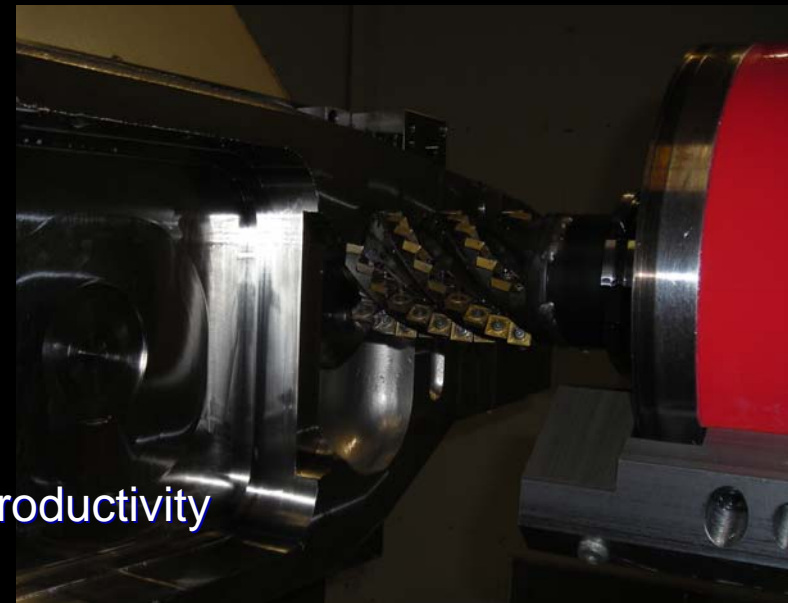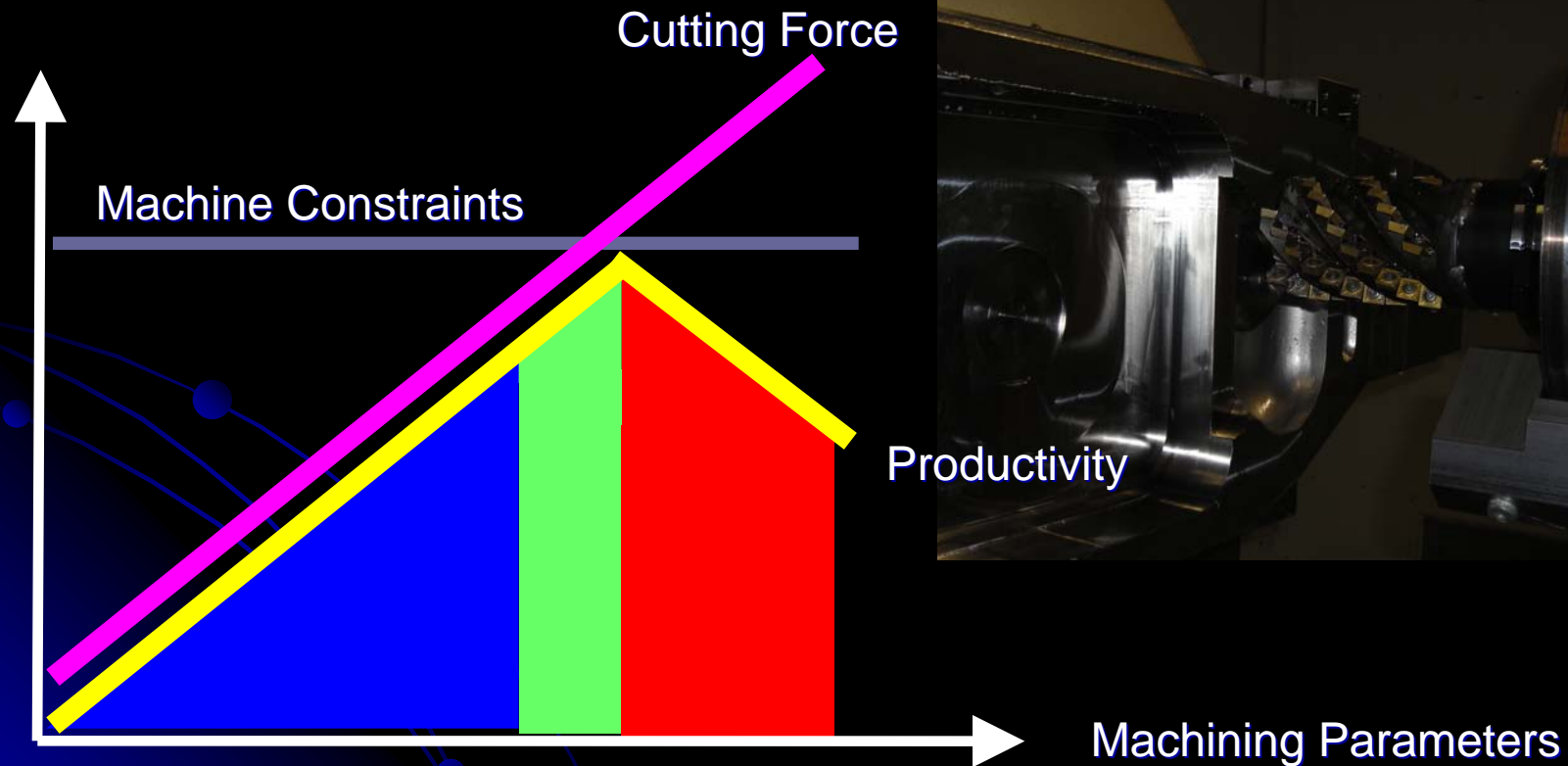# Machining Process Optimization with ISO 10303-238
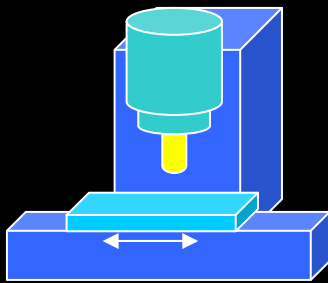
Leon Xu

The Boeing Company

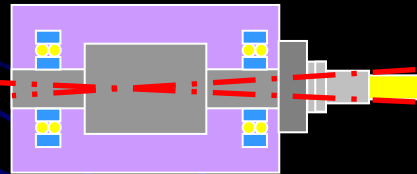# Machining Process Optimization
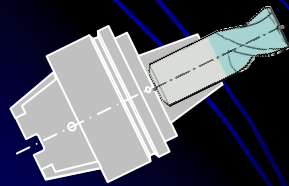
Machining System Constraints

Machine/spindle capability

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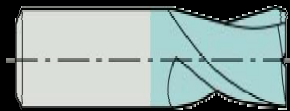- Axis torque and speed

System structural dynamics

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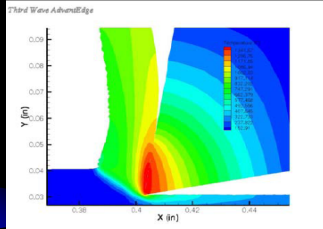- Cutting tool/holder/spindle

