



Predictive machining

SCL – Spiral Cutting Length

- Difficult to machine materials
- Large diameter components
- Tool life
 - roughing 3 to 15 mins
 - finishing 20 to 30 mins
- Roughing uses many edges to machine one component feature
 - *when to change the insert?*
- Finishing must complete one pass for surface integrity
 - *how far/long can each insert cut for?*
 - *what cutting data should be used?*



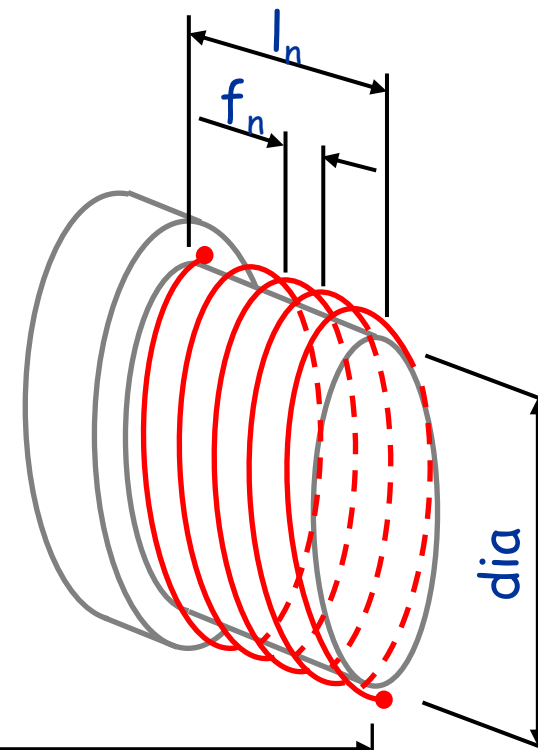


To select predictable tool life First calculate spiral cutting length - SCL

- Roughing – predict insert change
- Finishing – machine complete pass

For a given diameter and length of cut the SCL can be calculated for a given feed rate.

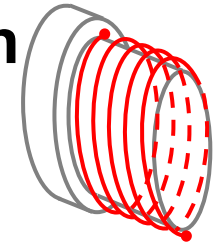
$$SCL = \pi \cdot dia \times \frac{L_n}{f_n}$$



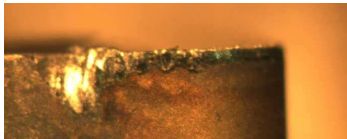


SCL - Optimised cutting data for ISM

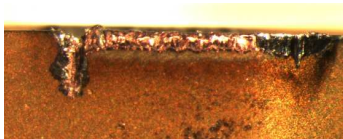
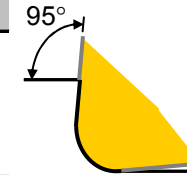
Insert program stops based on length of cut in CAM



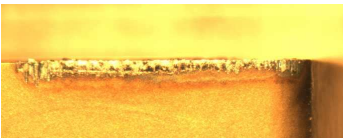
Inconel 718
(46HRC)



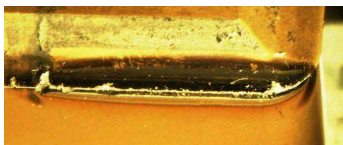
Insert	v_c m/min	a_p mm	f_n mm/rev	Tool life min	SCL m	Q cm ³ /min	Q _{tot} cm ³
C/DNMG QM 1105	50	2	0,25	5	250	25	125



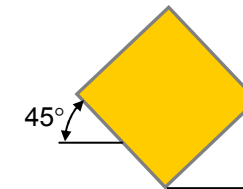
CNMX A2 SM S05F	50	2,7	0,35	9	450	47	425
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SNMG 12 QM S05F	50	3	0,35	9	450	53	473
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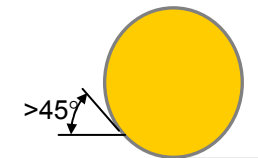
SNMG 19 SR S05F	50	5	0,35	9	450	88	788
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RCMT 12 SM S05F	50	2	0,5	5	250	50	250
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RNGN 12 6060	250	2	0,2	4	1000	100	400
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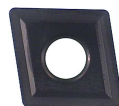
SCL - Optimised cutting data for LSM

