



HARMONY AI

FEToba
A-LINE

ALUMINIUM MACHINING

sutton tools

VS

Traditional

Trochoidal

Dynamic & Trochoidal Milling

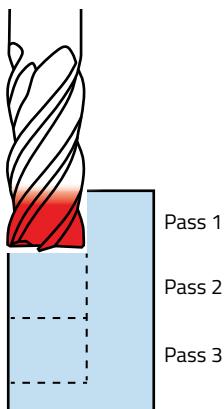
Dynamic & Trochoidal Milling strategies provide a tool engagement angle with the workpiece that utilises more of the cutting edge of the tool, ensuring a stable process, shorter machining times & longer tool life.

They also apply a lower radial step-over (ae) and a higher depth of cut (ap), spreading the wear, loads and heat across the entire cutting edge.

This method of milling adjusts the parameters to maintain a constant load on the tool, providing more aggressive metal removal rates (MRR).

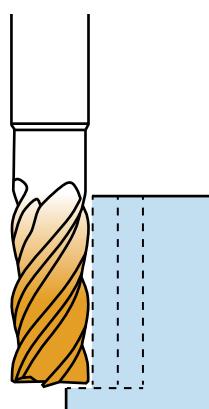
To use this technique, it requires a CAM package to generate the tool path on virtually any CNC machine.

Traditional



Traditional methods are typically higher step-over & lower depth of cut.

Trochoidal

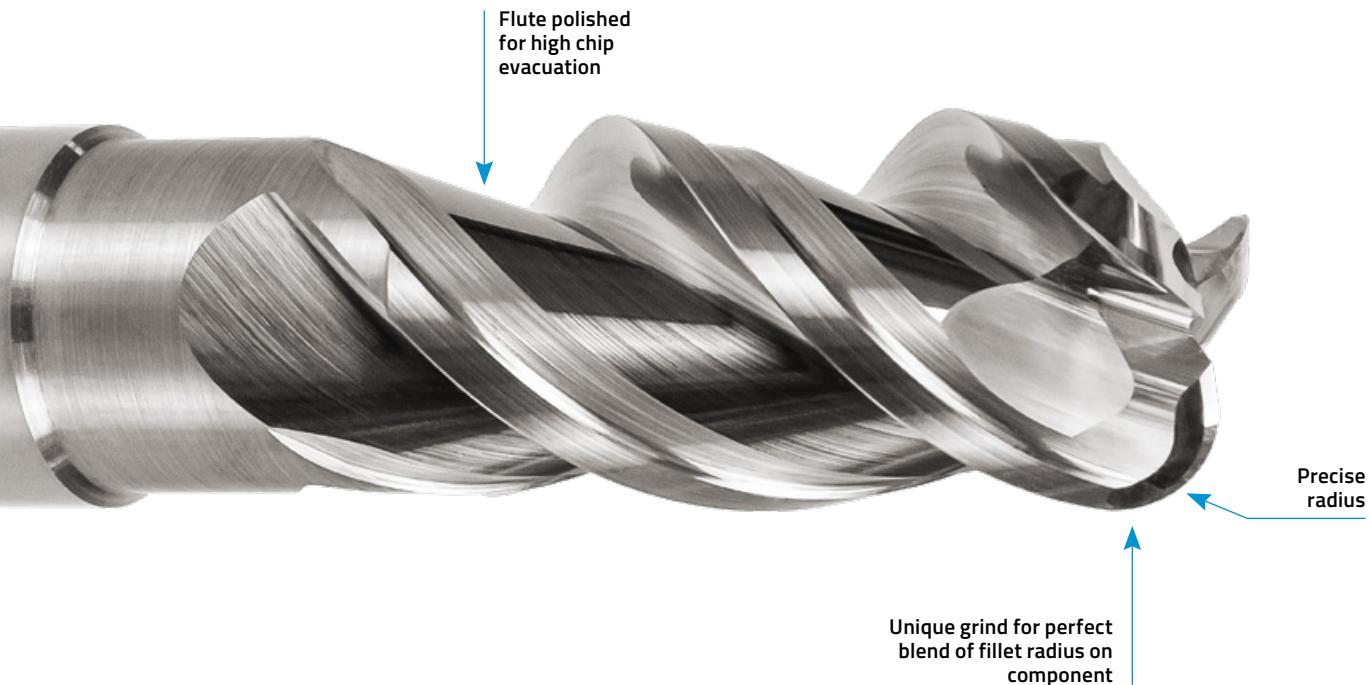


Dynamic & Trochoidal is mostly based on the theory of radial chip thinning that occurs with varying ae which relates to chip thickness and feed per tooth.