Cutting tools

- Edge rigidity
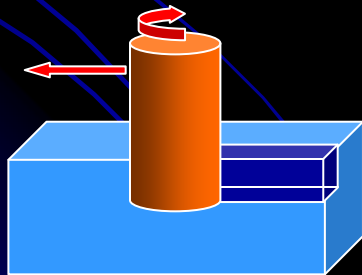- Surface velocity
- Rotational speed
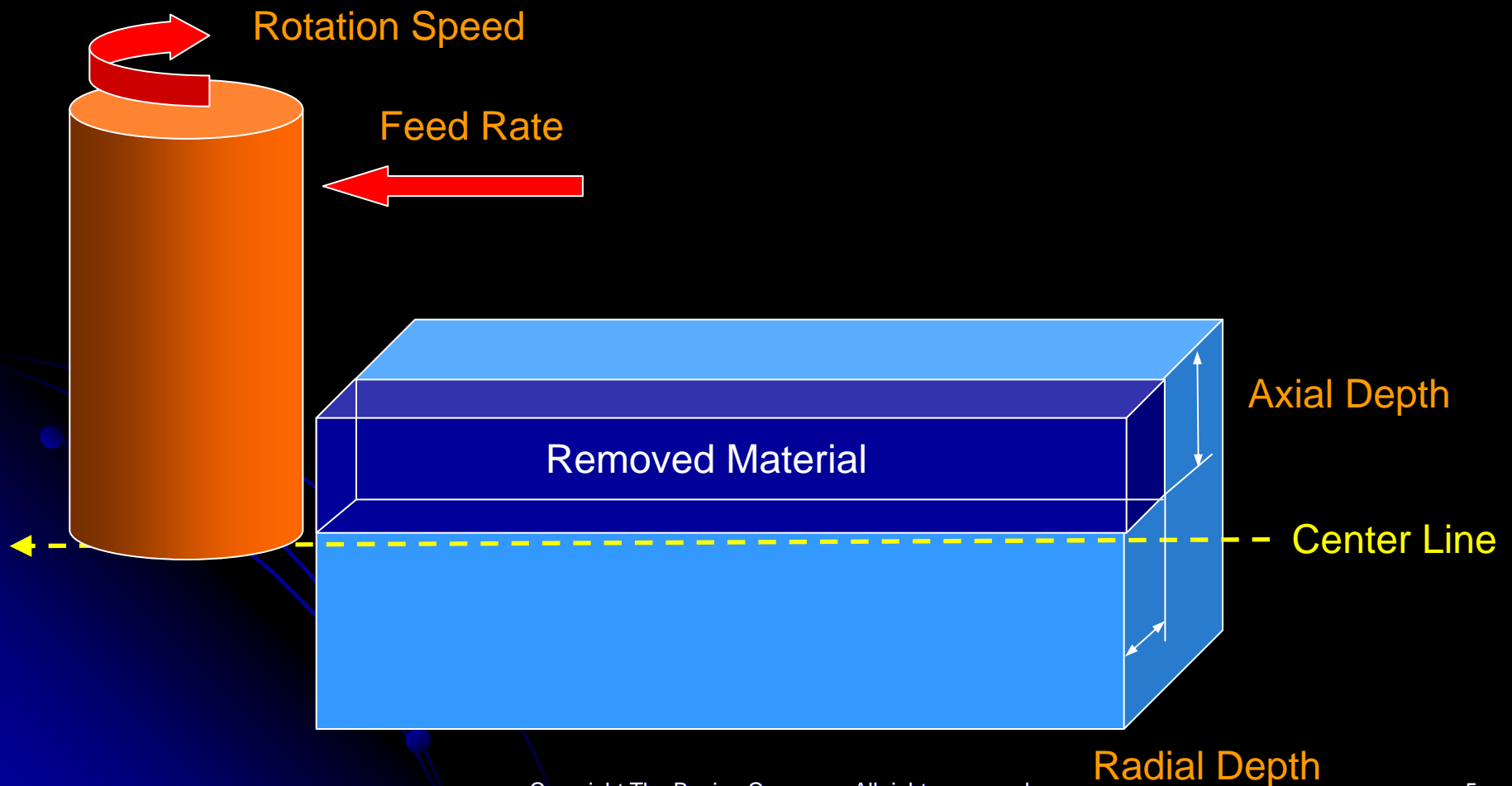- Wear

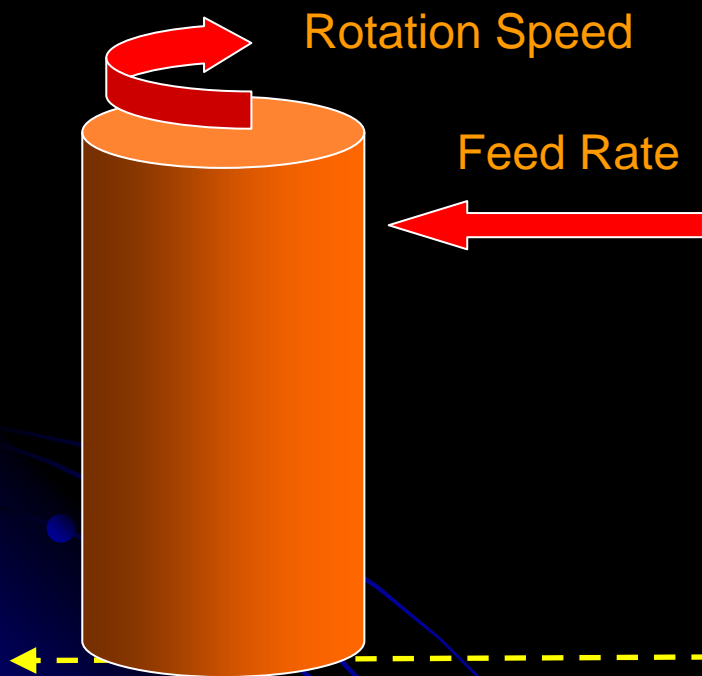# Affecting Factors

Cutting tool dimensions

Material properties

Machining parameters

Cutting Parameters and Path Geometry

Rotation Speed

Feed Rate

Removed Material

Axial Depth

Center Line

Radial Depth

5

Information in M-G Code (ISO 6983)

