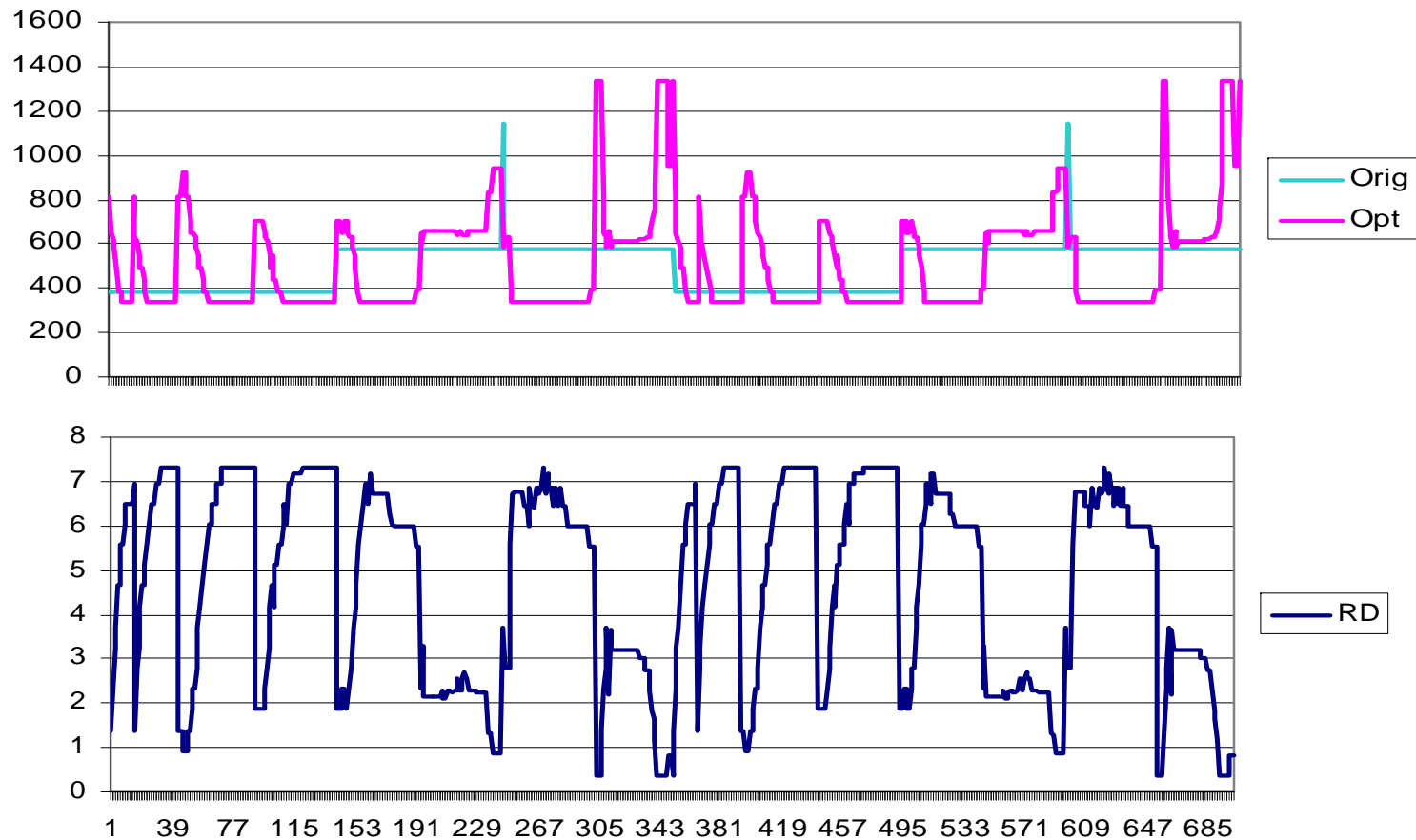
Feed/Tooth vs Radial Immersion



Feed and Radial Depth (T7)



