LAMINA
TECHNOLOGIES

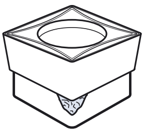
User Guide

Machining Optimization

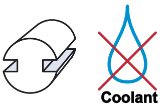
For new users of Lamina Technologies Multi-Mat™ (multi-material) inserts and to get more productivity and longer tool life, we have prepare a short machining guide to insure your satisfaction with our products.

The machining conditions included after each insert are our guidelines for optimal machining. However, our inserts can work in wide range of cutting conditions to meet special machining needs.

Turning

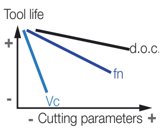


Check the condition of the tool holder (insert seat, shim, lever, screw) and check if the insert is well seated and clamped.



If there are interrupted cut or passes with short lengths of cut, dry operation is recommended to avoid thermal shocks. For heavy interrupted cut feed rate should be reduced.

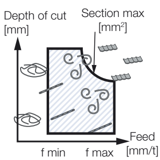
Check the stability of the machine. The tool overhang should be as short as possible.



Cutting speed has the greatest influence on tool life. For high productivity and long tool life, first increase d.o.c. and feed rate.

Feed x **d.o.c.**
=
Amax

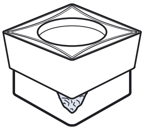
Respect maximum chip section area for each insert.
Amax = feed x d.o.c.



For higher productivity and better chip control in roughing, work close to the recommended Amax value.

Machining Optimization

Milling



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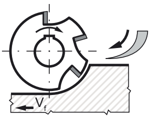
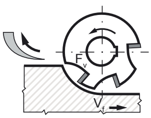
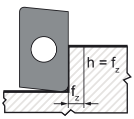


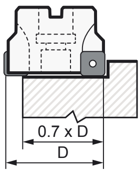
Climb Milling:
Usually this is the recommended direction. Tool life up to 40% longer than conventional.



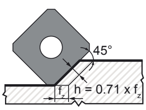
Conventional Milling:
Recommended only for:
- Old machines with backlash in the table transmission
- Flame cut, forged and cast workpieces
- Thin workpieces (in order to reduce vibration)



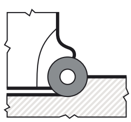
κ = 90° Approach angle
High radial forces / Low axial forces.
Recommended:
- When 90° wall is needed
- For unstable conditions
- For slender workpieces



For face milling the width of cut (ae) should be about 70% of the cutter diameter, in order to achieve better chip formation and longer tool life. For limited engagement conditions, it is necessary to increase feed per tooth.



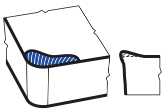
κ = 45° Approach angle identical radial and axial forces.
High productivity   fz = 1.41 x h
Recommended:
- When overhang is long (lower vibration tendency)
- For face milling (1st choice)



Round Inserts:
Roughing and general purposes. Strongest cutting edge.

Machining Optimization

Built-up Edge (Adhesive Wear)



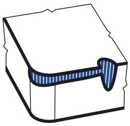

Description

The workpiece material is welded to the cutting edge. Normally caused by low temperatures.

Solution

- Increase cutting speed
- Increase feed
- Use more positive geometry

Notch wear (Adhesive/Mechanic Wear)



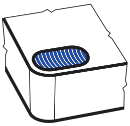

Description

Result of adhesive or mechanical action. Chipping or localized wear at the depth of cut line.

Solution

- Use more positive geometry
- Reduce feed
- Vary depth of cut

Crater (Chemical Wear)



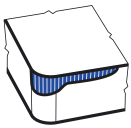
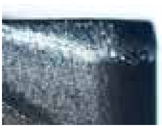

Description

Happens on the rake surface. Normally the result of a combination of a diffusion and abrasion wear mechanism.

Solution

- Decrease cutting speed
- Check coolant direction
- Use more positive geometry

Flank Wear (Abrasive Wear)

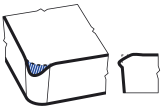
Description

Abrasive wear mechanism that happens on the cutting edge's flank. Not common in Lamina inserts.