Rotation Speed

Feed Rate

```
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

Rotation Speed

Feed Rate

Removed Material
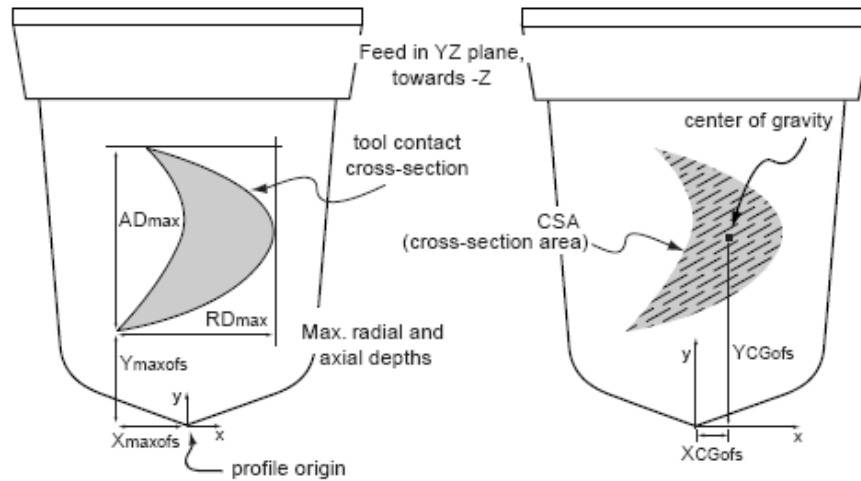
Axial Depth

Center Line

Radial Depth
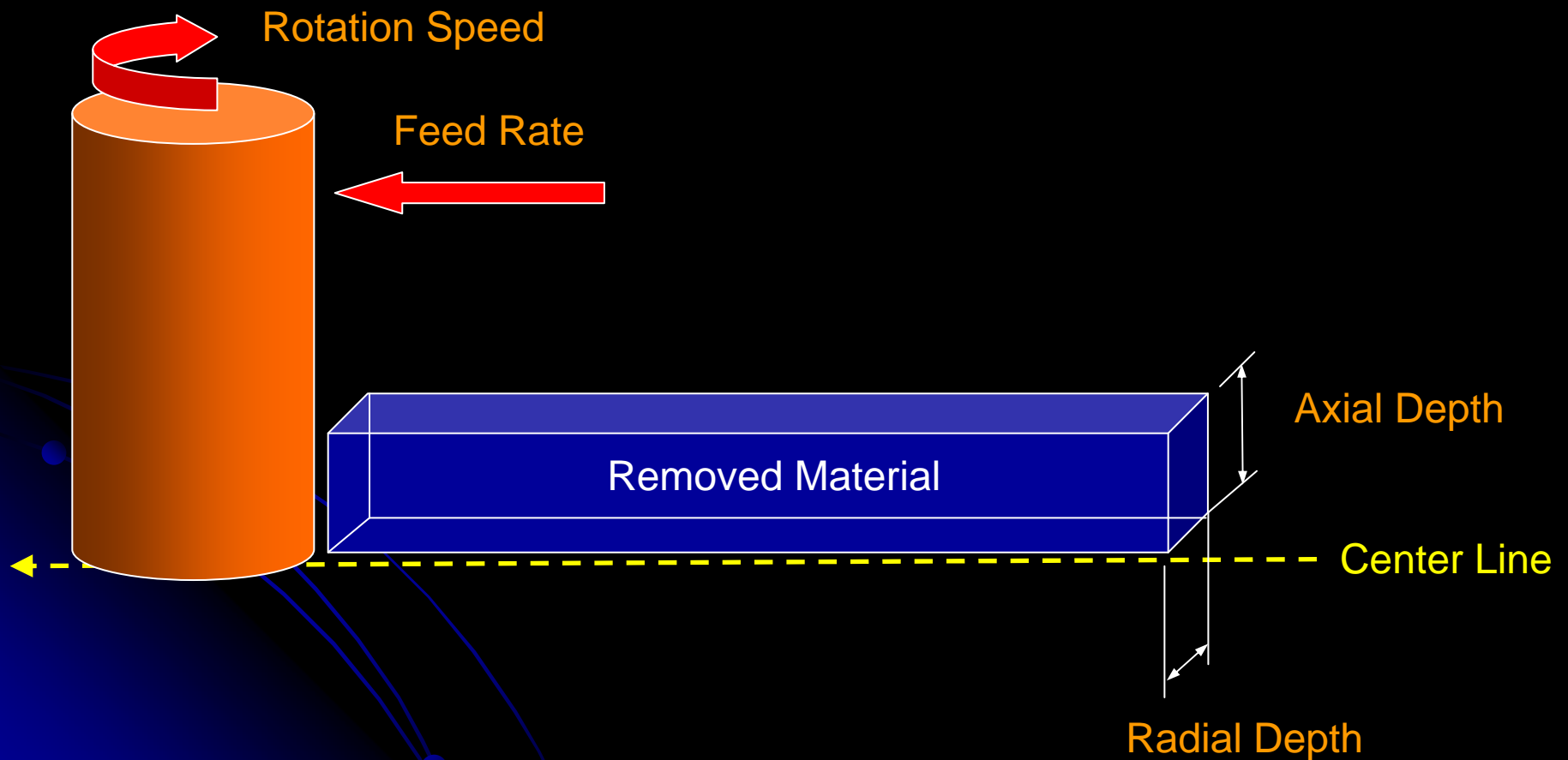
Cross-Sectional Area in ISO 10303-238
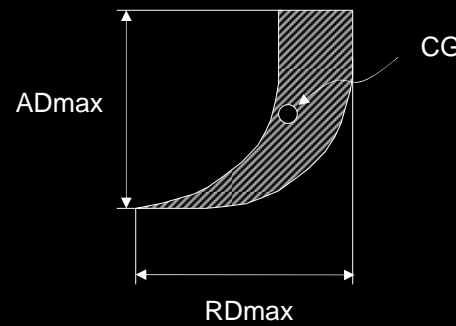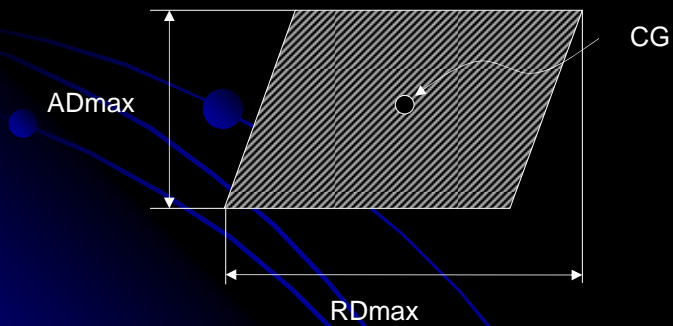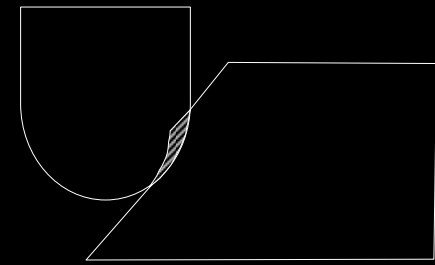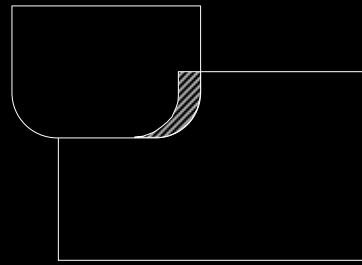

