Optimizing Tool Life with STEP-NC

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ISO 10303 AP 238 Meeting

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Tool Life for Milling Operations

$$VT^n = C$$

Taylor Equation

$$T = C\, n_{sp}^{-\frac{1}{p}}\, f^{-\frac{1}{m}} e_r^{-\frac{1}{q}}$$

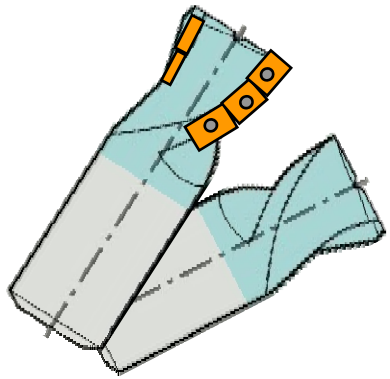
Tool Life for Milling Operations

N_{sp} Spindle speed

f Feed rate

e_r Radial immersion
(radial depth / cutter diameter)

C, p, m, q Constants



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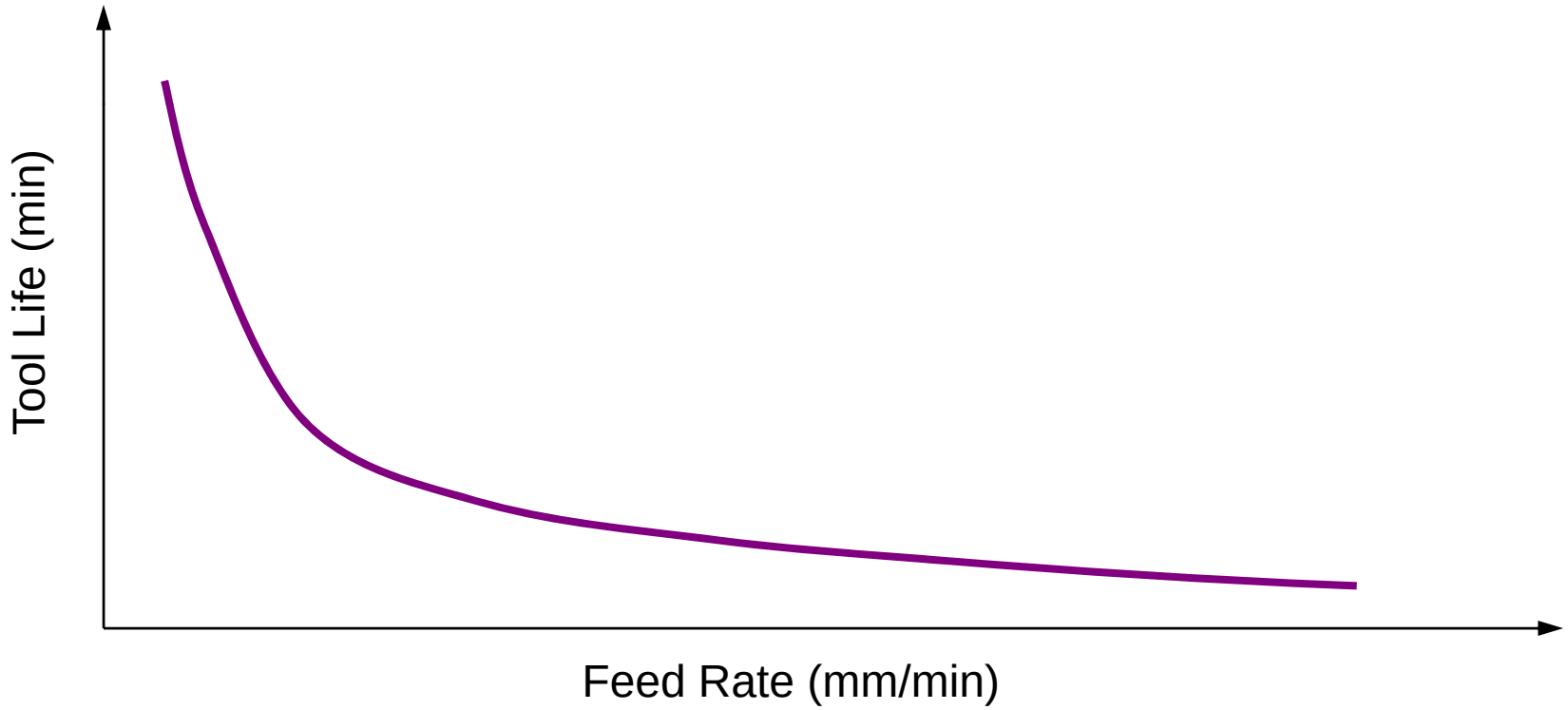
Tool Life vs. Feed Rate

$$T = C\, n_{sp}^{-\frac{1}{p}}\, f^{-\frac{1}{m}}\, e_r^{-\frac{1}{q}}$$



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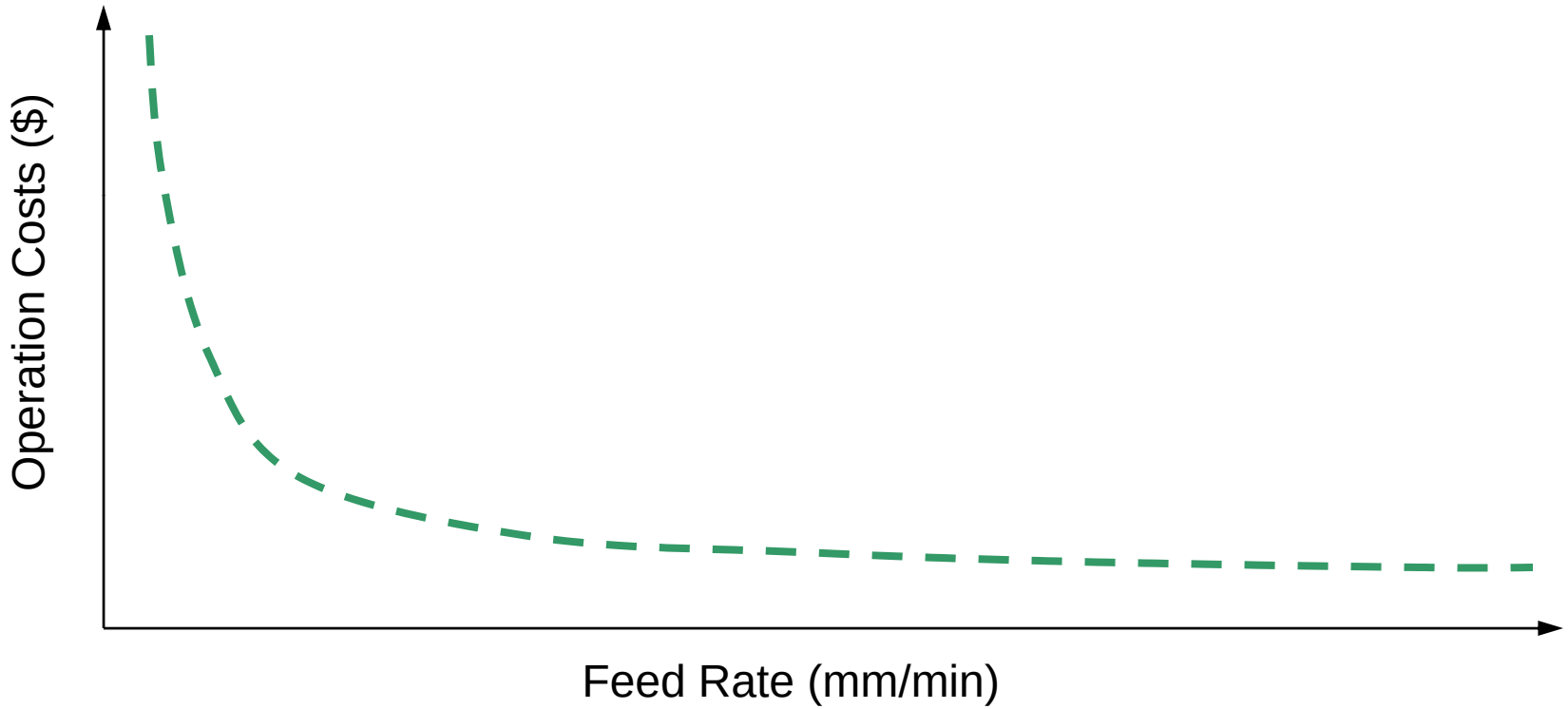
Machine Operation Costs vs. Feed Rate