Select insert and cutting data based on cutting length required

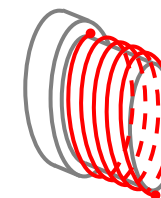
CNMG 120408-MF S05F



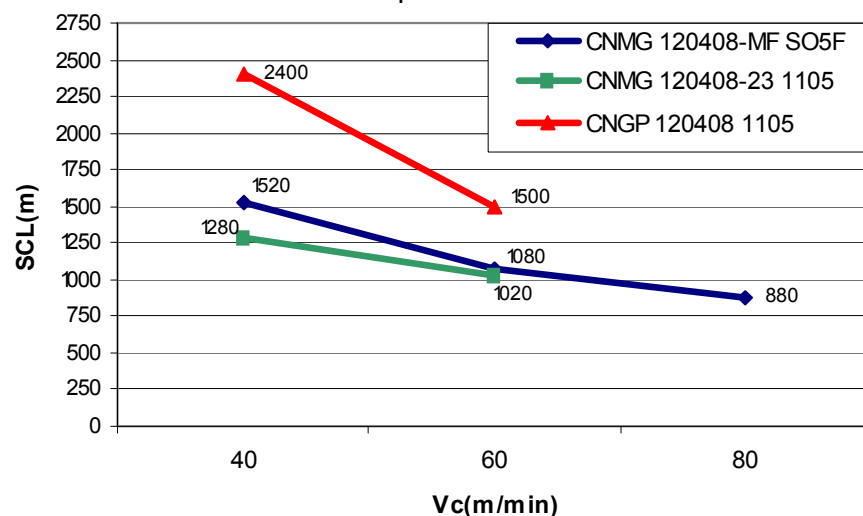
CNMG 120408-23 1105



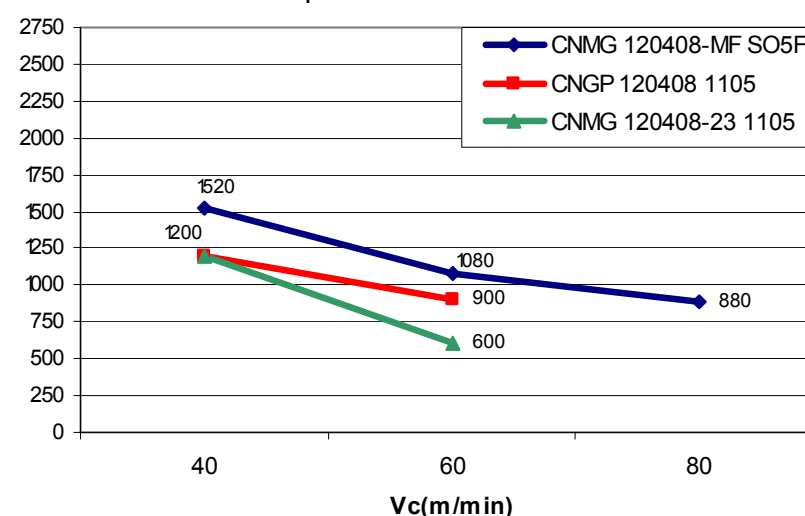
CNGP 120408-1105



$a_p 0.25 - f_n 0.15$



$a_p 0.25 - f_n 0.25$



Inconel 718 (46HRC)