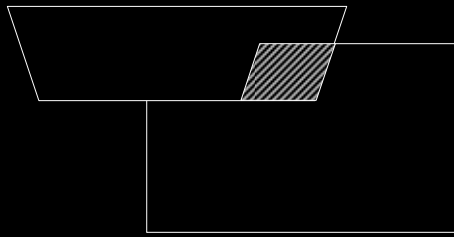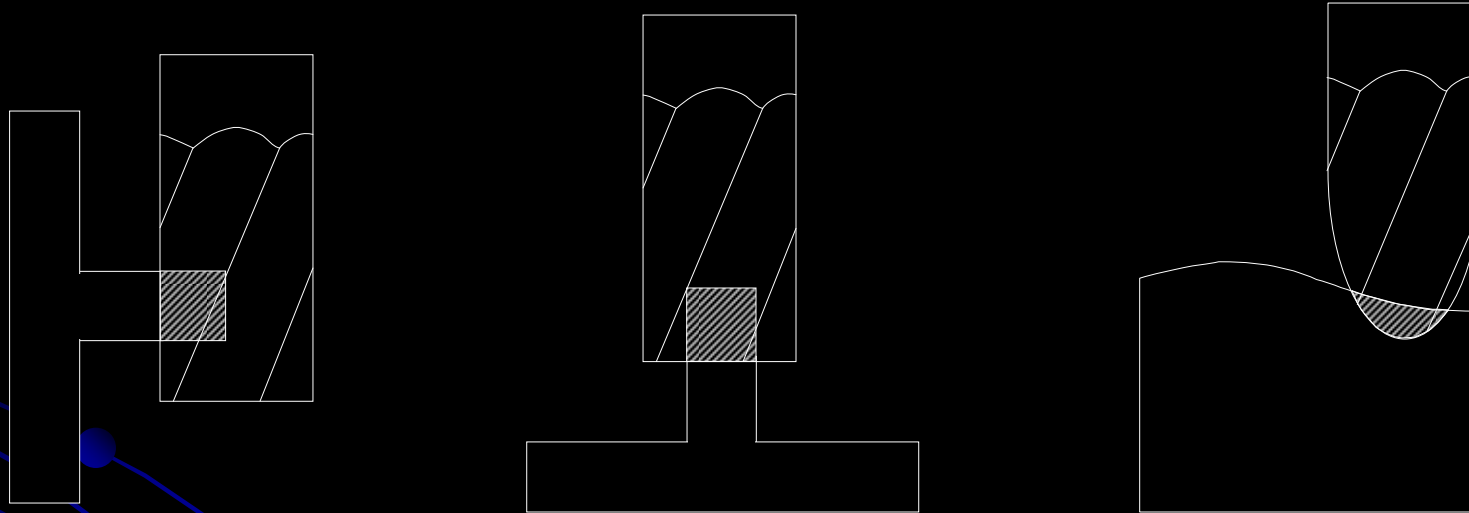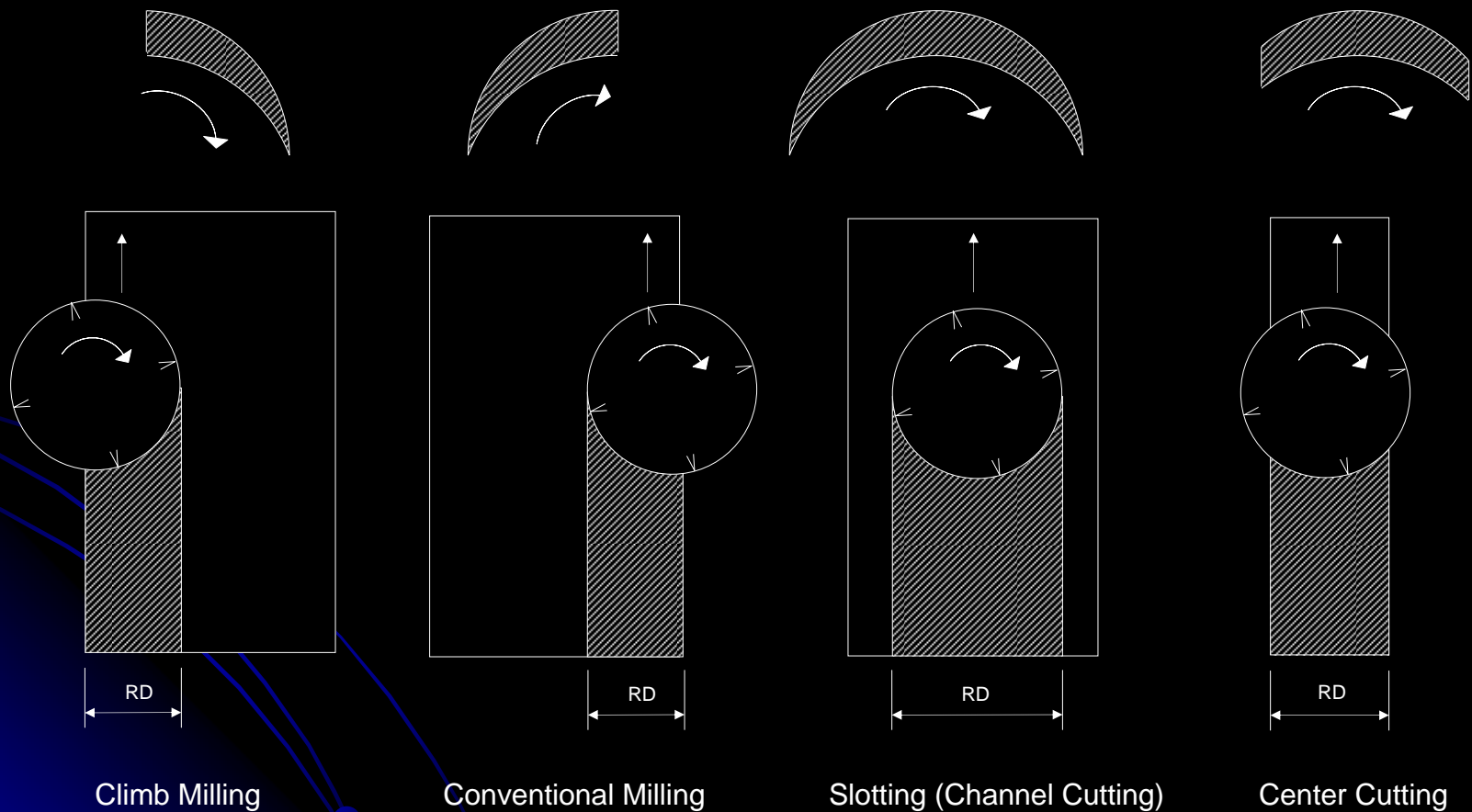Figure 34 - Cross-section parameters for milling
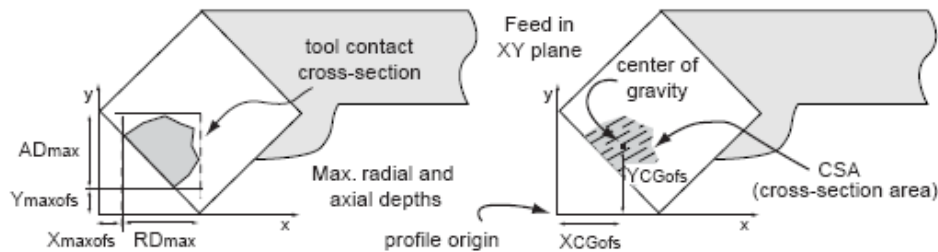
Figure 35 - Cross-section parameters for turning

Examples of Cross-Sectional Area
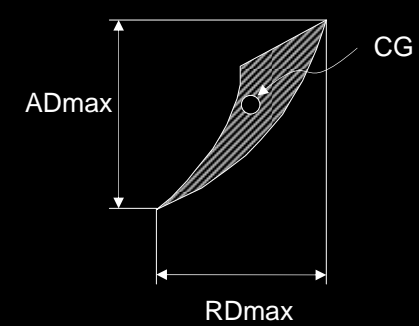
Engagement Locations

Engagement Start-End Conditions

Climb Milling   Conventional Milling   Slotting (Channel Cutting)   Center Cutting

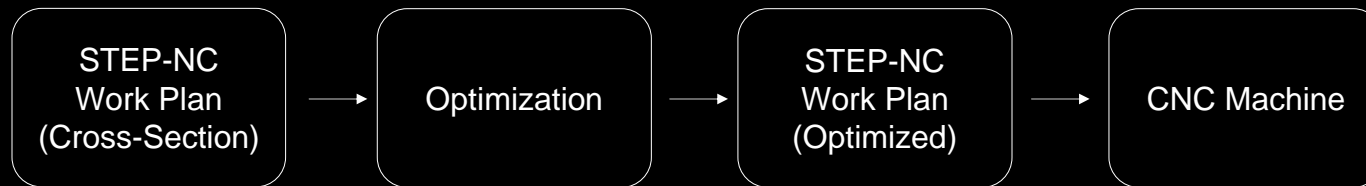# Maximum Engagement Conditions