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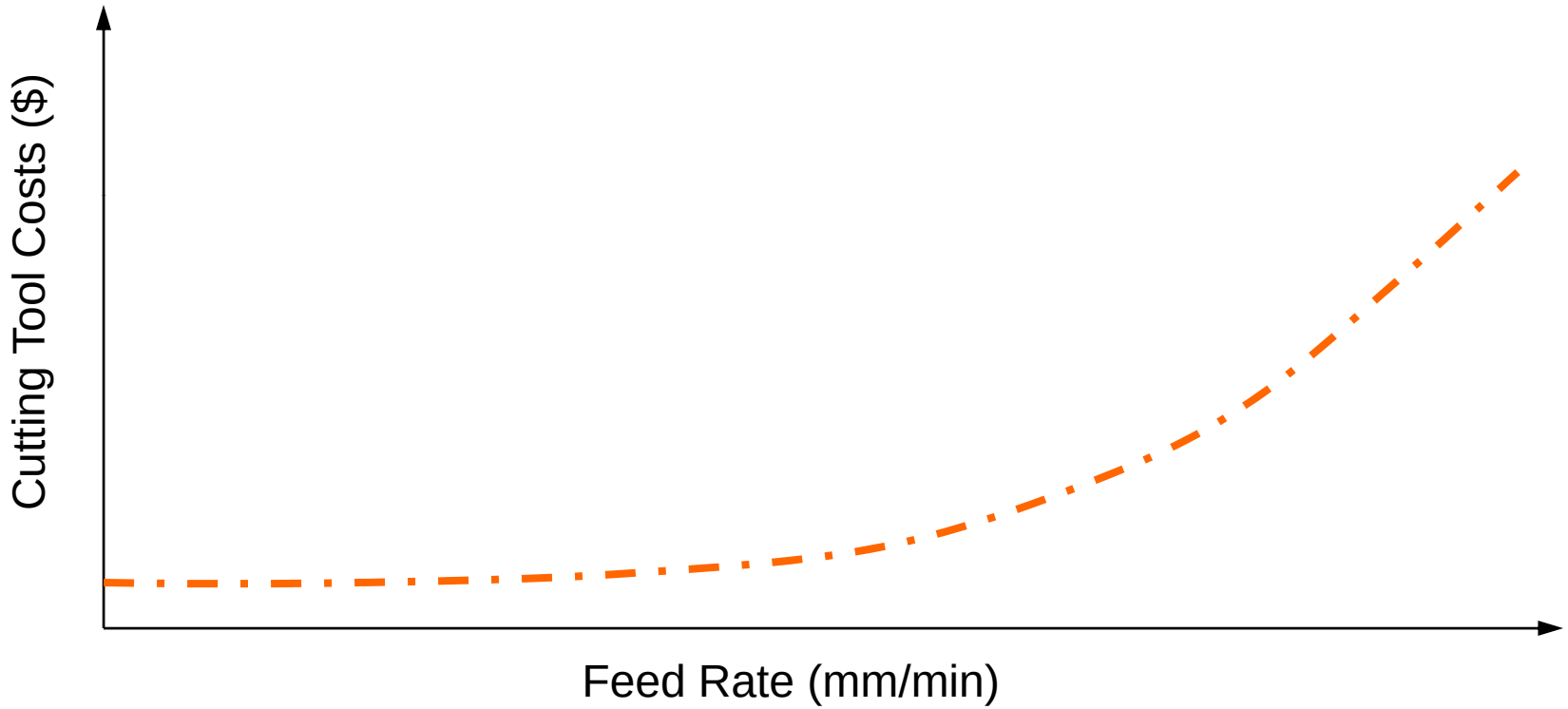
Cutting Tool Costs vs. Feed Rate



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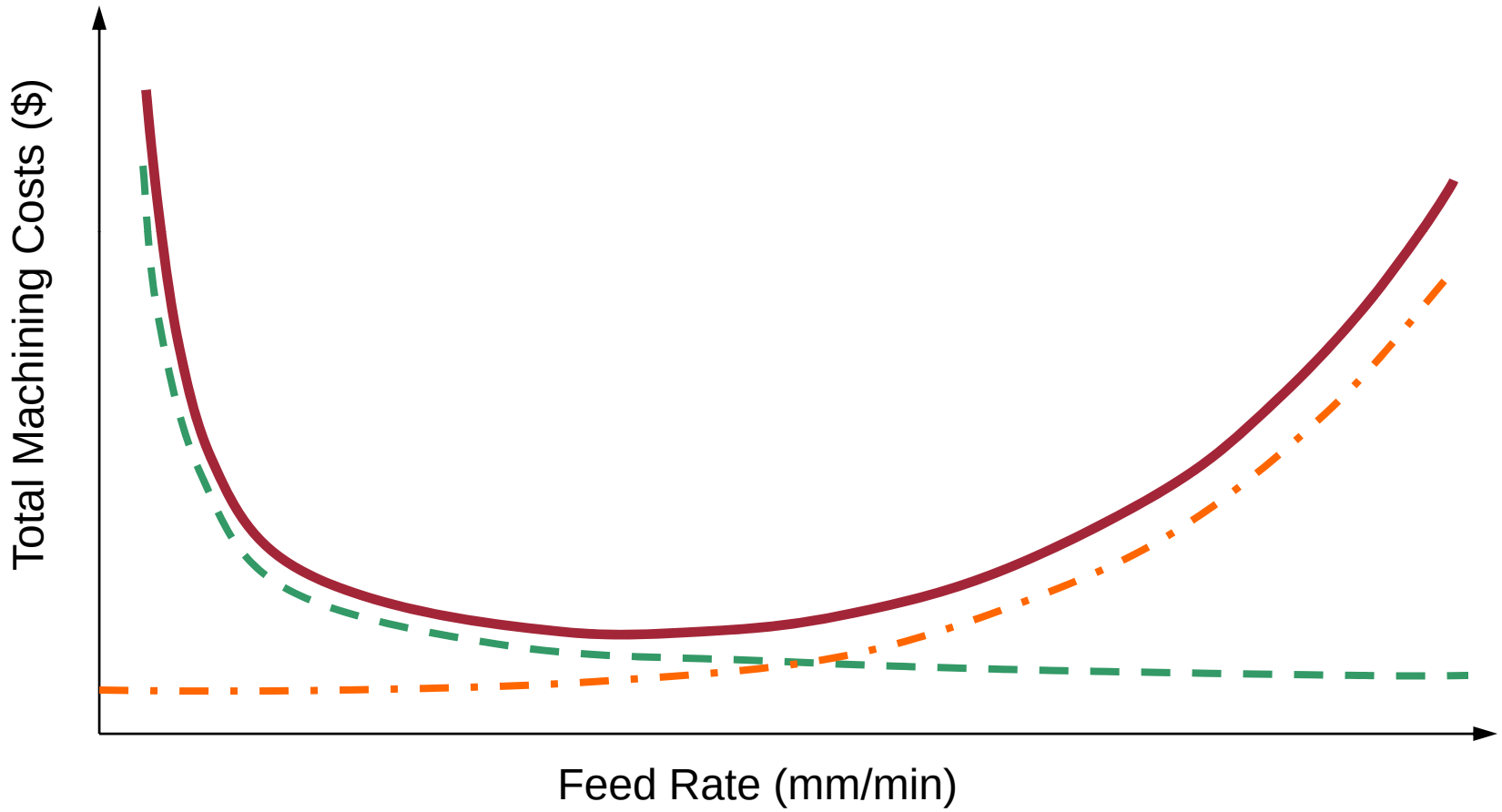
Total Machining Costs vs. Feed Rate