Feed and Radial Depth (T9)



Feed Optimization

STEP-NC Explorer - impeller_alternate_1_cross_section_20080923_opt

File View Setup Simulate Tolerances Probing Help

Views Position Cross Section Simulation

Model Tools for WS Features for WS Tolerances for WS Probing

Stock Part Fixture Tool AS IS TO BE Delta

- ro2 - 45 degree #556975
- ro2 - 90 degree #556984
- ro2 - 135 degree #556993
- ro2 - 180 degree #557002
- ro2 - 225 degree #557011
- ro2 - 270 degree #557020
- ro2 - 315 degree #557029
- WP r03 #562295
 - ro3 - 0 degree #557038
 - ro3 - 45 degree #557047

Tool Position

X: -58.3813
 Y: -12.9958
 Z: -101.6805

I: -0.5561
 J: 0.1291
 K: 0.821

Feed: 659.29 (123%)

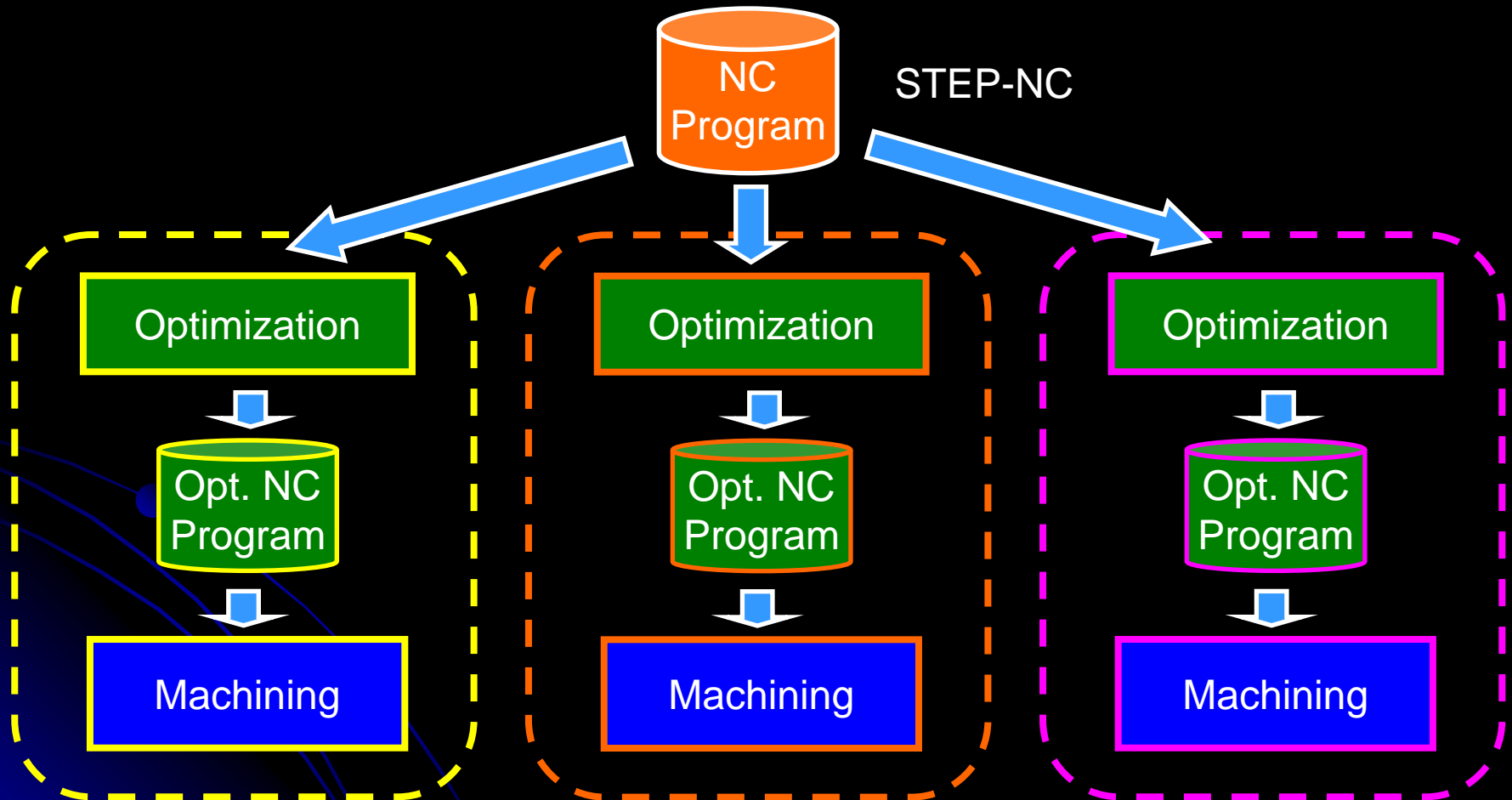
Base: 535
 RPM: 1910 CW

Toolpath Cross Section

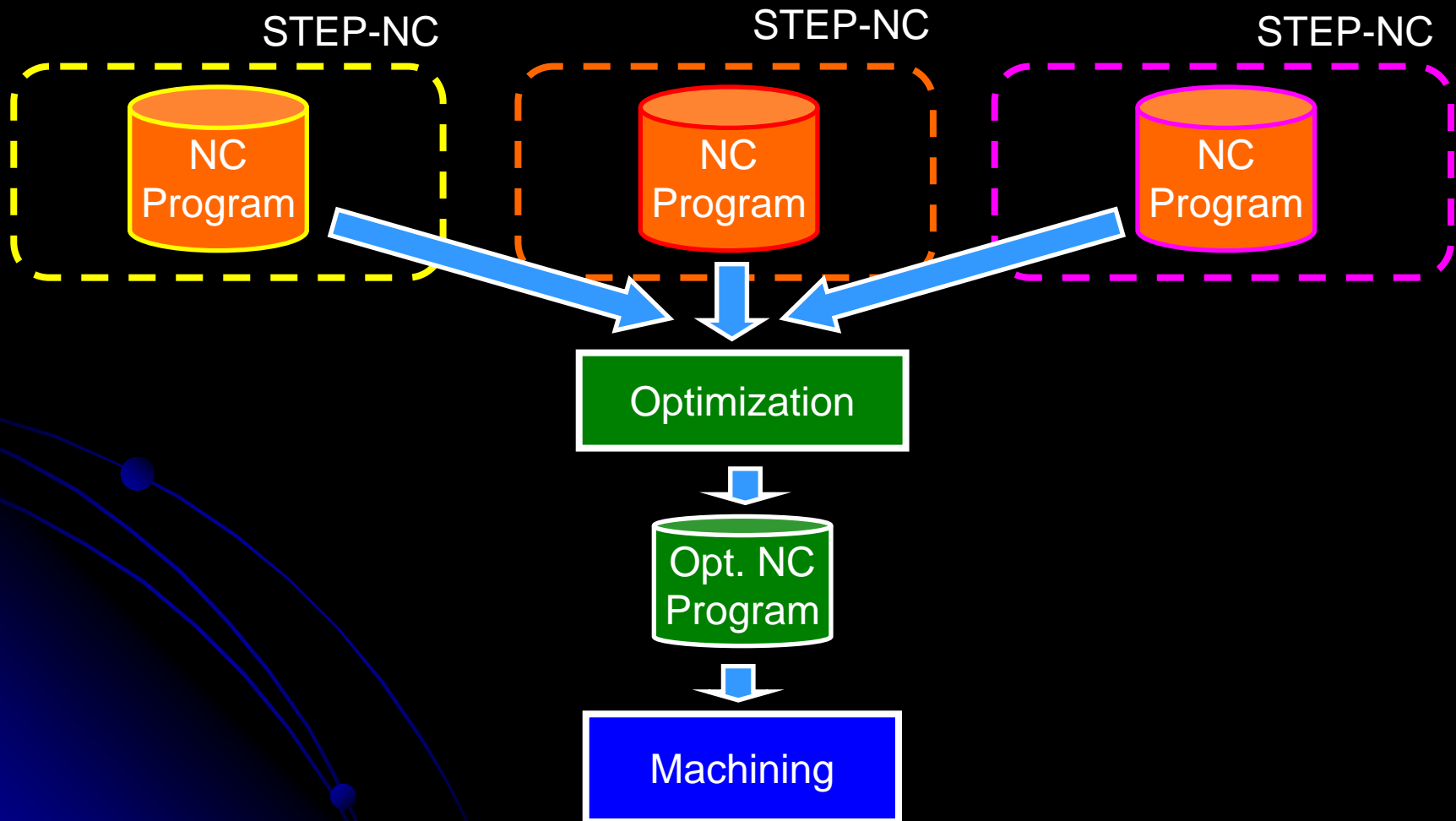
Name: Line 28940

	(stored)	(calc)	(TC params calc)
RC Max:	0.79	0.0	RD Max: 0.0
AC Max:	6.28	0.0	AD Max: 0.0
X ofs:	9.22	0.0	X ofs: 0.0
Y ofs:	4.19	0.0	Y ofs: 0.0