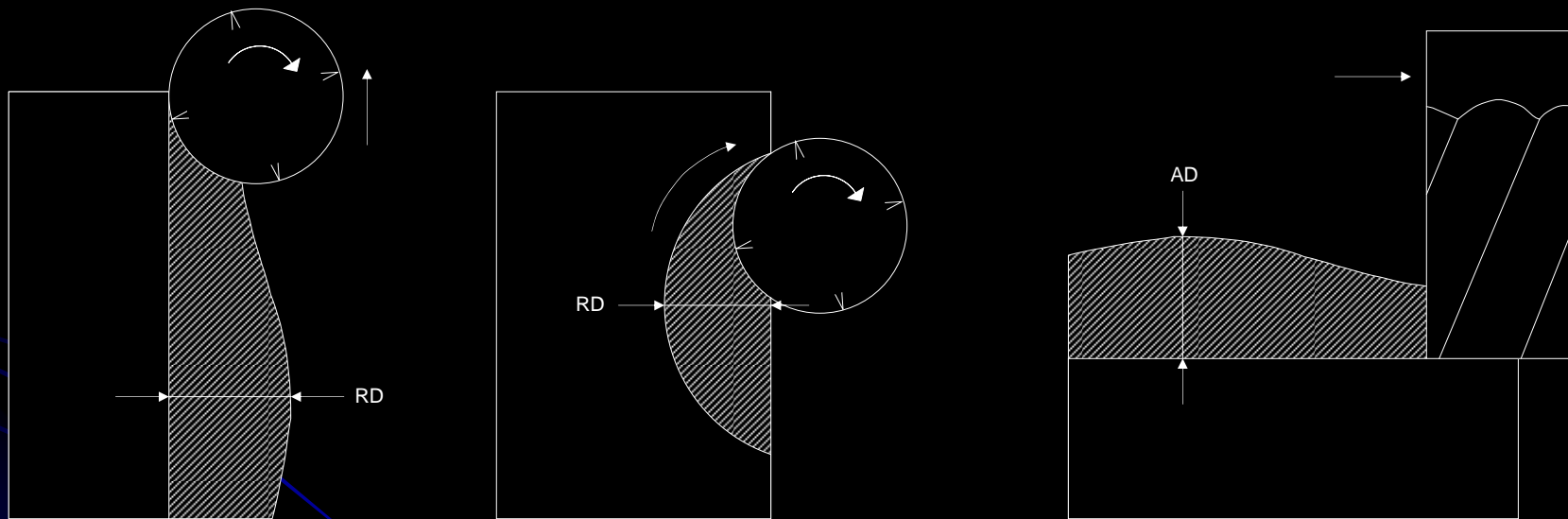
Current Optimization Process
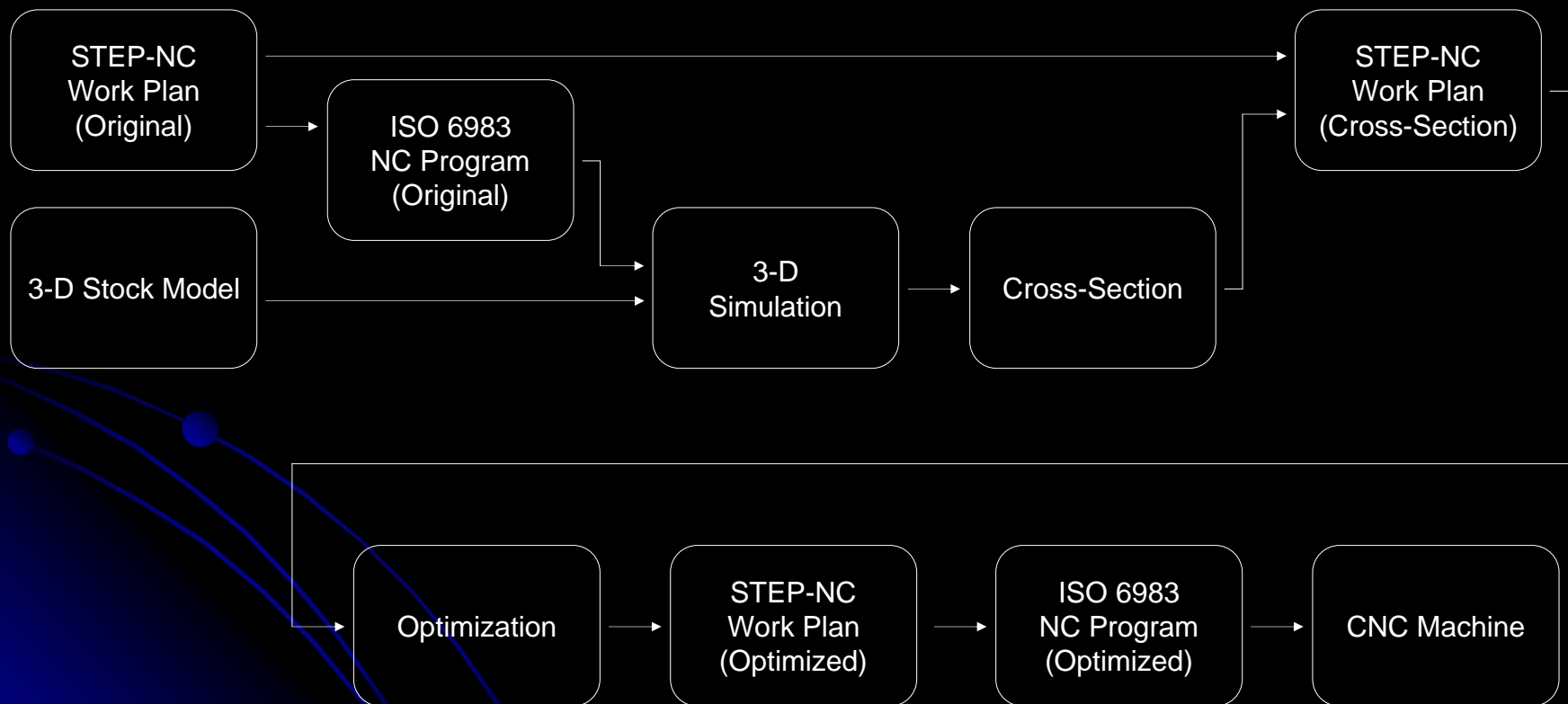
Future Optimization Process

STEP-NC Work Plan (Cross-Section) → Optimization → STEP-NC Work Plan (Optimized) → CNC Machine
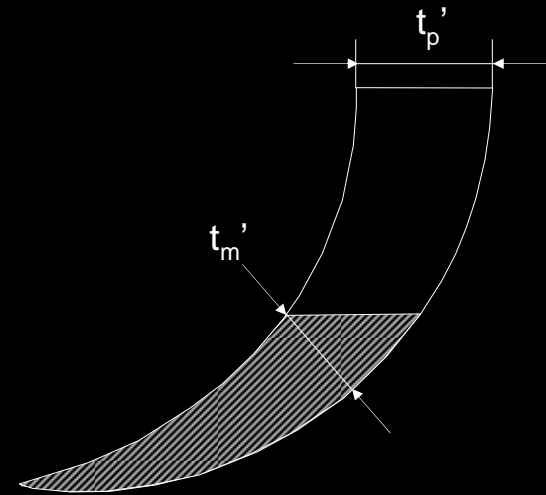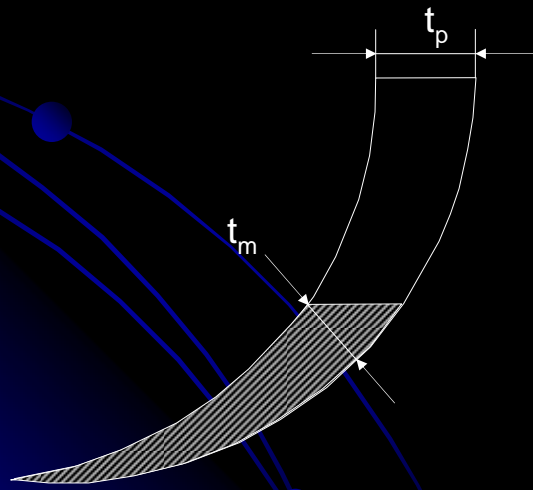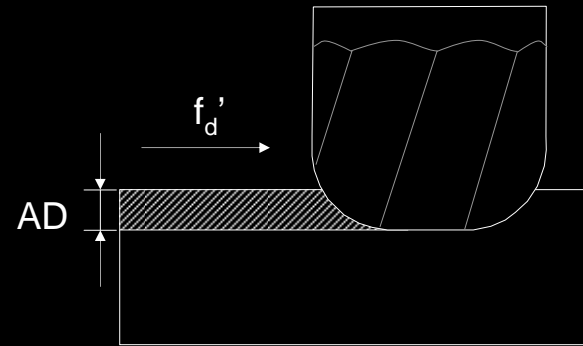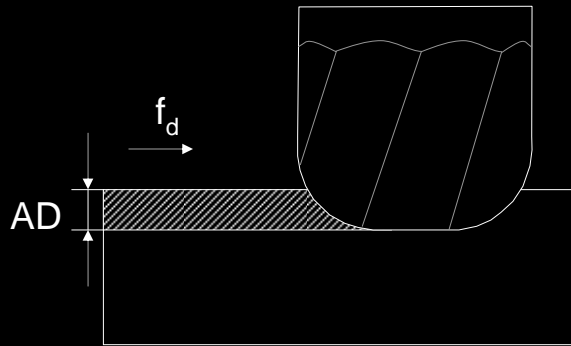
Optimization Methods

- Volume Based Optimization

- Force Based Optimization

- Tool Wear Optimization