Solution

- Decrease cutting speed
- Check coolant direction.

Plastic Deformation (Thermal Wear)



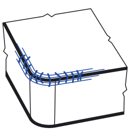

Description

Caused by cutting forces and too high temperature. Not common in Lamina inserts.

Solution

- Decrease cutting speed
- Decrease feed rate

Thermal Cracks (Thermal Wear)



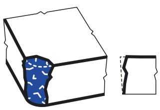

Description

Small cracks normally at 90° to the cutting edge caused by temperature variation

Solution

- Stabilize the temperature
- Shut off the coolant

Breakage (Mechanic Wear)




Description

Most breakages happen because the wear development is not seen in time.

Solution

- Check the tool holder
- Check the tool overhang
- Check the Amax
- Decrease feed and Vc
- Apply more robust insert
- Check the run-out

Material Groups

	Material Group	Gr. N°	VDI Group	Material Examples*	Description	Caution
Steel	Non-alloyed	1	1	C35, Ck45, 1020, 1045, 1060, 28Mn6	<u>Non-alloyed Steel</u> **Composition:** Fe-C alloy (usually 0.1 to 0.6% carbon). **Characteristics:** Good machinability and high cutting speeds can be applied. When it has less than 0.25% carbon, it can be very sticky, requiring positive rake and small land inserts. <u>Alloyed Steel</u> **Composition:** Fe-C alloy (maximum 2.1% carbon) with additives like Cr, Mo, V, Ni, Mn, Co, W, etc. **Characteristics:** The variation in the amount of alloying elements and different heat treatments control features such as mechanical resistance and machinability. It's important to follow the cutting speeds recommended according to the hardness of the steel, as it influences temperature as well as chemical and adhesive wears. <u>High alloyed Steel</u> have more than 5% alloying elements.	**Built-up edge Crater**
			2			
			3			
	Low alloyed	2	6	42CrMo4, St50, Ck60, 4140, 4340, 100Cr6		**Built-up edge Crater**
			4,6			
			5,7			
			8			
	High alloyed	3	10	X40CrMoV5, H13, M42, D3, S6-5-2, 12Ni19		**Crater**
			10			
			11			
			11			
Stainless Steel	Austenitic	4	14	304, 316, X5CrNi18-9	**Composition:** Alloyed steel, more than 11% chrome (Cr). **Characteristics:** Stainless steels do not stain, corrode, or rust as easily as ordinary steel. Usually they are difficult to machine because of its narrow range of cutting speeds. If the cutting speed is too low, the material sticks in the cutting edge, if it's too high, the high quantity of additives produces abrasive wears in the cutting edge.	**Built-up edge Notch wear**
			14			
	Duplex	5	14	X2CrNiN23-4, S31500		**Notch wear Crater**
			14			
	Ferritic & Martensitic	6	12	410, X6Cr17, 17-4 PH, 430		**Crater**
			13			
Cast Iron	Grey	7	15	GG20, GG40, EN-GJL-250, No30B	**Composition:** Fe-C alloy with 2.1 to 5% of carbon. It can be alloyed with Si, P, Mn and Ni. **Characteristics:** Grey cast iron tends to be brittle, and malleable cast irons usually have a more ductile but less homogeneous microstructure. Reinforced cutting edges will perform best. High productivity can be achieved by using high feeds.	**Flank wear Crater Mechanical cracks**
			15			
			16			
	Malleable & Nodular	8	17,19	GGG40, GGG70, 50005		
			17,19			
			18,20			
High Temp.Alloys	Fe, Ni & Co based	9	31,32	Incoloy 800	**Composition:** Iron (Fe) based, Nickel (Ni) based or Cobalt (Co) based alloys and Titanium alloys. **Characteristics:** High temperature alloys and titanium provide excellent mechanical strength resistance, as well as corrosion and oxidation resistance. Relatively low cutting speed is recommended due to their poor thermal conductivity.	**Notch wear Crater**
			33	Inconel 700		
			34	Stellite 21		
	Ti based	10	36	TiAl6V4		
			37	T40		
Hardened Mat.	Steel	11	38	X100CrMo13, 440C, G-X260NiCr42	This group includes hardened and tempered steel up to 55 HRc, chilled and white cast iron up to 55 HRc. Machining success depends largely on clamping system rigidity, as cutting forces and power consumption are high. Finishing represents the majority of the operations for this material group.	**Crater**
			38			
			38			
	Chilled Cast Iron		40	Ni-Hard 2		
	White Cast Iron		41	G-X300CrMo15		
NF	Al (>8%Si)	12	25	AlSi12	Non-ferrous and soft materials (less than 130HB of hardness). Most common: Aluminum **Composition:** Al alloys can be alloyed with Cu, Zn, Mg, Mn and Si. **Characteristics:** Aluminium is widely used due to its low density and relatively good strength to weight ratio. When machining, it tends to have long chips and built-up edge. A highly positive cutting edge together with low friction coating control the chips and reduce built up edge.	**Built-up edge**
	Al (<8%Si)	13	21, 22 23, 24	Si < 4 %		
				4% < Si < 8 %		
	Cooper Alloys	14	26,27,28	CuZn30		
	Non-Metallic	15	29	Fiber Plastics		
			30	Hard Rubber		
			-	Graphite		