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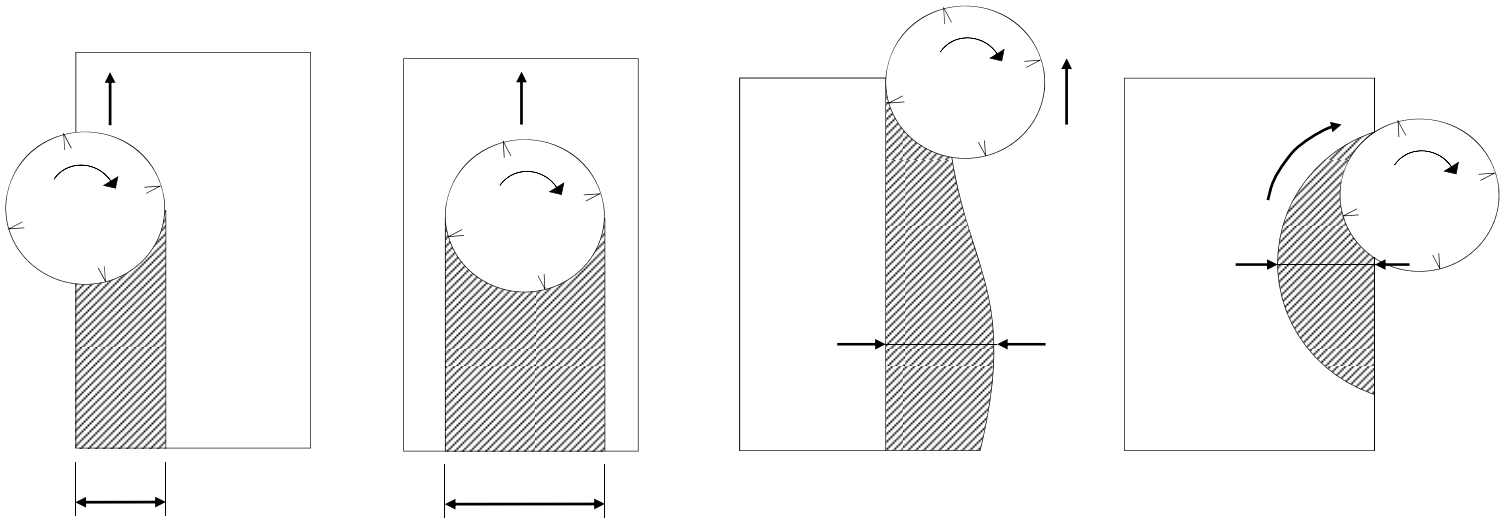
Radial Immersion in Milling Operations

$$T = C\, n_{sp}^{-\frac{1}{p}}\, f^{-\frac{1}{m}}\, e_r^{-\frac{1}{q}}$$



e_r = Radial Depth of Cut / Cutter Diameter

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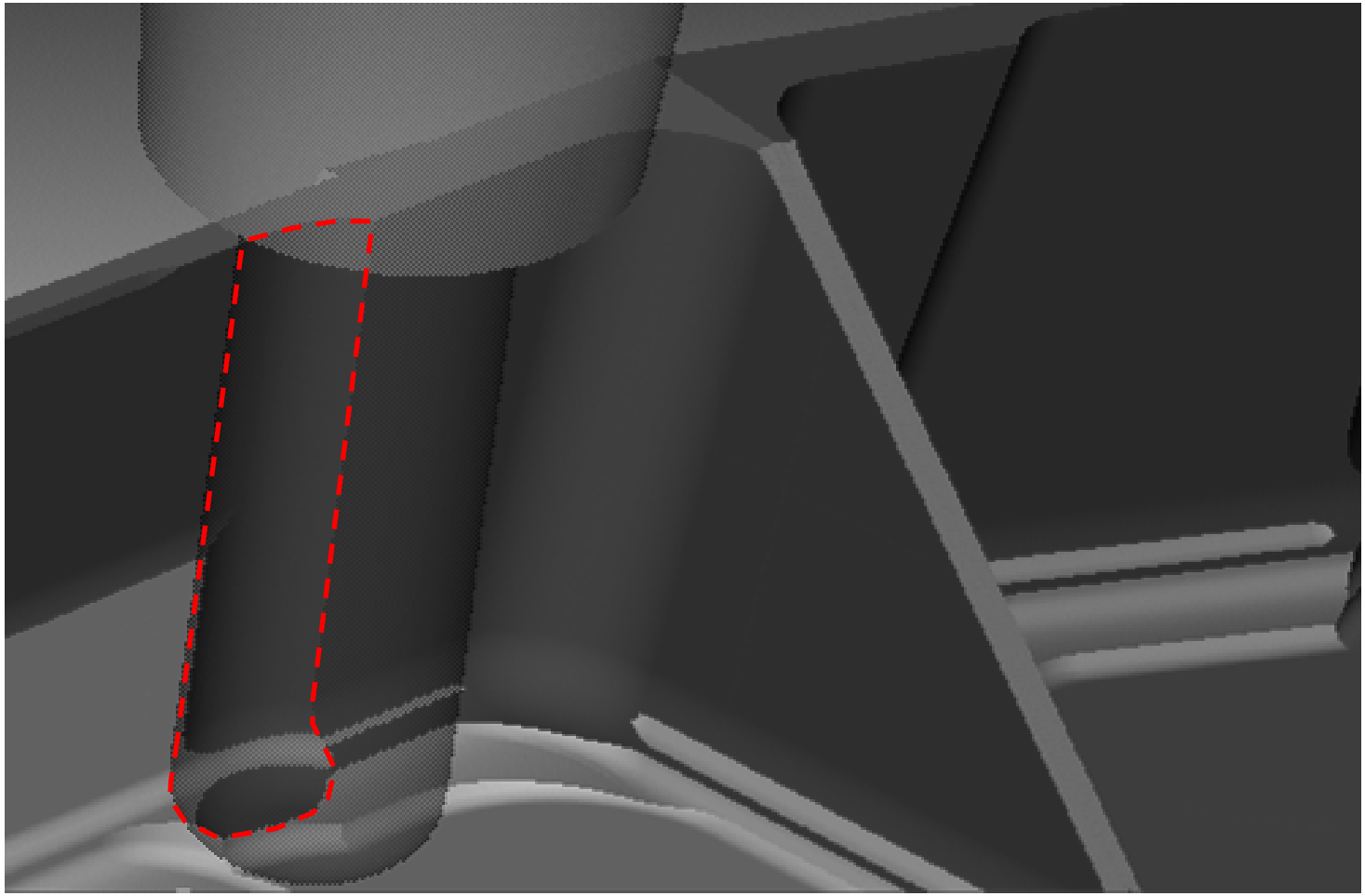
Obtain Cross-sectional Area from 3-D Model