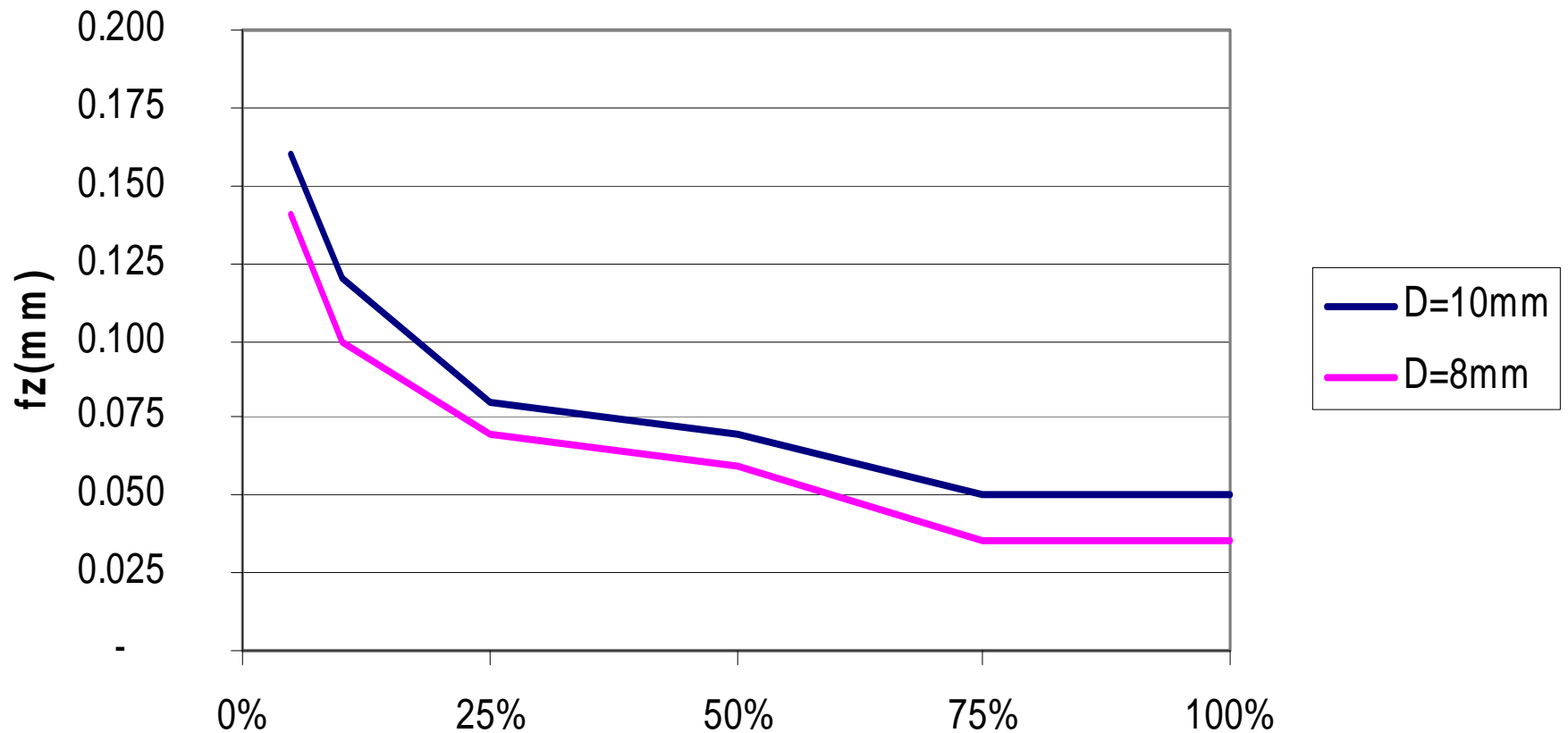- Constant Chip Optimization

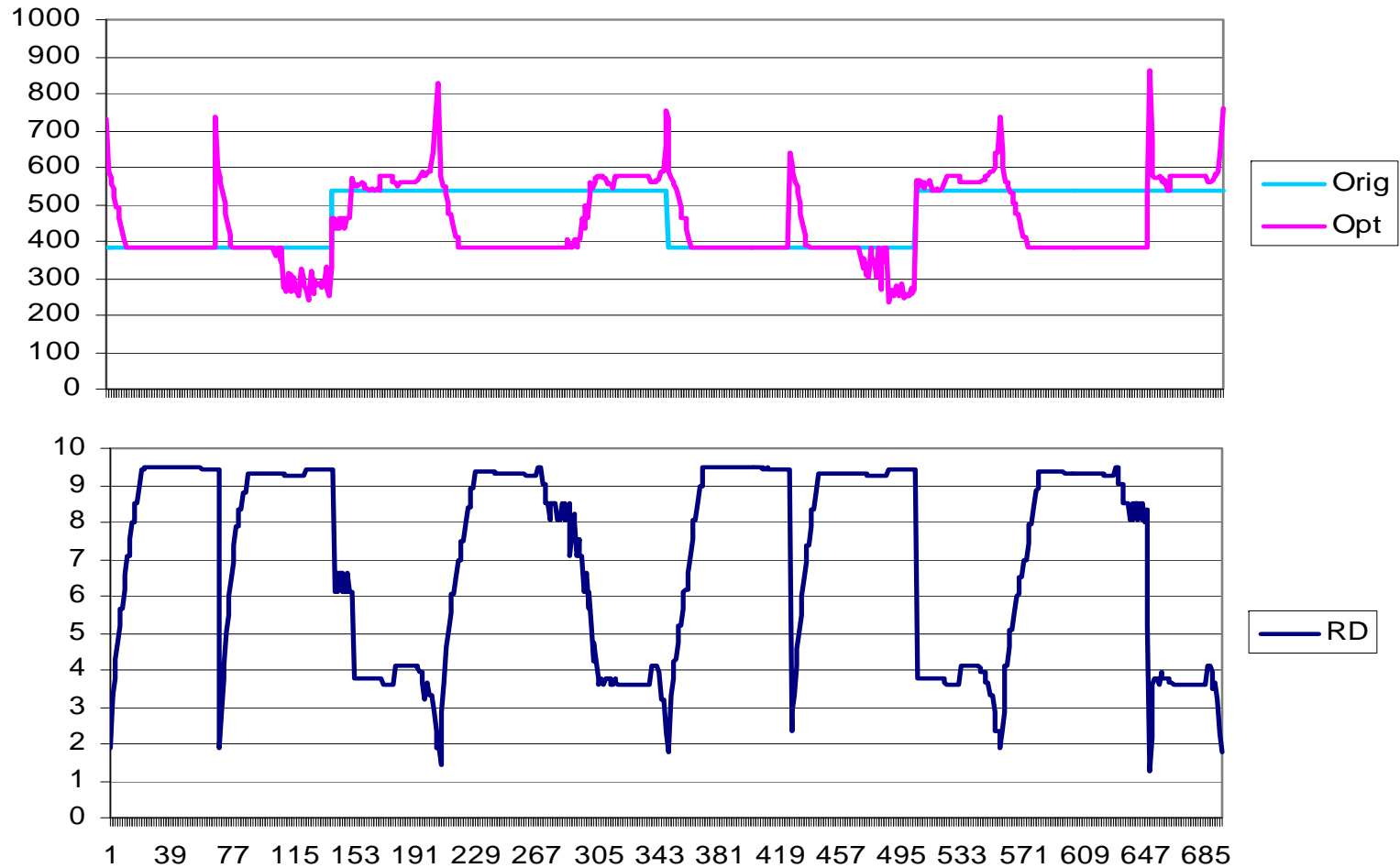- User-defined Optimization

Radial Chip-Thinning Compensation
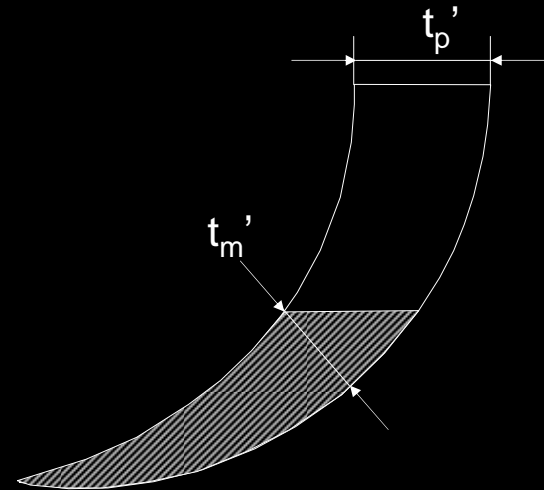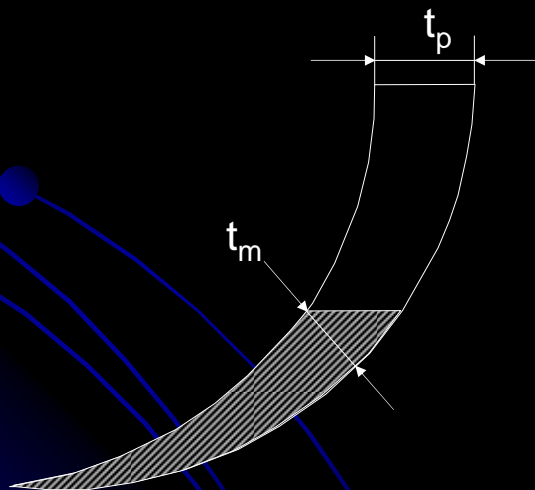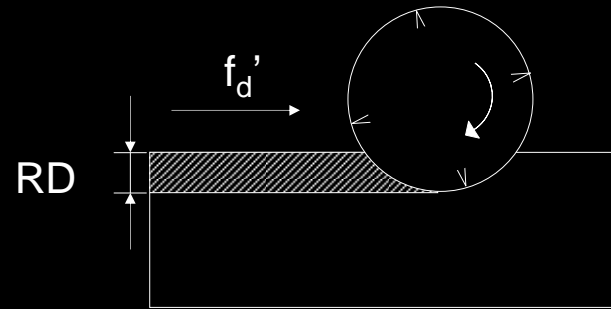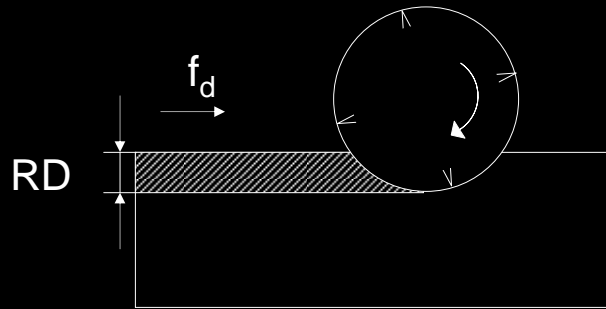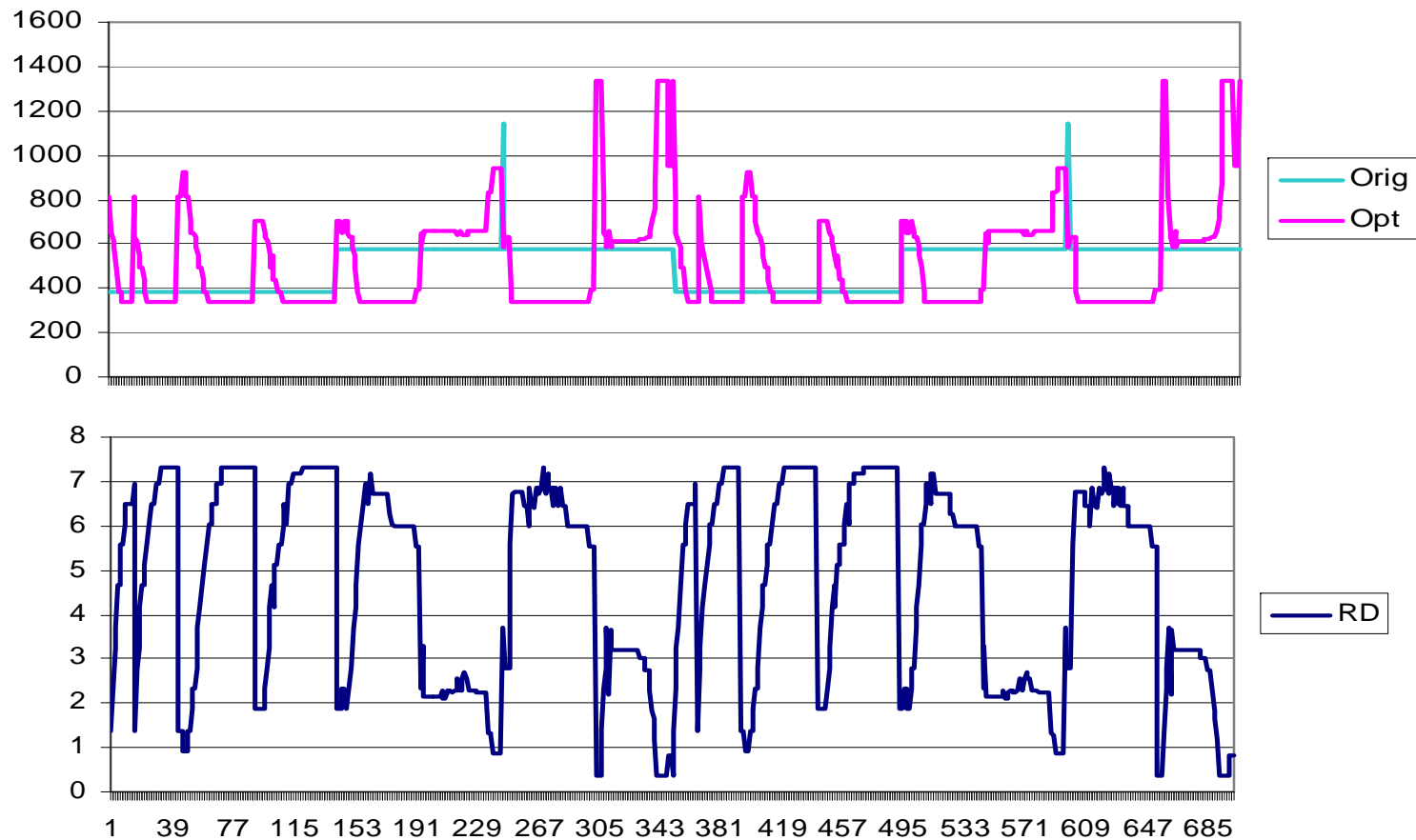
Axial Chip-Thinning Compensation

f_d

AD

$f_d{'}$

AD

t_p

t_m

$t_p{'}$

$t_m{'}$

Feed/Tooth vs Radial Immersion

Feed and Radial Depth (T7)