Optimization for Different Machines

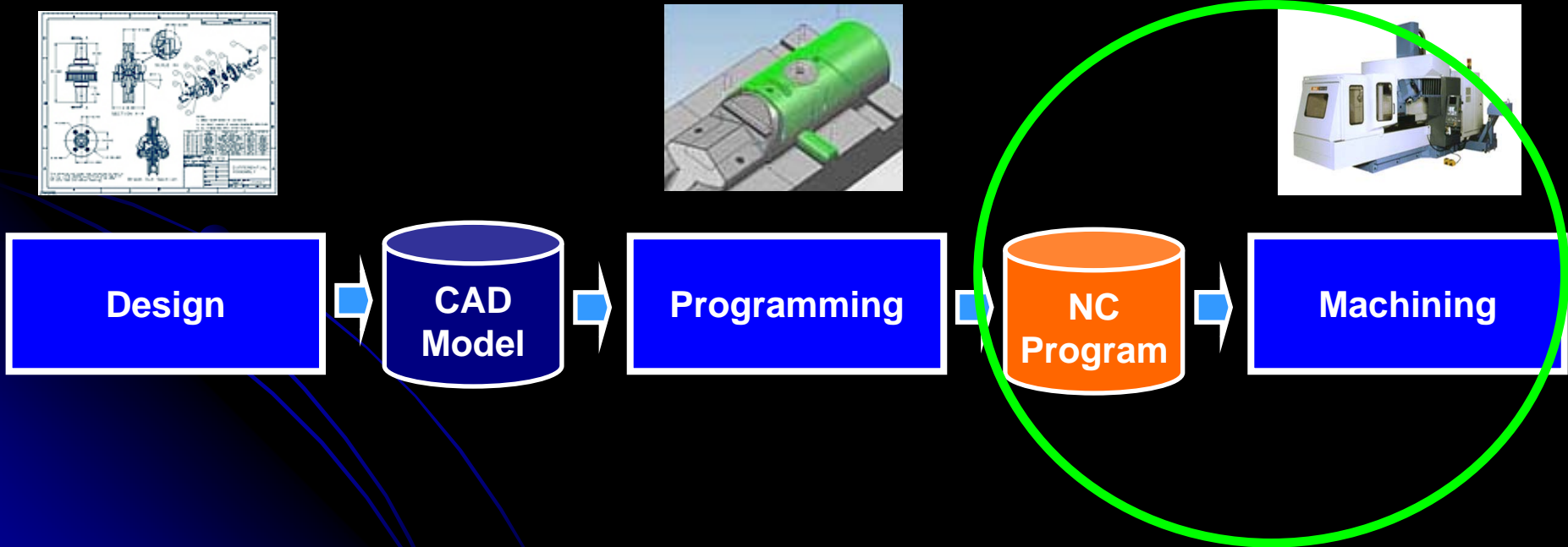


Optimization of Different Programs



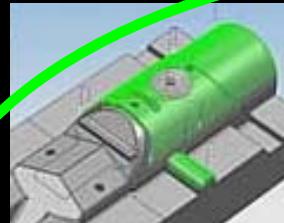
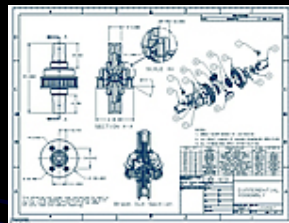