Advantages of Dynamic & Trochoidal Milling

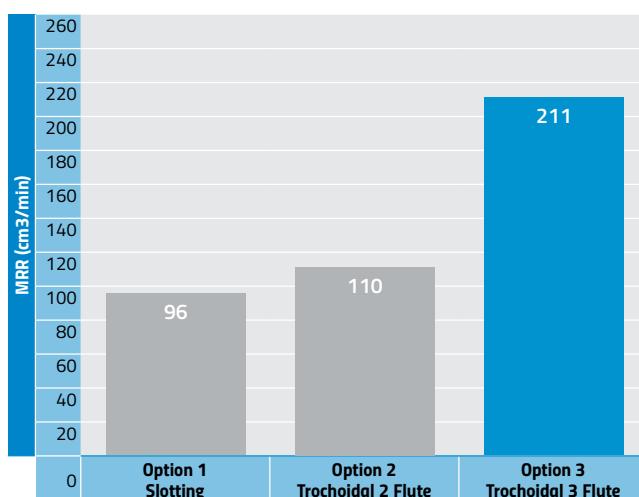
- Decreased cutting forces
- Reduced heat
- Reduced tool wear
- Suitable for lower powered machines
- Greater machining accuracy
- Spindle & machine friendly
- Improved tool life
- Faster cycle time
- One tool for multiple slot sizes (trochoidal)
- Thin wall applications

E478 Corner Radius Series



Producing 20mm Slots in Aluminium

- Option 1** Using a **20mm 2-flute endmill** results in high vibration with an under-utilised cutting edge with two passes to get to the full depth. It is a more expensive option due to the larger tool size.
- Option 2** Using a **12mm 2-flute endmill in trochoidal milling** provides a much higher metal removal rate with a smoother cut, resulting in an all-round stable cutting environment as well as a lower tool cost.
- Option 3** Using a **12mm 3-flute endmill in trochoidal milling** similar to Option 2. The design of this tool has a variable helix and when used with trochoidal methods, at least two of the cutting edges are always engaged in the depth of cut (in this case $ap=24\text{mm}$). The variable helix design also suppresses the vibration caused from the interrupted cutting action of milling. This means that greater speeds are possible, increasing the volume of material removed (MRR) dramatically.



Test Data	Option 1 Slotted	Option 2 Trochoidal 2 Flute	Option 3 Trochoidal 3 Flute
Tool	R40 AI	R40 AI	R42/43/44 HARMONY AI
Part No. / Reference	E3102000	E3101200	E4001200
Tool Diameter (mm)	20	12	12
Z (teeth number)	2	2	3
ae (mm)	20	2	2
ap (mm) / depth	12 + 12 (2 passes)	24 (single pass)	24 (single pass)
RPM	1600	5300	6600
Feed Rate (mm/min)	200	2300	4400

At Sutton Tools, we often talk about 'Good, Better, Best' when diagnosing the right cutting tool for an application. The above example illustrates this concept well. Our R&D Team are continuously running tests to determine the Good, Better or Best tooling solution for our customers' unique requirements.