Feed and Radial Depth (T9)

Feed Optimization

Optimization for Different Machines
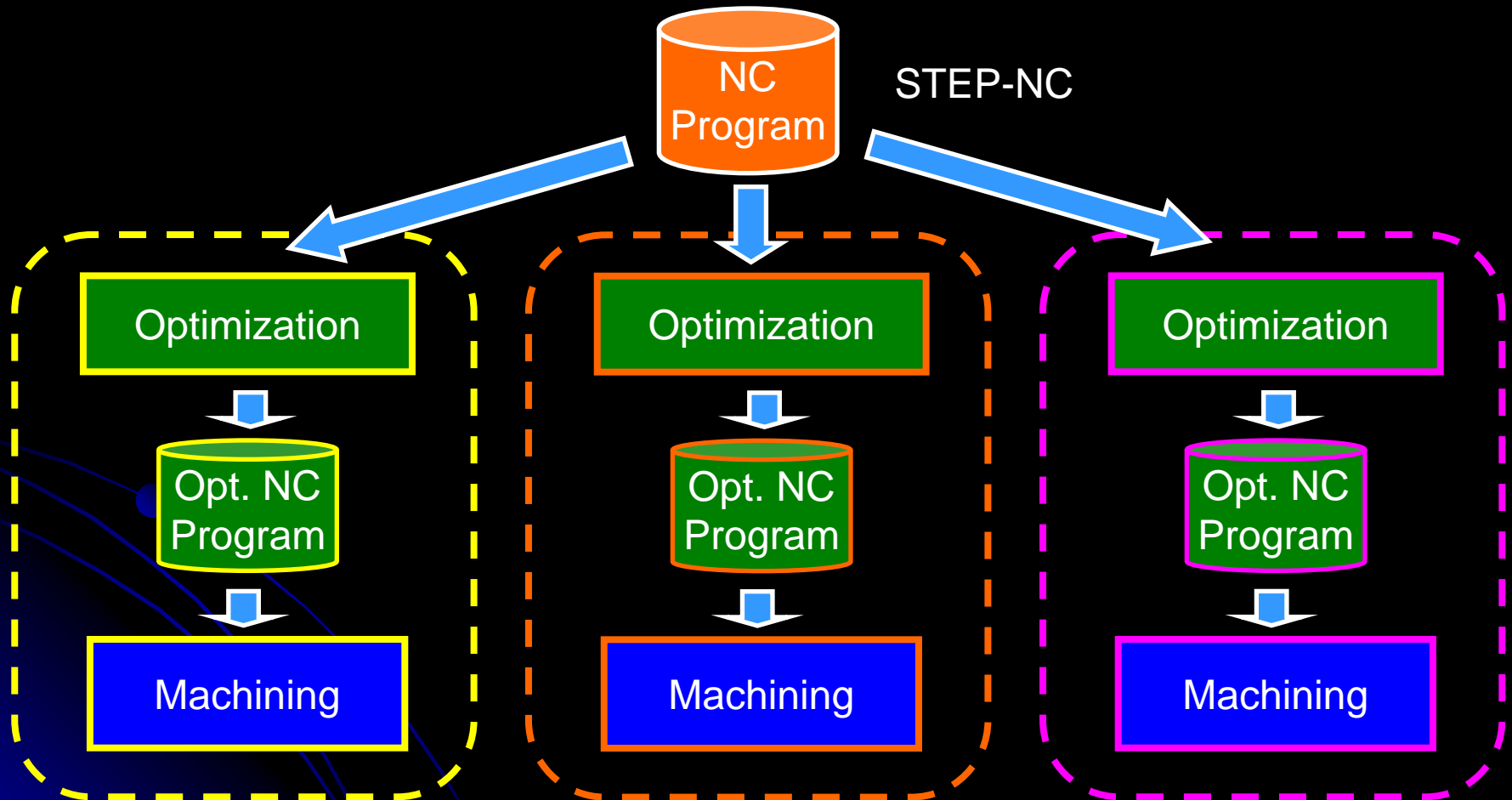
Optimization of Different Programs

STEP-NC

STEP-NC

STEP-NC

NC Program

NC Program

NC Program

Optimization

Opt. NC Program

Machining

Machining Process Optimization

- Feed and speed

Design → **CAD Model** → **Programming** → **NC Program** → **Machining**
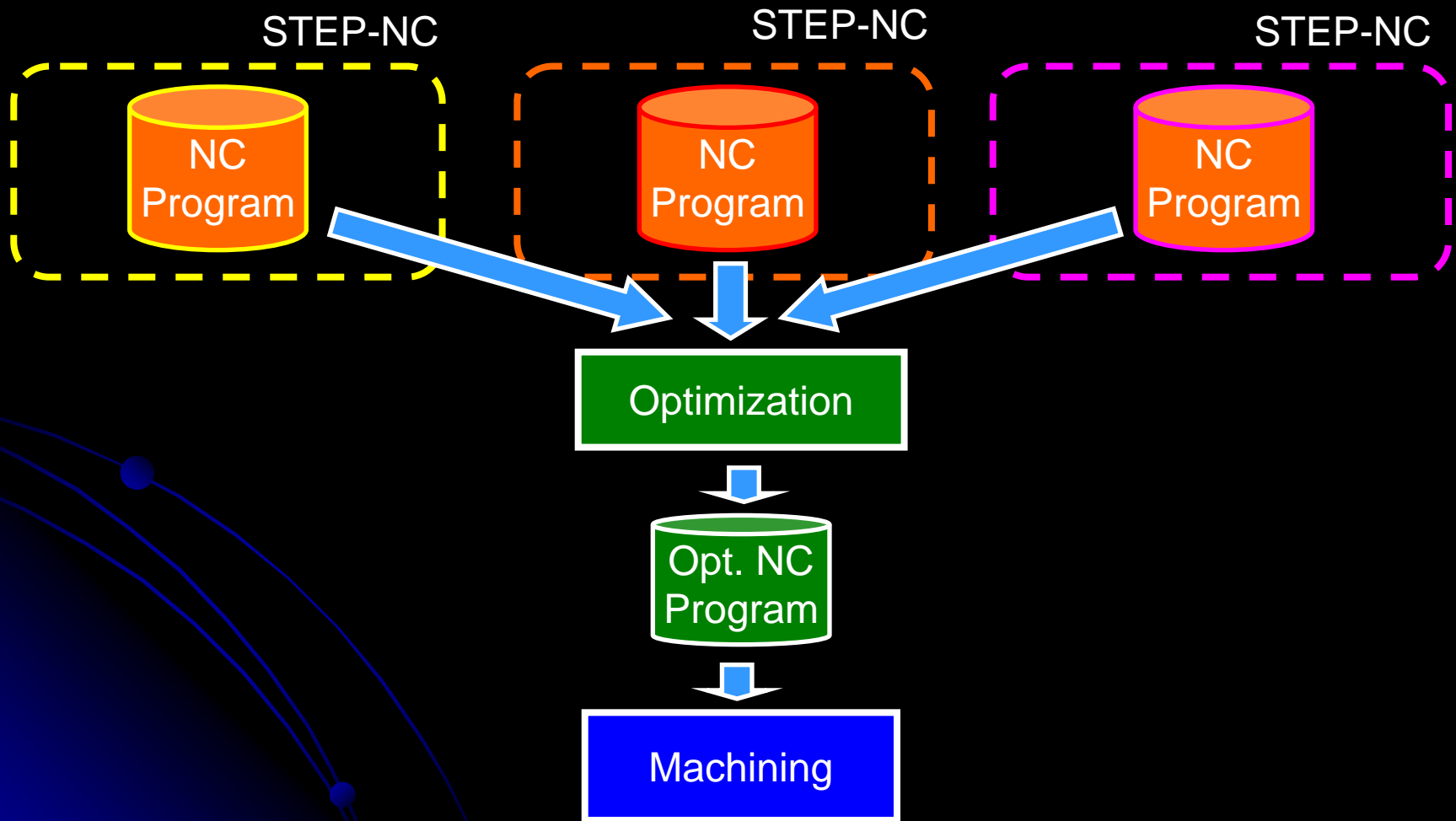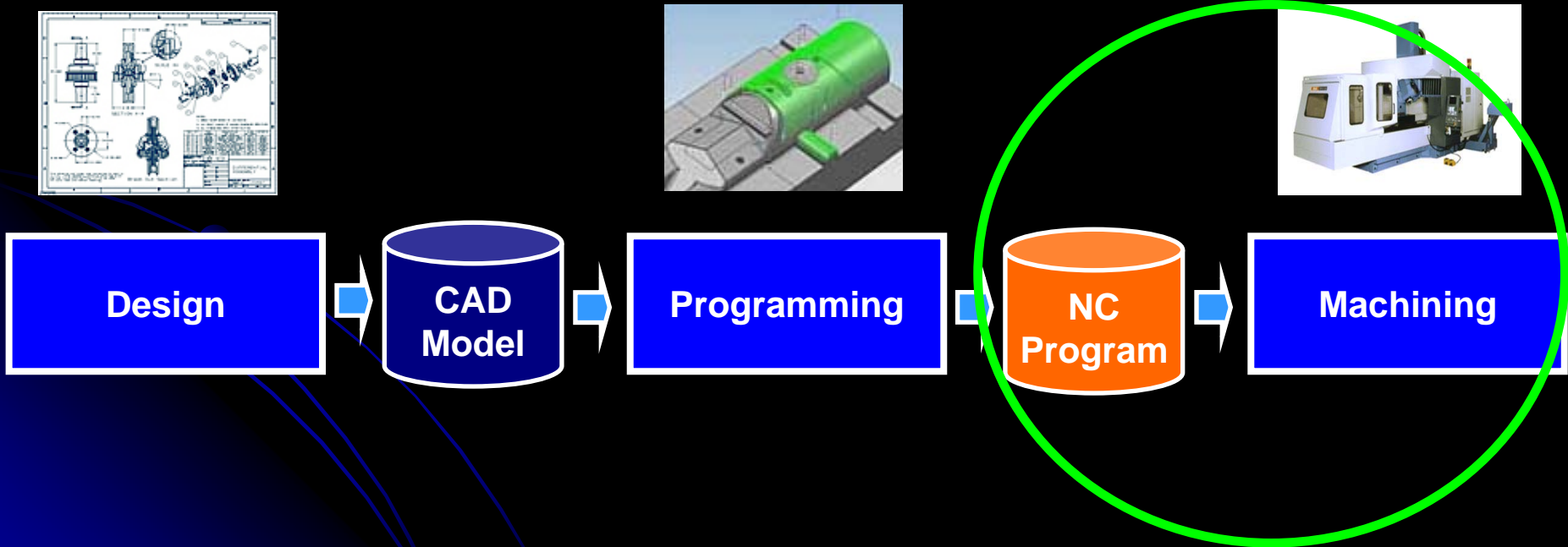
Machining Planning Optimization