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Cross-section Parameters in AP 238

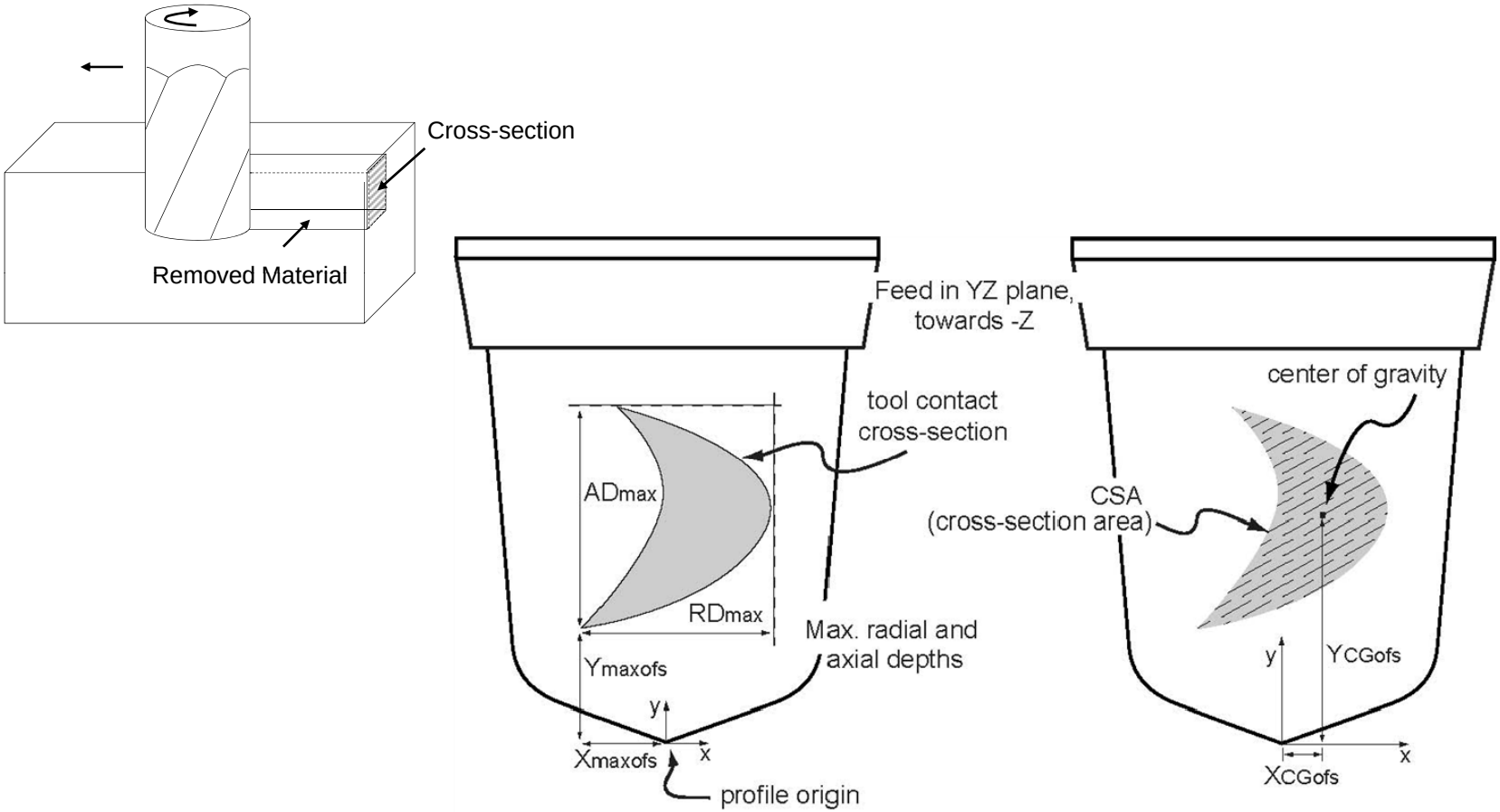

Figure 34 - Cross-section parameters for milling

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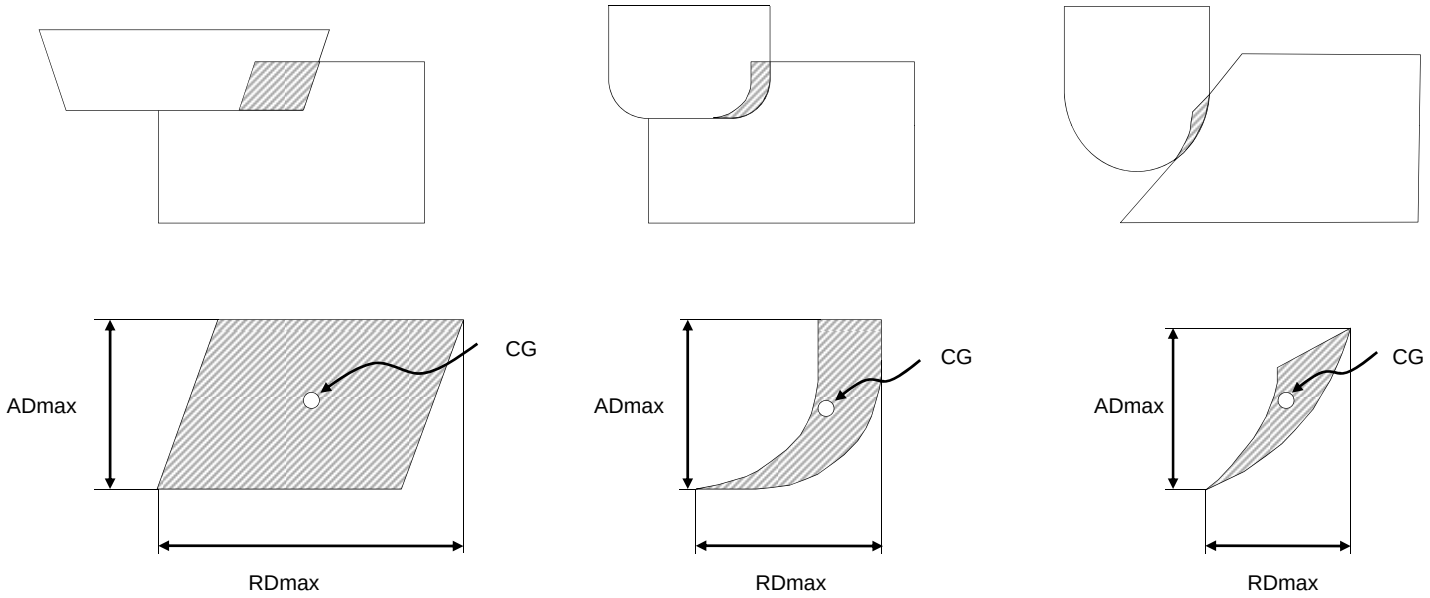
Cross-section by Non-rectangular Cutters