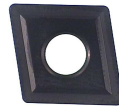
Total material removed

$$Q_{cm^3} = SCL \times a_p \times f_n$$

CNMG 120408-MF S05F



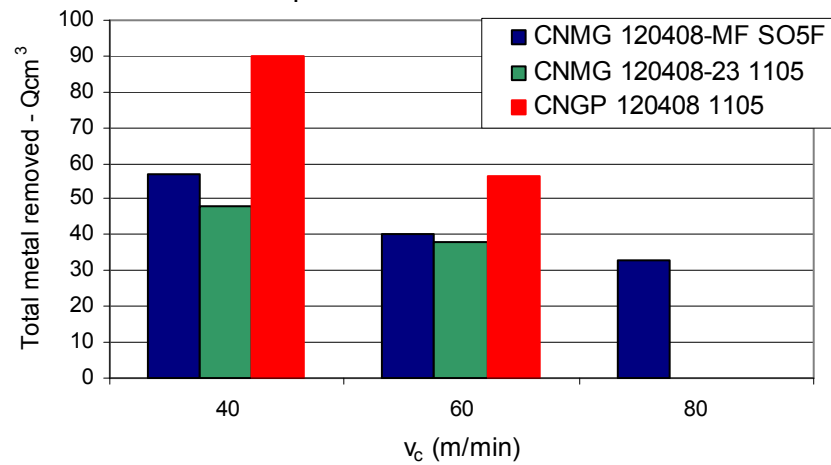
CNMG 120408-23 1105



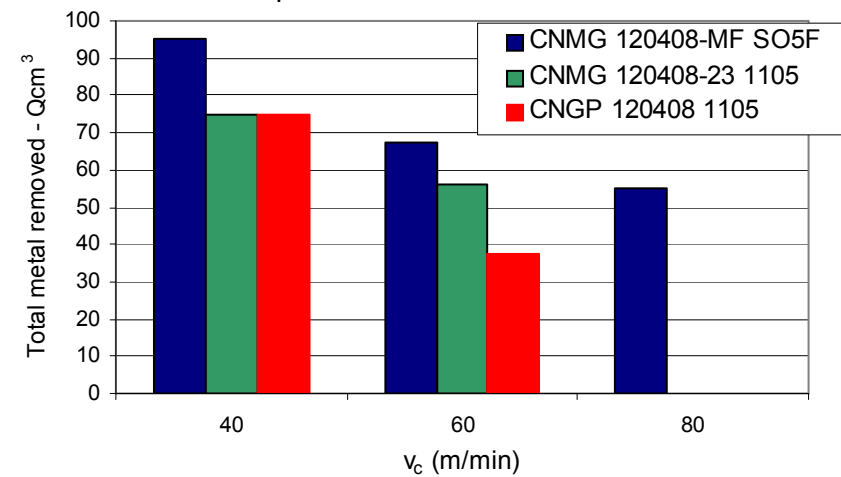
CNGP 120408-1105



$a_p 0.25 - f_n 0.15$



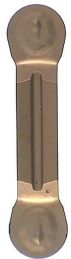
$a_p 0.25 - f_n 0.25$



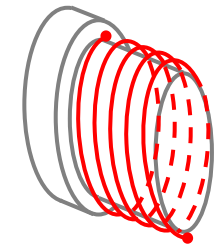
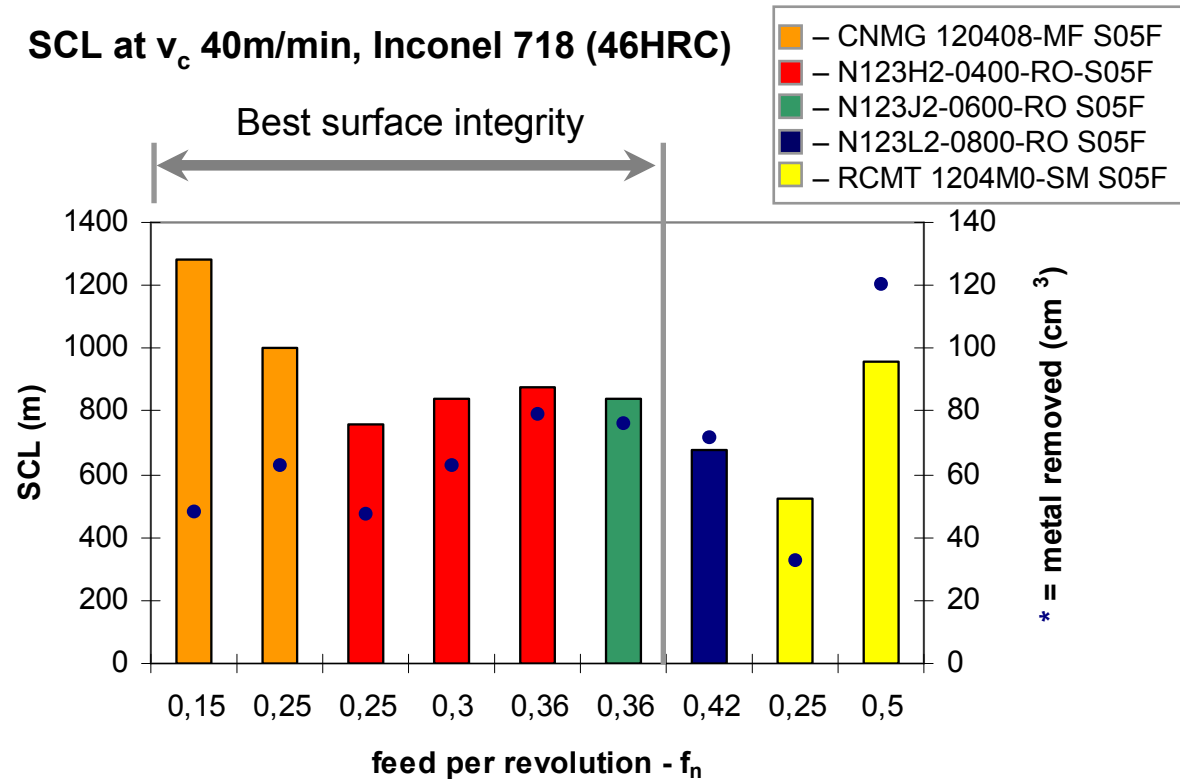


SCL - Optimised cutting data for LSM

Select insert and cutting data based on cutting length required



SCL at v_c 40m/min, Inconel 718 (46HRC)



Note:-