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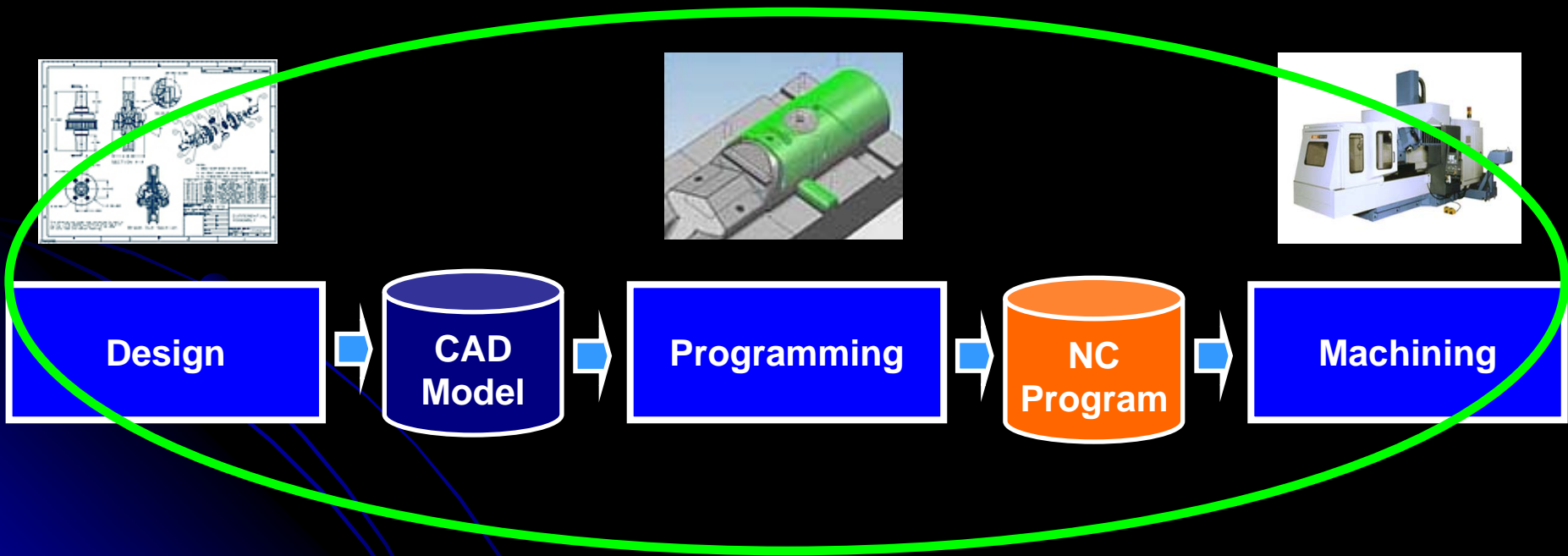- Path trajectory, radial and axial depths, number of passes…

Design → **CAD Model** → **Programming** → **NC Program** → **Machining**
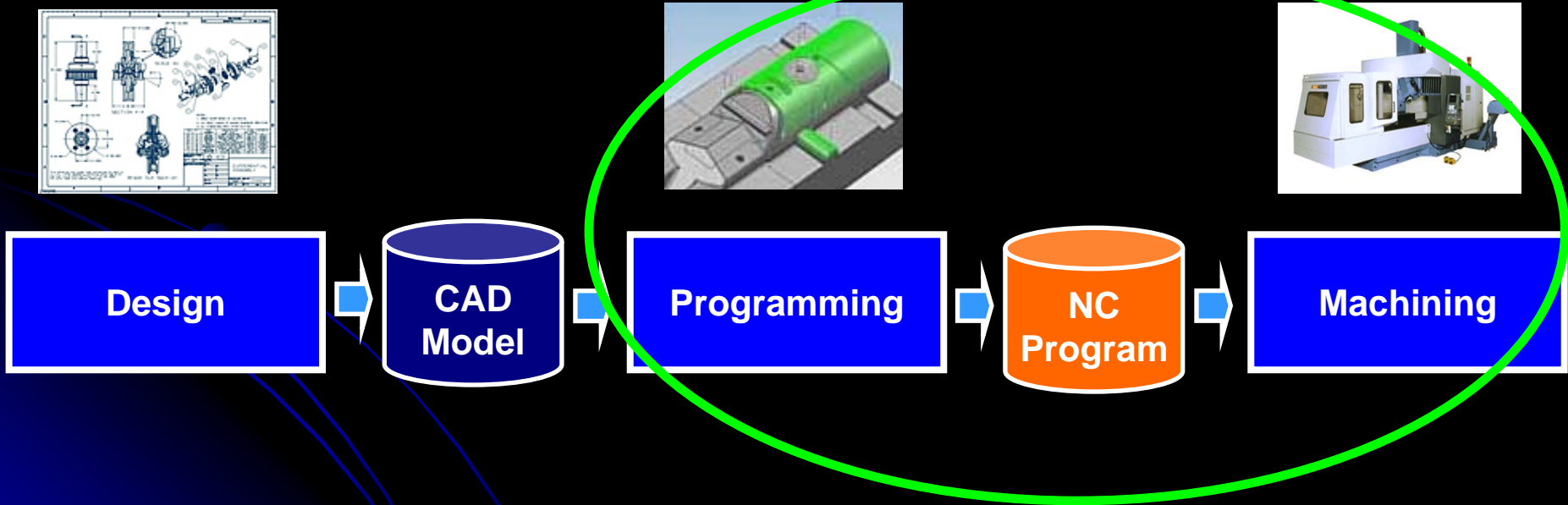
Machining Design Optimization

- "Machining friendly" feature design

| Design | → | CAD Model | → | Programming | → | NC Program | → | Machining |

Total Manufacturing Optimization

Design → CAD Model → Programming → NC Program → Machining

Thank you!