Machining Process Optimization

- Feed and speed



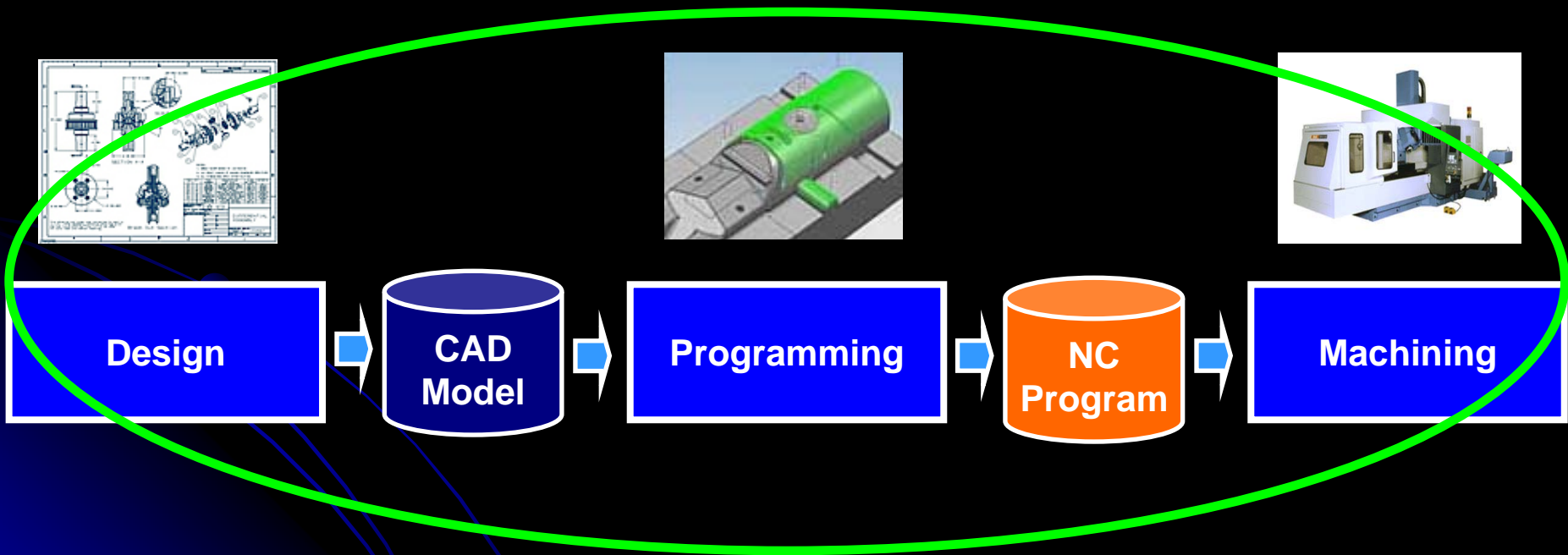
Machining Planning Optimization

- Feed and speed
- Path trajectory, radial and axial depths, number of passes...