Increasing feed rate with S05F often increases SCL and total material removed capability as well as reducing the length of cut required



Calculating SCL for finishing **Example**

$$\text{SCL} = \text{circumference} \times \underline{\text{length of cut}} \\ \text{feed rate}$$

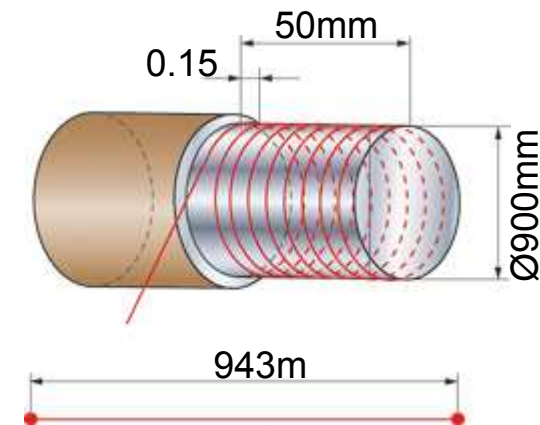
Comparison of S05F against uncoated

- Existing cutting data
H13A - v_c 30m/min, f_n 0.15

- Calculate:-

$$\begin{aligned} \text{SCL} &= [(900/1000) \times 3.142] \\ &\times (50 / 0.15) \\ &= 943\text{m} \end{aligned}$$

$$\begin{aligned} \text{Time to machine} &= \text{SCL} / v_c \\ &= 31.4\text{mins} \end{aligned}$$