Contents

Page	Item Code	Tool	Diameter range	Type	No. of Flutes	Geometry	Surface Finish	Standard	Non-Ferrous Metals	
5	E444		3-12mm	HA	1	R30	BrT	Sutton Std	●	
6	E310		2-20mm	HA	2	R40	BrT	DIN6527 L	●	
7	E660		1-25mm	HA	2	R55	BrT	DIN6527 L	●	
8	E670		6-20mm	HA	2	R45	ASX	DIN6527 L	●	
9	E671		3-20mm	HA	2	R55	ASX	DIN6527 L	●	
10	E672		6-20mm	HA	2	R55	ASX	DIN6527 L	●	
11	E673		6-20mm	HA	2	R55	ASX	DIN6527 L	●	
13	E661		6-20mm	HA	2	R55	BrT	DIN6527 L	●	
14	E480		3-20mm	HA	3	R45/46/44	BrT	DIN6527 L	●	
15	E400		6-25mm	HA	3	R45/46/44	CrN	DIN6527 L	●	
	E401		6-25mm	HB						
16	E402		6-25mm	HA	3	R45/46/44	CrN	Sutton Std	●	
	E403		6-25mm	HB						
17	E668		6-20mm	HA	3	R40	HCR	DIN6527 L	●	
18	E478		12-20mm	HA	3	R45/46/44	BrT	DIN6527 L	●	
19	E669		6-20mm	HA	3	R40	ASX	DIN6527 L	●	
21	E408		6-25mm	HA	3	R45/46/44	CrN	Sutton Std	●	
	E409		6-25mm	HB						
22	E446		6-20mm	HA	3	R25	BrT	DIN6527 L	●	
	E447		6-20mm	HB						
23	E662		12-20mm	Corner Radius Int. Coolant	HA	3	R45	BrT	DIN6527 L	●
24	E663		6-20mm	Square End Chip Breaker	HA	4	R45	HCR	DIN6527 L	●
	E664		6-20mm	HB						
25	E665		6-20mm	Corner Radius	HA	4	R45	HCR	DIN6527 L	●
	E666		6-20mm	HB						
26	E667		12-20mm	Corner Radius	HA	4	R45	HCR	DIN6527 L	●

Optimal ● Effective ○

ISO	VDI	Material Group	Sutton	
P	A	Steel	N	
M	R	Stainless Steel	VA	
K	F	Cast Iron	GG	UNI
N	N	Non-Ferrous Metals, Aluminums & Coppers	AI	W
S	S	Titaniums & Super Alloys	TI	Ni
H	H	Hard Materials (≥ 45 HRC)		H

[^] VDI 3323 material groups can also be determined by referring to the workpiece material cross reference listing. Refer to main index of this section.

For expert tooling recommendations, go to:
www.suttontools.com/expert-tool-selector

The image displays a horizontal array of seven distinct end mill tools. From left to right, they include: 1) A standard solid cylindrical end mill with a straight shank and a single helical fluted cutting edge. 2) A solid cylindrical end mill featuring a double helical fluted cutting edge. 3) A solid cylindrical end mill with a triple helical fluted cutting edge. 4) A solid cylindrical end mill with a quadruple helical fluted cutting edge. 5) A solid cylindrical end mill with a triple helical fluted cutting edge, but with a larger diameter than the third one. 6) A solid cylindrical end mill with a double helical fluted cutting edge, similar to the second one but with a different profile. 7) A solid cylindrical end mill with a single helical fluted cutting edge, similar to the first one but with a different profile.

Catalogue Code Material	E310	E400 / E401	E402 / E403	E408 / E409	E444		E446 / E447	E478 / E480
	VHM	VHM-ULTRA		VHM-ULTRA	VHM		VHM	VHM-ULTRA
	Brt	CrN		CrN	Brt		Brt	Brt
Sutton Designation	AI	AI		AI	AI		AI	AI
Type of Cut: Slitting	●	●		●	●		●	●
Finishing								
Universal	●	●		●	●		●	●
Roughing								
Profiling		●		●	●		●	●
↑ ap x Ø	1.0	1.5	1.5	1.5	1.5	1.5	1.0	1.5
↔ ae x Ø	1.0	0.25	0.4	1.0	0.25	0.4	0.1	0.05

Condition: A (Annealed), AH (Age Hardened), C (Cast),
HT (Hardened & Tempered), QT (Quenched & Tempered)

Bold = Optimal | Regular = Effective

Notes on Milling

1. Above values are guidelines for the size and type of cut nominated.
 2. For long series tools, reduce speed by 40% and feed by 20%.
 3. For Ramping, reduce speed by and feed by 70%.
 4. For Ultra High Speeds - high speed/feed balancing & high pressure coolant (50-70 Bar) improves results