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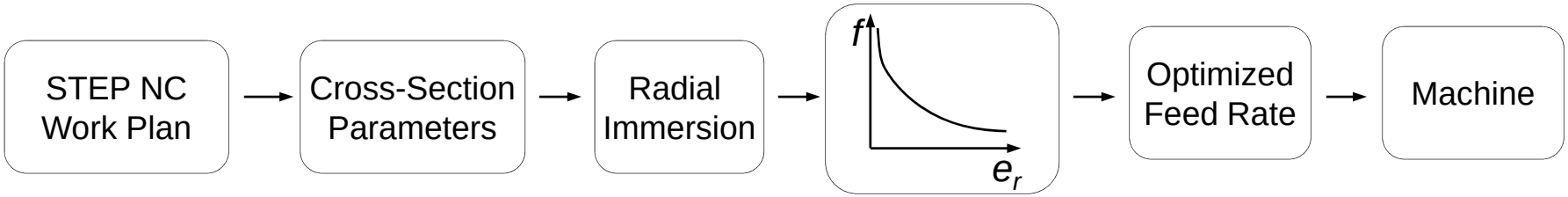
Tool Life Optimization with STEP-NC



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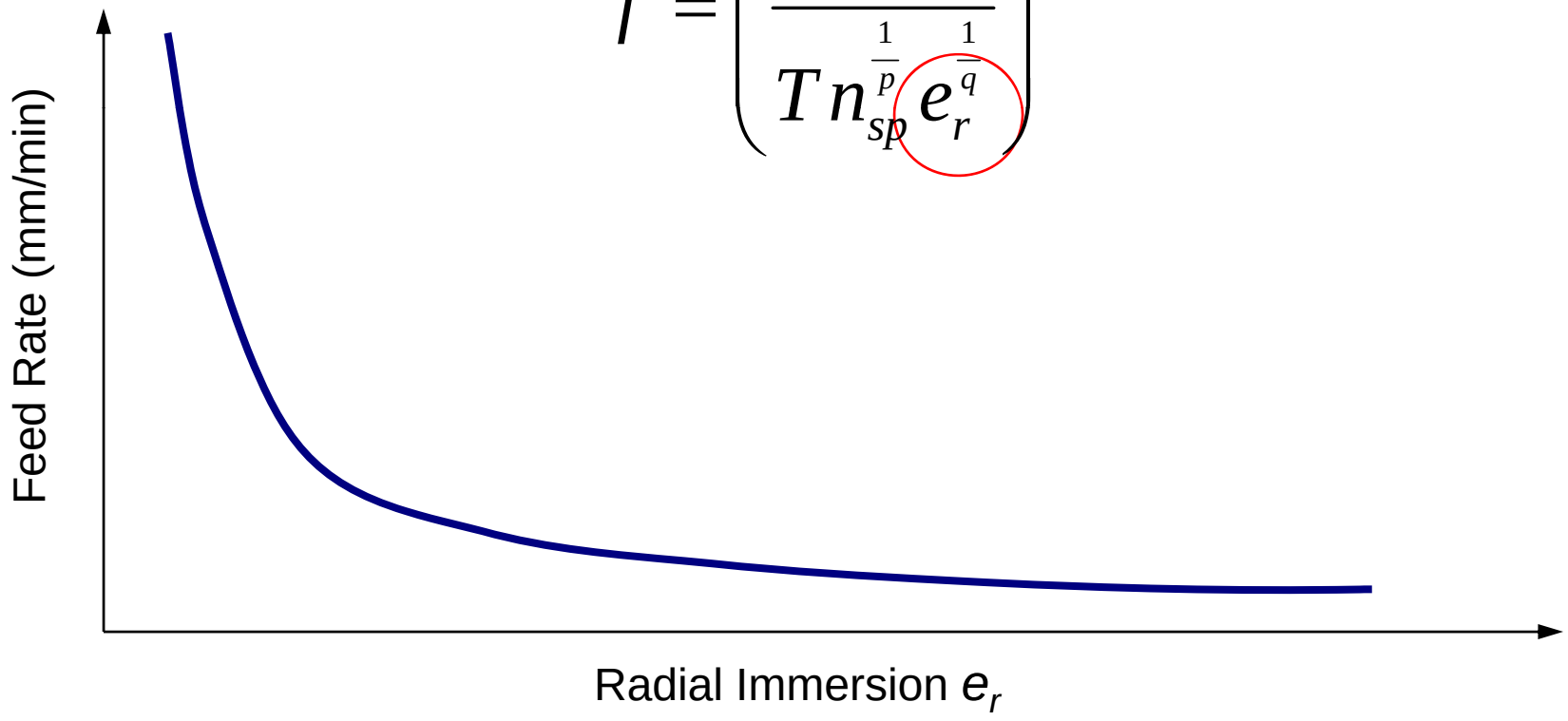
Feed Rate vs. Radial Immersion

$$f = \left(\frac{C_1}{T n_{sp}^{\frac{1}{p}} e_r^{\frac{1}{q}}} \right)^m$$



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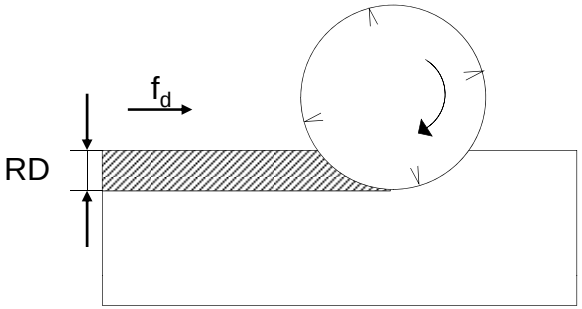
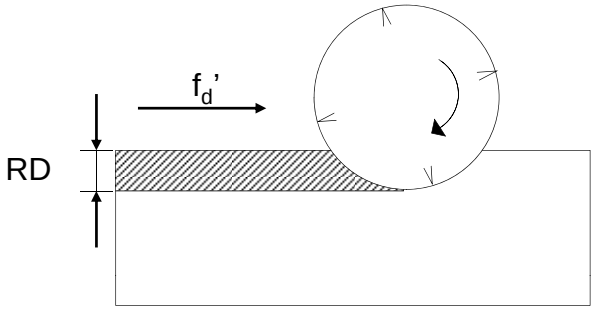
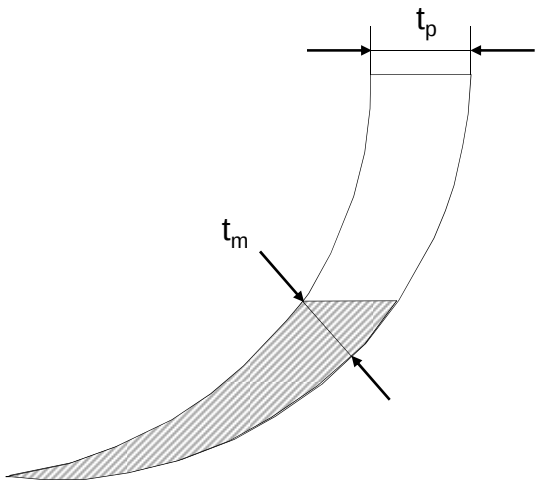
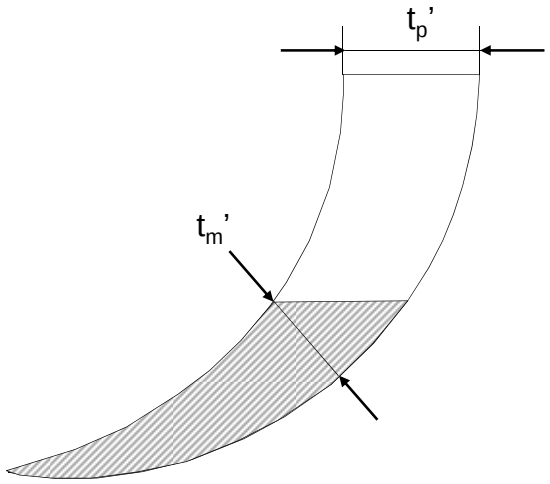
Constant Chip Load Method