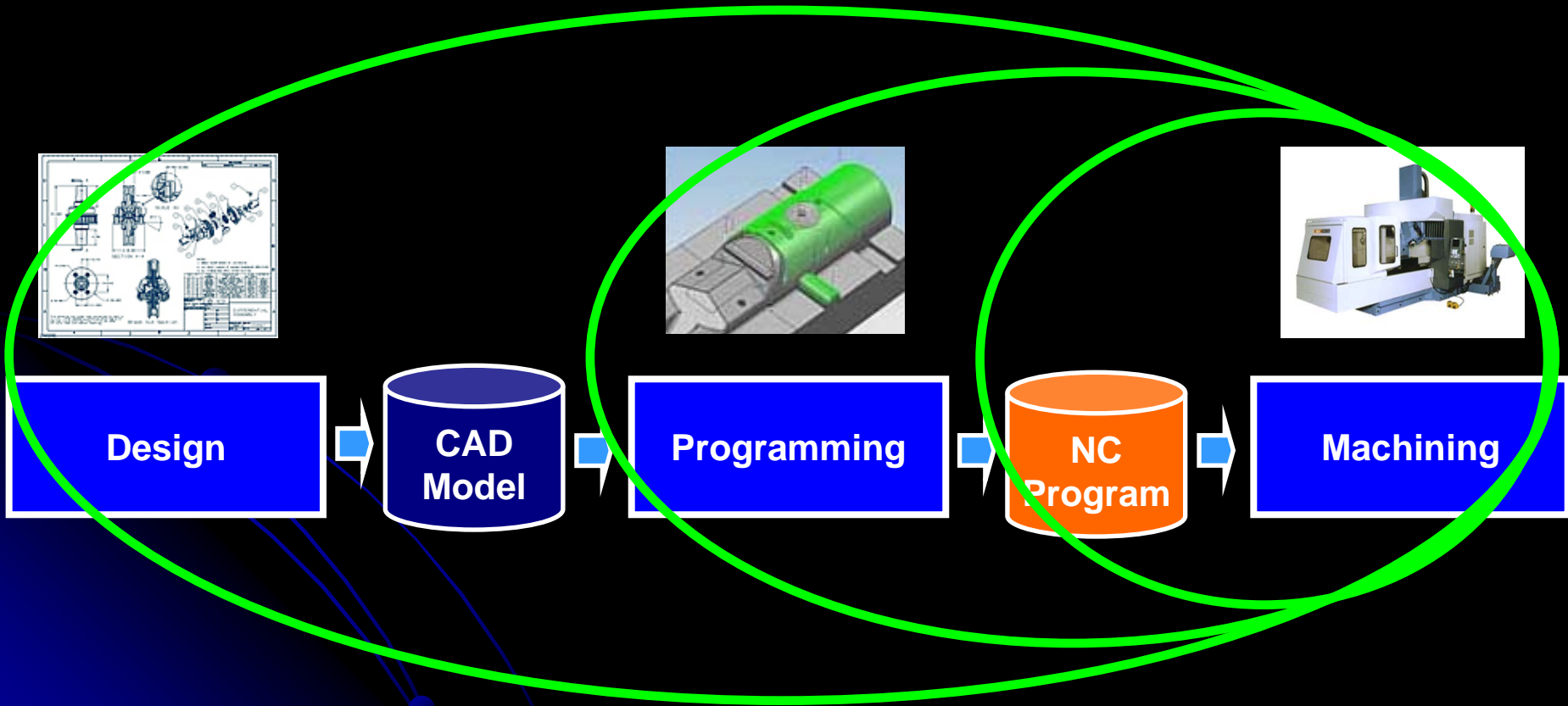


Machining Design Optimization

- “Machining friendly” feature design



Total Manufacturing Optimization





Thank you!