METRIC ENDMILLS (mm size)	
\emptyset	= nominal tool diameter (mm)
n	= Spindel speed (RPM) $n = \frac{V_c \times 1000}{\emptyset \times \pi} \approx \frac{V_c}{\emptyset} \times 318$
V_c	= Cutting speed (m/min)
f_z	= Feed rate per tooth (mm/tooth) $V_c = \frac{n \times \emptyset \times \pi}{1000} \approx \frac{n \times \emptyset}{318}$
V_f	= Feed rate (mm/min)
z	= No. cutting edges $f_z = \frac{V_f}{z \times n}$
Q	= Metal removal rate (cm^3/min) $V_f = f_z \times z \times n$
a_p	= Cutting depth (mm) $Q = \frac{a_p \times a_w \times V_f}{1000}$
a_w	= Cutting width (mm)

Feed Table (fz) (mm/tooth)

Ø	Feed Table (fz / mm/tooth)																					
	Feed #																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
2	0.001	0.002	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.010	0.011	0.013	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.030		
3	0.002	0.003	0.004	0.005	0.006	0.008	0.009	0.010	0.012	0.014	0.016	0.018	0.020	0.023	0.025	0.028	0.032	0.034	0.038	0.042		
4	0.004	0.005	0.006	0.007	0.009	0.010	0.012	0.014	0.016	0.018	0.021	0.023	0.026	0.030	0.032	0.036	0.040	0.044	0.045	0.050		
5	0.005	0.006	0.008	0.009	0.011	0.013	0.015	0.017	0.020	0.023	0.025	0.030	0.032	0.036	0.040	0.044	0.050	0.055	0.060	0.065		
6	0.006	0.008	0.009	0.011	0.013	0.016	0.018	0.021	0.024	0.028	0.030	0.034	0.038	0.042	0.045	0.050	0.055	0.060	0.070	0.075		
8	0.010	0.012	0.014	0.017	0.019	0.022	0.025	0.028	0.032	0.036	0.040	0.045	0.050	0.055	0.060	0.065	0.075	0.080	0.085	0.095		
10	0.013	0.015	0.018	0.021	0.024	0.028	0.032	0.036	0.040	0.045	0.050	0.055	0.060	0.070	0.075	0.085	0.090	0.100	0.11	0.12		
12	0.016	0.019	0.022	0.026	0.030	0.034	0.038	0.044	0.050	0.055	0.060	0.065	0.075	0.080	0.090	0.100	0.11	0.12	0.13	0.14		
16	0.020	0.024	0.028	0.034	0.038	0.044	0.050	0.055	0.060	0.070	0.080	0.085	0.095	0.11	0.12	0.13	0.14	0.16	0.17	0.18		
20	0.022	0.028	0.032	0.038	0.044	0.050	0.060	0.065	0.075	0.085	0.095	0.11	0.12	0.13	0.15	0.16	0.18	0.20	0.22	0.24	0.26	0.29
25	0.025	0.032	0.038	0.045	0.055	0.060	0.070	0.080	0.090	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.22	0.24	0.26	0.29		

Application Guide Speeds & Feeds - Carbide Endmills

FETOGA
A-LINE

ISO VDI Material Group		Sutton	
P	A Steel	N	INI
M	R Stainless Steel	VA	GG
K	F Cast Iron	AI	W
N	N Non-Ferrous Metals, Aluminiums & Coppers	Ti	Ni
S	S Titanums & Super Alloys		
H	H Hard Materials (≥ 45 HRC)		H

[^] VDI 3323 material groups can also be determined by referring to the workpiece material cross reference listing. Refer to main index of this section.