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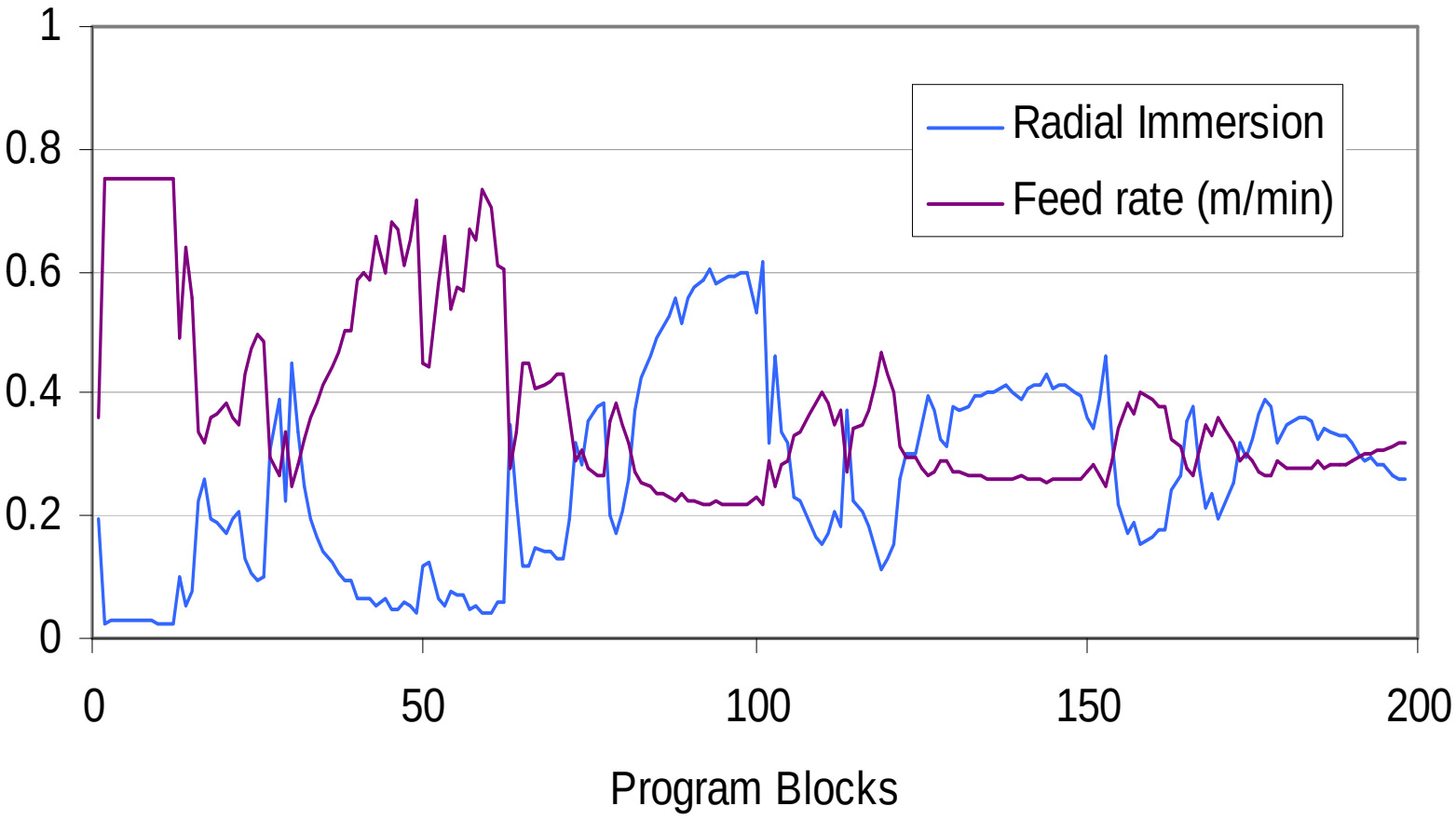
Feed Rate Adjustment with Radial Immersion



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Machine Making Boxy

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Cutting Boxy

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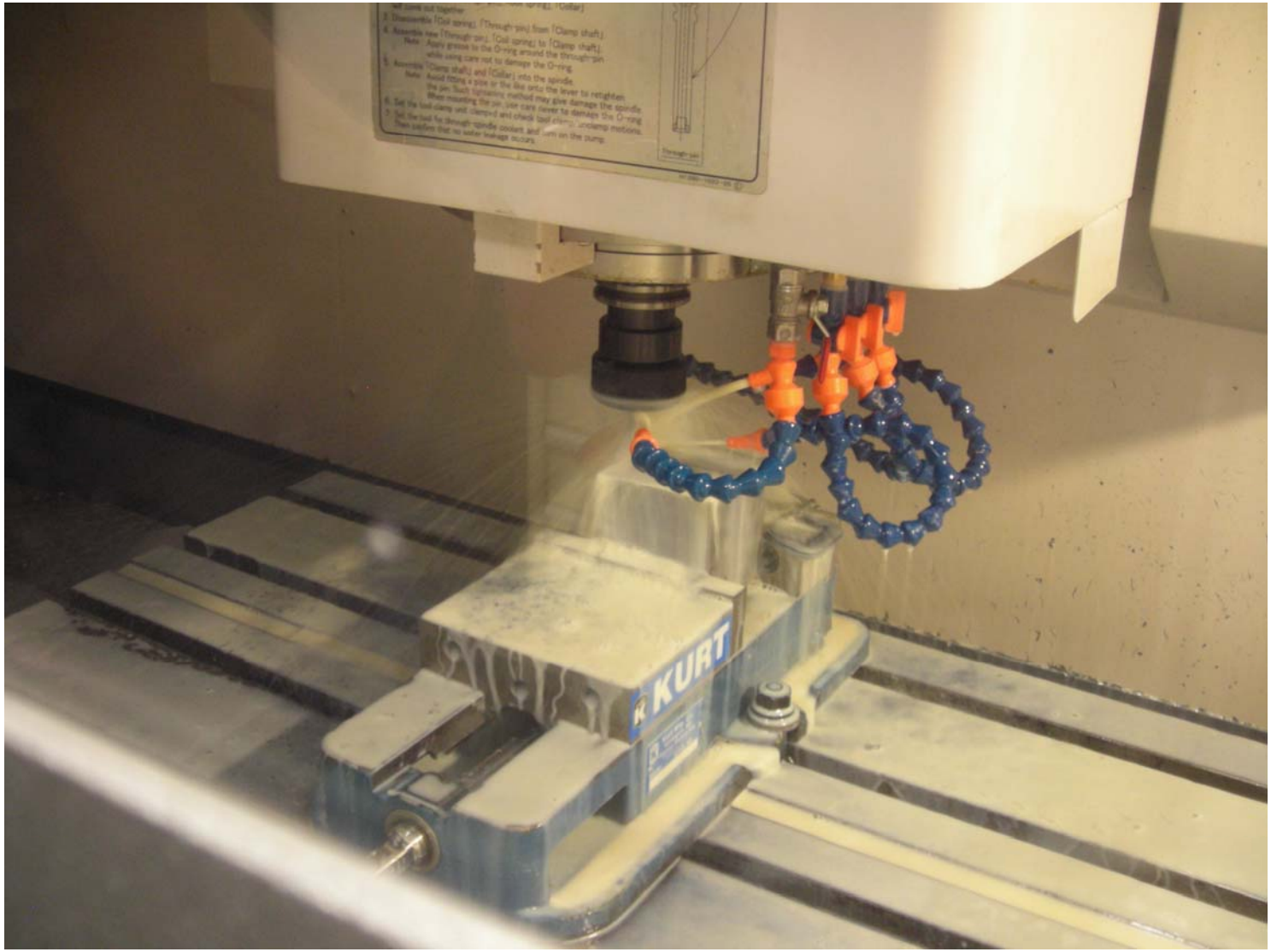