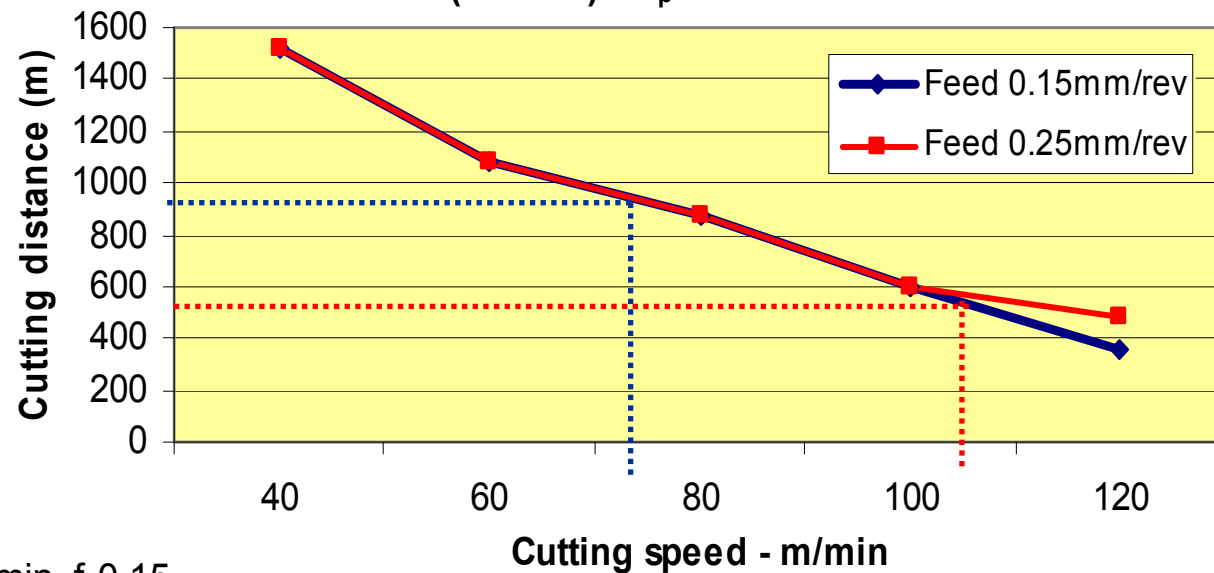




Calculating SCL for finishing Optimising CNMG



Cutting distance for S05F - Material Inconel 718
(46HRC) - $a_p 0.25\text{mm}$



Uncoated at $v_c 30\text{m/min}$, $f_n 0.15$

Time to machine - **31.4mins**

Feed 0.15mm/rev with S05F

$$\text{SCL} = [(900/1000) \times \pi] \times (50 / 0.15) = \mathbf{943\text{m}}$$

Best productivity achieved at approx **70m/min**

Time to machine - **13.5mins**

Feed 0.25mm/rev with S05F

$$\text{SCL} = [(900/1000) \times \pi] \times (50 / 0.25) = \mathbf{566\text{m}}$$