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Catalogue Code	Material	Surface Finish	Sutton Designation	Type of Cut:	Slotting	Finishing	Universal	Roughing	Profiling	$\downarrow \uparrow ap \times \emptyset$
				VHM-ULTRA	VHM-ULTRA	VHM-ULTRA	VHM-ULTRA	VHM-ULTRA	VHM-ULTRA	
E660	BrT	BrT	BrT							
E661	BrT	BrT	BrT							
E662	BrT	BrT	AI - IK							
E663	HCR	AI	AI							
E665	HCR	AI	AI							

Al
AI
AI - IK
AI
AI

1.0 1.5 1.5
0.5 1.5 0.1
1.0 0.25 0.4
1.0 1.0
1.0 0.25 0.5
1.0 1.0
1.0 0.25 0.4
1.0 0.25 0.4

ISO	VDI ³³²³	Material	Condition	HB	Vc	Feed #			Vc	Feed #			Vc	Feed #			Vc	Feed #		
						Feed #	Vc	Feed #		Feed #	Vc	Feed #		Feed #	Vc	Feed #				
N	21	Aluminum & Magnesium - wrought alloy	Non Heat Treatable	60	400-500	16 18 17	400-500	16 18 17	15	16 18 17	400-500	16 18 17	15	16 18 17	400-500	16 18 17	15	16 18 17	400-500	16 18 17
	22		Heat Treatable	AH	100	400-530	16 18 17	400-530		16 18 17	400-530	16 18 17		15 16 17	400-530	16 18 17		15 16 17	400-530	16 18 17
	23	Aluminum & Magnesium - cast alloy $\leq 12\%$ Si	Non Heat Treatable		75	230-360	15 17 16	230-360	15 17 16	14	15 17 16	230-360	15 17 16	14 15 17	230-360	15 17 16	14 15 17	230-360	15 17 16	
	24		Heat Treatable	AH	90	230-360	15 17 16	230-360	15 17 16		14 15 17	230-360	15 17 16	14 15 17	230-360	15 17 16	14 15 17	230-360	15 17 16	
	25	Al & Mg - cast alloy $> 12\%$ Si	Non Heat Treatable		130	230-360	15 17 16	230-360	15 17 16		14 15 17	230-360	15 17 16	14 15 17	230-360	15 17 16	14 15 17	230-360	15 17 16	
	26	Copper & Cu alloys (Brass/Bronze)	Free cutting, Pb $> 1\%$		110	100-210	14 16 15	100-210	14 16 15	14	15 16 15	100-210	14 16 15	14 15 16	100-210	14 16 15	14 15 16	100-210	14 16 15	
	27		Brass (CuZn, CuSnZn)		90	100-210	14 16 15	100-210	14 16 15		14 15 16	100-210	14 16 15	14 15 16	100-210	14 16 15	14 15 16	100-210	14 16 15	
	28		Bronze (CuSn)		100	100-210	14 16 15	100-210	14 16 15		14 15 16	100-210	14 16 15	14 15 16	100-210	14 16 15	14 15 16	100-210	14 16 15	
	29	Non-metallic - Thermosetting & fiber-reinforced plastics				490-600	18 20 19	490-600	18 20 19		15 16 17	490-600	18 20 19	15 16 17	490-600	18 20 19	15 16 17	490-600	18 20 19	
	30	Non-metallic - Hard rubber, wood etc.				- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -				

*Up to 2500

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METRIC ENDMILLS (mm size)

$$\begin{aligned} \emptyset &= \text{nominal tool diameter (mm)} \\ n &= \frac{V_c \times 1000}{\emptyset \times \pi} \approx \frac{V_c}{\emptyset} \times 318 \\ V_c &= \frac{n \times \emptyset \times \pi}{1000} \approx \frac{n \times \emptyset}{318} \\ f_z &= \frac{V_f}{z \times n} \quad V_f = f_z \times z \times n \\ Q &= \frac{a_p \times a_e \times V_f}{1000} \end{aligned}$$