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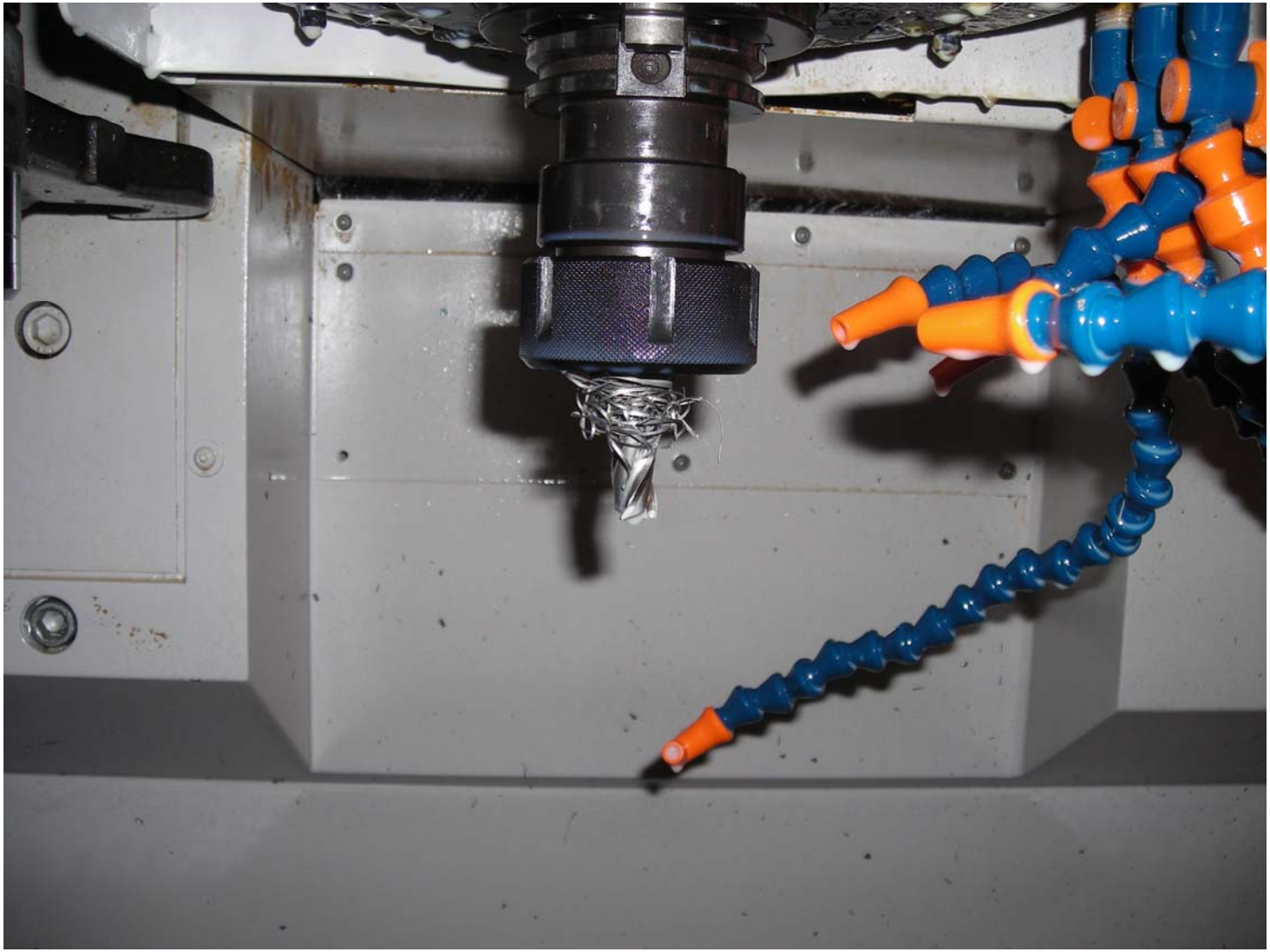
Chips Caused by 10.5 mm Drilling and 12.7 mm Milling



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Setup

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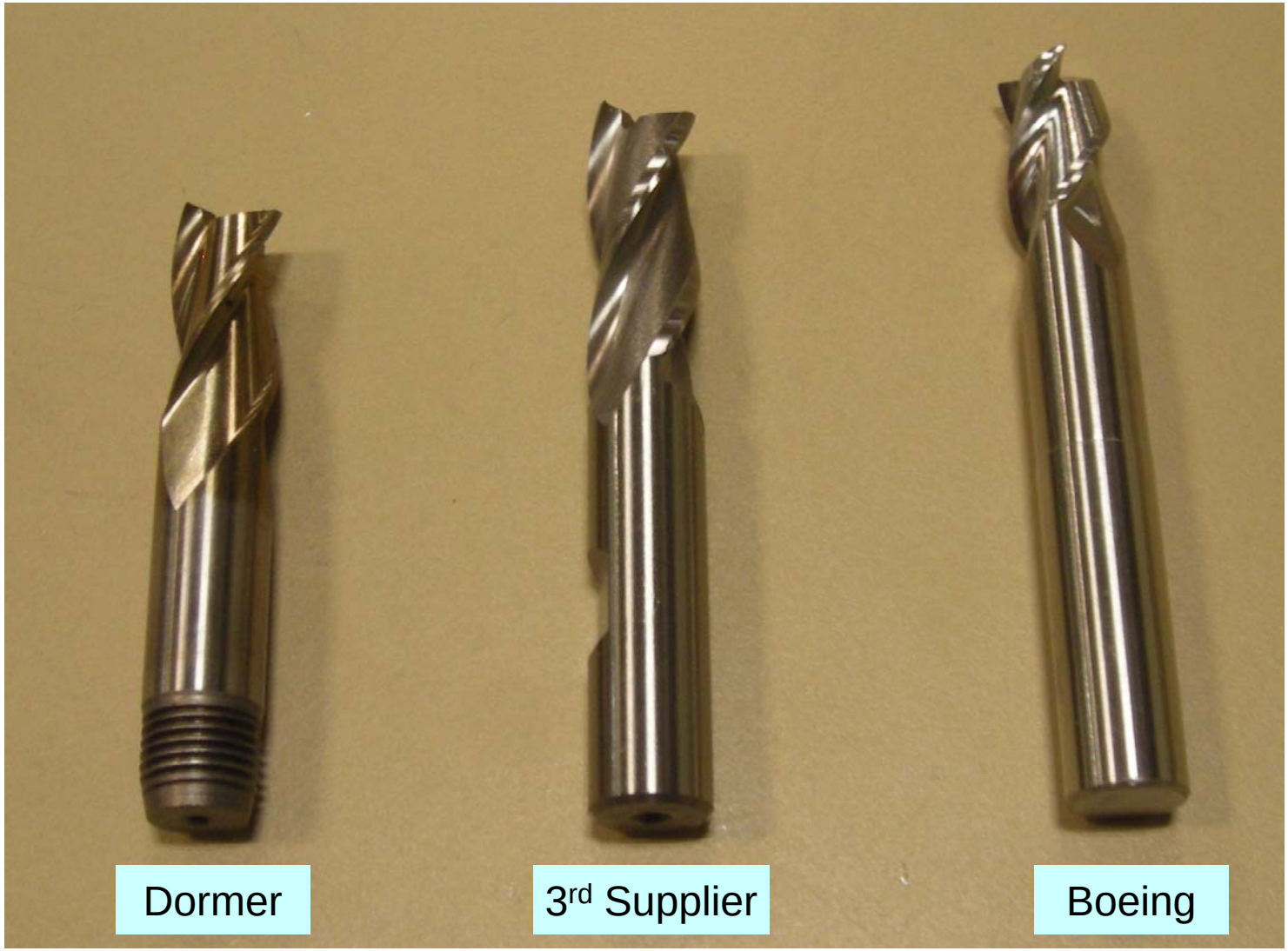
Cutting Tools