Best productivity achieved at approx

100m/min

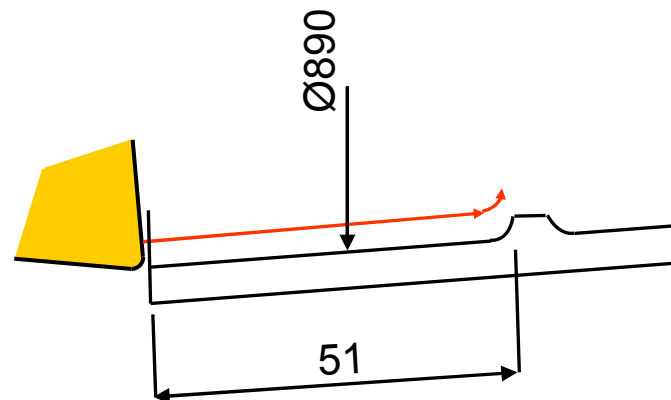
Time to machine - **5.7mins**



Finishing optimising test

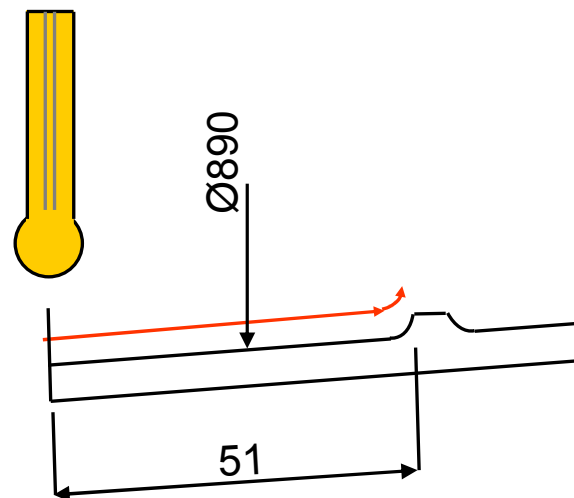
Optimise with CNMG 120408-MF S05F

f_n	SCL	v_c	time	R_a
0.15	951	70	13.6	0.9
0.25	570	100	5.7	2.3



Optimised CoroCut N123J2-0600 RO S05F

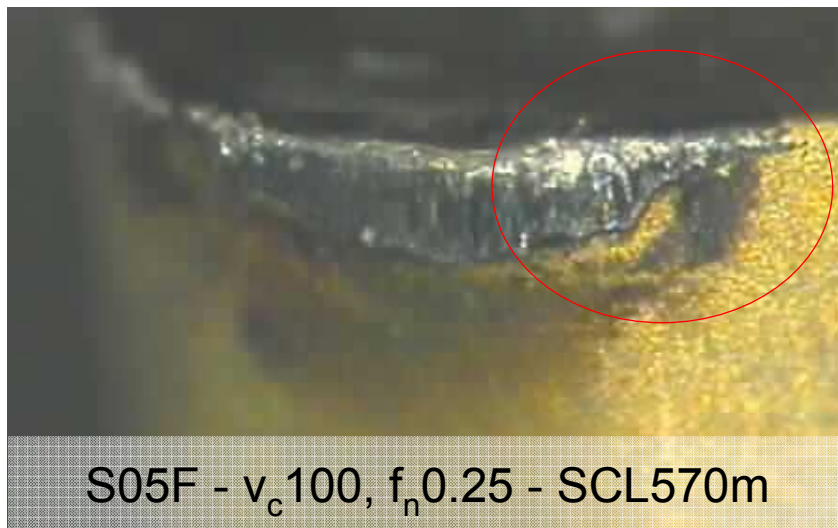
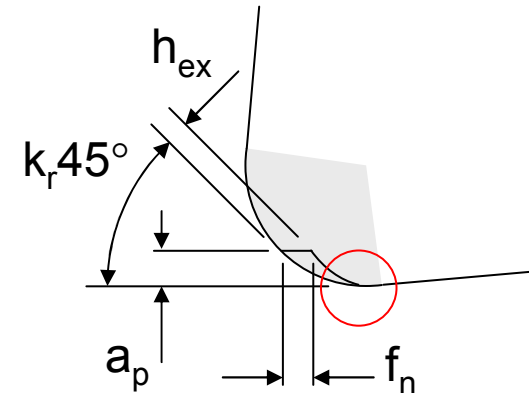
f_n	SCL	v_c	time	R_a
0.25	570	60	9.5	0.8
0.35	407	60	6.8	1.2





Result of SCL optimisation

- Time reduced from 32mins to 6mins to cut the same distance
- Surface finish and tolerance greatly improved due to reduced wear on trailing edge



S05F - $v_c 100$, $f_n 0.25$ - SCL570m



H13A - $v_c 30$, $f_n 0.25$ - SCL570m