\emptyset	Feed Table (fz) (mm/tooth)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	0.001	0.002	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.010	0.011	0.013	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.030
3	0.002	0.003	0.004	0.005	0.006	0.008	0.009	0.010	0.012	0.014	0.016	0.018	0.020	0.023	0.025	0.028	0.032	0.034	0.038	0.042
4	0.004	0.005	0.006	0.007	0.009	0.010	0.012	0.014	0.016	0.018	0.021	0.023	0.026	0.030	0.032	0.036	0.040	0.044	0.048	0.050
5	0.005	0.006	0.008	0.009	0.011	0.013	0.015	0.017	0.020	0.023	0.025	0.030	0.032	0.036	0.040	0.044	0.050	0.055	0.060	0.065
6	0.006	0.008	0.009	0.011	0.013	0.016	0.018	0.021	0.024	0.028	0.030	0.034	0.038	0.042	0.045	0.050	0.055	0.060	0.070	0.075
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10	0.013	0.015	0.018	0.021	0.024	0.028	0.032	0.036	0.040	0.045	0.050	0.055	0.060	0.065	0.075	0.080	0.090	0.090	0.100	0.11
12	0.016	0.019	0.022	0.026	0.030	0.034	0.038	0.044	0.050	0.055	0.060	0.065	0.075	0.080	0.090	0.100	0.11	0.12	0.13	0.14
16	0.020	0.024	0.028	0.034	0.038	0.044	0.050	0.055	0.060	0.070	0.080	0.085	0.095	0.11	0.12	0.13	0.14	0.16	0.17	0.18
20	0.022	0.028	0.032	0.038	0.044	0.050	0.060	0.065	0.075	0.085	0.095	0.11	0.12	0.13	0.15	0.16	0.18	0.19	0.21	0.23
25	0.025	0.032	0.038	0.045	0.055	0.060	0.070	0.080	0.090	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.22	0.24	0.26	0.29

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f_z	= Feed rate per tooth (mm/tooth)
V_f	= Feed rate (mm/min)
z	= No. cutting edges
Q	= Metal removal rate (cm^3/min)
a_p	= Cutting depth (mm)
a_e	= Cutting width (mm)
n	$n = \frac{v_c \times 1000}{\emptyset \times \pi} \simeq \frac{v_c}{\emptyset} \times 318$
v_c	$v_c = \frac{n \times \emptyset \times \pi}{1000} \simeq \frac{n \times \emptyset}{318}$
f_z	$f_z = \frac{V_f}{z \times n}$
V_f	$V_f = f_z \times z \times n$
Q	$Q = \frac{a_p \times a_e \times V_f}{1000}$

Feed Table (fz) (mm/tooth)

Ø	Feed Table (fz / mm/tooth)																			
	Feed #																			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
2	0.001	0.002	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.010	0.011	0.013	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.030
3	0.002	0.003	0.004	0.005	0.006	0.008	0.009	0.010	0.012	0.014	0.016	0.018	0.020	0.023	0.025	0.028	0.032	0.034	0.038	0.042
4	0.004	0.005	0.006	0.007	0.009	0.010	0.012	0.014	0.016	0.018	0.021	0.023	0.026	0.030	0.032	0.036	0.040	0.044	0.045	0.050
5	0.005	0.006	0.008	0.009	0.011	0.013	0.015	0.017	0.020	0.023	0.025	0.030	0.032	0.036	0.040	0.044	0.050	0.055	0.060	0.065
6	0.006	0.008	0.009	0.011	0.013	0.016	0.018	0.021	0.024	0.028	0.030	0.034	0.038	0.042	0.045	0.050	0.055	0.060	0.070	0.075
8	0.010	0.012	0.014	0.017	0.019	0.022	0.025	0.028	0.032	0.036	0.040	0.045	0.050	0.055	0.060	0.065	0.075	0.080	0.085	0.095
10	0.013	0.015	0.018	0.021	0.024	0.028	0.032	0.036	0.040	0.045	0.050	0.055	0.060	0.070	0.075	0.085	0.090	0.100	0.111	0.12
12	0.016	0.019	0.022	0.026	0.030	0.034	0.038	0.044	0.050	0.055	0.060	0.065	0.075	0.080	0.090	0.100	0.111	0.12	0.13	0.14
16	0.020	0.024	0.028	0.034	0.038	0.044	0.050	0.055	0.060	0.070	0.080	0.085	0.095	0.111	0.12	0.13	0.14	0.16	0.17	0.18
20	0.022	0.028	0.032	0.038	0.044	0.050	0.060	0.065	0.075	0.085	0.095	0.111	0.12	0.13	0.15	0.16	0.18	0.19	0.21	0.23
25	0.025	0.032	0.038	0.045	0.055	0.060	0.070	0.080	0.090	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.22	0.24	0.26	0.29

Regrinding and Recoating Services

Regrinding

The relationship with you does not end after the delivery of our products. Sutton Tools supports you by reducing your production costs through our regrinding service of carbide tools available at our state-of-the-art facility.