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Bengt's Data Sheet

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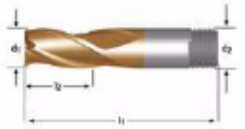
DORMER Product Selector

Data sheet

C391

DORMER

Slot Drill



Entered Application Details

cutting diameter d1:	1/2		Shank Cutter Slotting
Ap = 21.00 mm			Conventional
		Machining Type:	Emulsion

Chosen Material Group

1.3 Plain Carbon

Tool recommendation

order no.:	C3911/2
d1:	1/2
Cutting tool material	HSCo Bronze
cutting diameter d1:	12.7
overall length l1:	70.0
flute length l2:	24.0
shank diameter d2:	12.7 - 1/2
No. of teeth z:	3

Cutting Data

vc: cutting speed [m/min]:	26.0	(RPM: 652 [1/min])
hex: max chip thickness	0.057	
Ap [mm]:	5.00	
Ae [mm]:	12.70	

Estimated tool life:
L: Cutting length [m]:1.68
Time / cut [s]:2141

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Boxy Machining Summary

Source	Feed (mm/min)	Speed (rpm)	Time (min)	No. of 12.7mm (Short) Cutters	Tool Change
Bengt	111	652	190	1.5	Setup 7
130%	144	848	146	2	Setup 6
80%	89	522	238	1	N/A

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Boxy (Foam)

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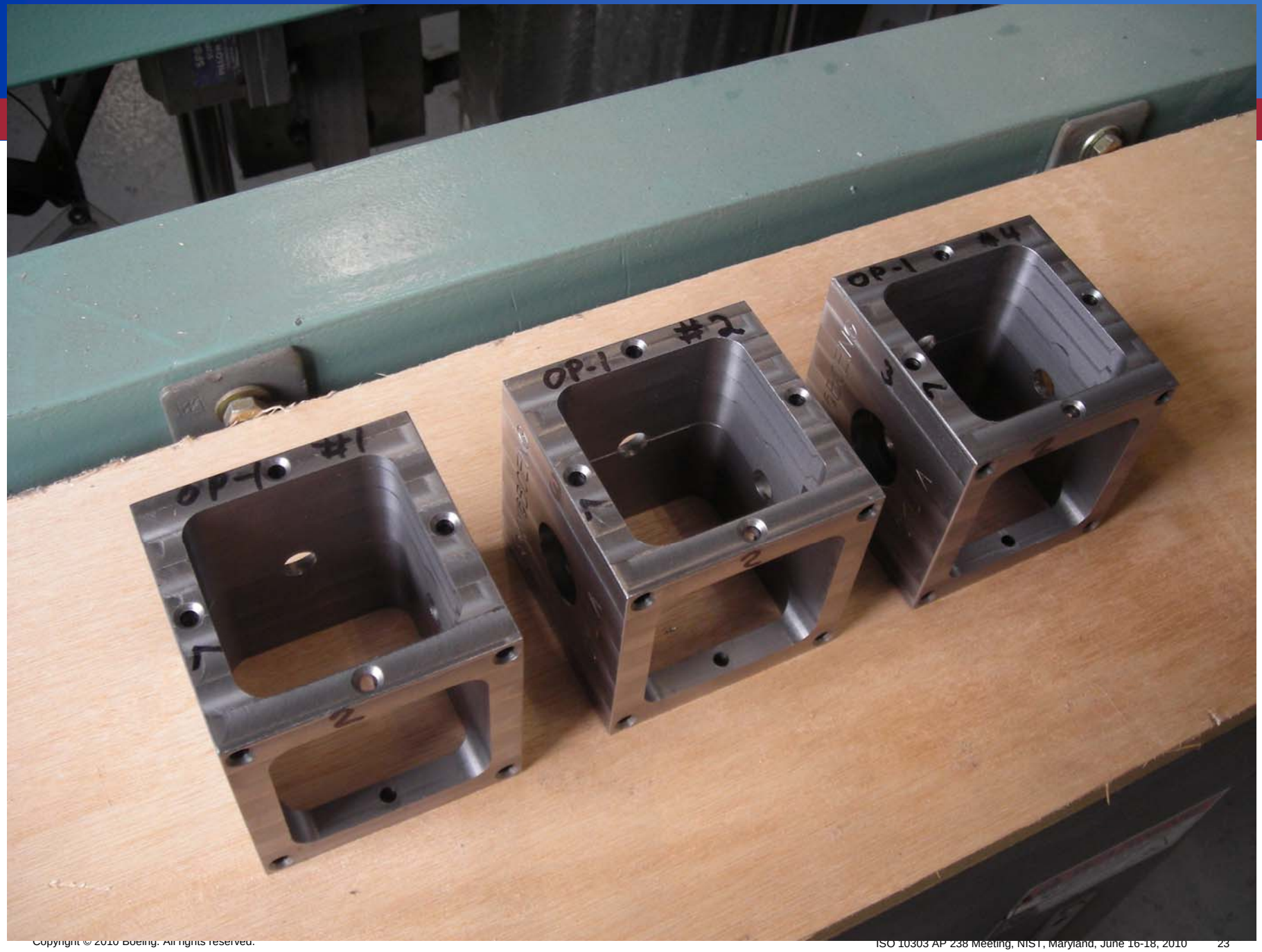

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Conclusions

- **Tool life directly affects the production costs and energy consumption of machining processes**
- **Tool life varies with the radial immersion in milling processes**
- **To predict and manage tool life, feed rate needs to be adjusted based on radial immersion**
- **STEP-NC provides essential cross-section information for tool life optimization**

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