Using our regrinding service means:

- ✓ Reground with original geometry
- ✓ Quality assured
- ✓ Handled by highly experienced personnel
- ✓ Lower tooling cost

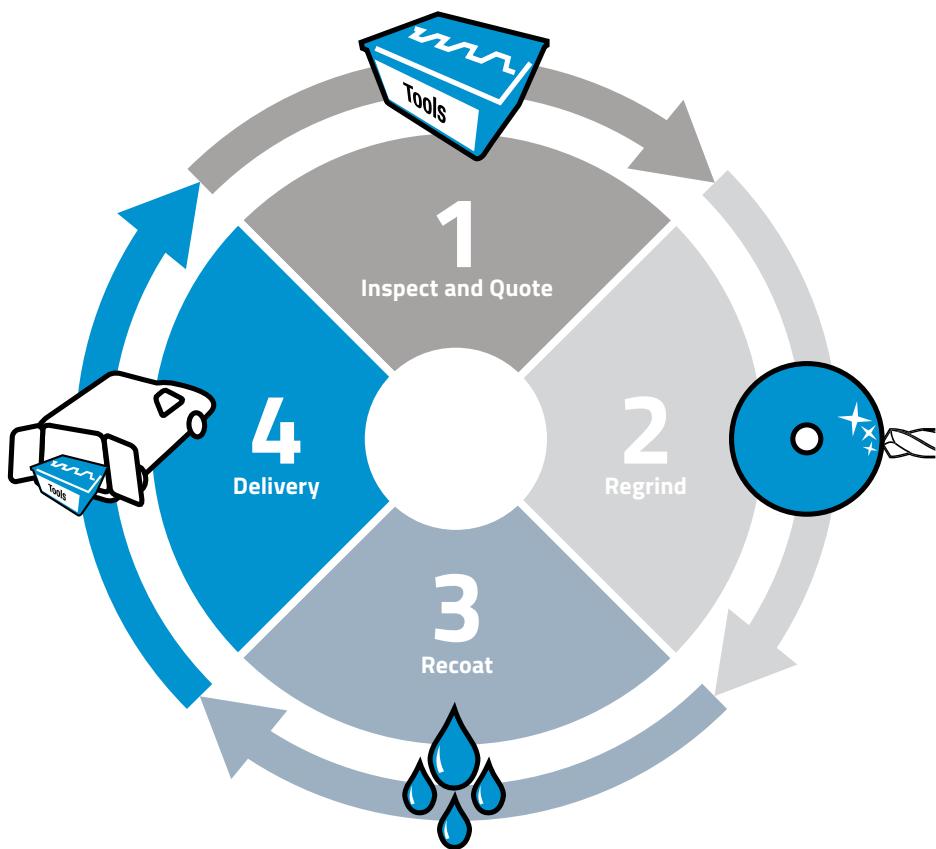
Recoating

As a total solution provider, Sutton Tools uses world leading heat treatment PVD coating (Physical Vapour Deposition) based on Oerlikon Balzers technology on their latest INNOVA coating machine to add life to our products.

The benefits of PVD coatings include:

- ✓ 300%–1000% increase in tool life
- ✓ Increased productivity
- ✓ Uniform thickness
- ✓ Corrosion resistant
- ✓ Less tool changes due to less wear
- ✓ Better wear condition for regrinds

Tool Regrinding and Recoating Process



Custom Tools and Modifications

With the synergy of facility and services, Sutton Tools are able to manufacture custom tools to your exact requirements. Simply provide your details via our enquiry form and our team of engineers will be able to design a custom solution for your tooling needs in no time.