Magia Premium Grades

Lamina Technologies has augmented its Magia range of premium grades with the introduction of two new optimized, multi-layer CVD grades for turning and an advanced PVD grade for milling.

Magia for Turning

Now with three Magia grades for turning, Lamina Technologies provides further options for a greater range of application, improved efficiency and longer tool life.

LT 1000
Recommended for general usage

Multi-Mat™ LT 1000 is the most versatile grade of the Magia turning line with excellent combination of hardness and toughness.

It is the first choice for customers with short production runs, different machining applications and different types of workpiece materials.

LT 1005
Recommended for stable conditions, moderate to high speeds, for P, K, H material groups

Increased hardness and wear resistance at high temperatures makes this grade well suited for stable conditions and higher cutting speeds.

Highly resistant to plastic deformation thus maintains high dimensional tolerance.

LT 1025
Recommended for unstable conditions, moderate to low speeds, for P, M, K material groups

Increased toughness makes this grade excellent for unstable conditions, such as interrupted cut.

The low chemical affinity between top ceramic layer and workpiece material ensures low friction and increased resistance to built-up edge development even at low cutting speeds in facing applications.

Magia for Milling

Lamina Technologies' new generation, premium Multi-Mat™ milling grade, LT 3000, provides higher performance, more productivity, excellent mechanical and improved thermal shock resistance for even longer tool life.

LT 3000

Denser micro structured coating. High quality substrate.

Magia LT 3000 inserts are made from Lamina Technologies' advanced substrate, now with a denser micro structured, smoother coating, which allows for even lower wear rates.

Progressive and predictable wear.

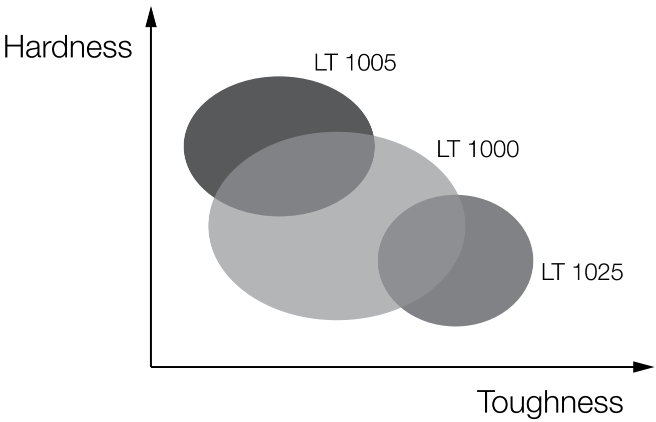
The new silver top layer provides more contrast on worn edges making it easy to identify which edge has been used and the level of wear development.

More flexibility. Extended application range.

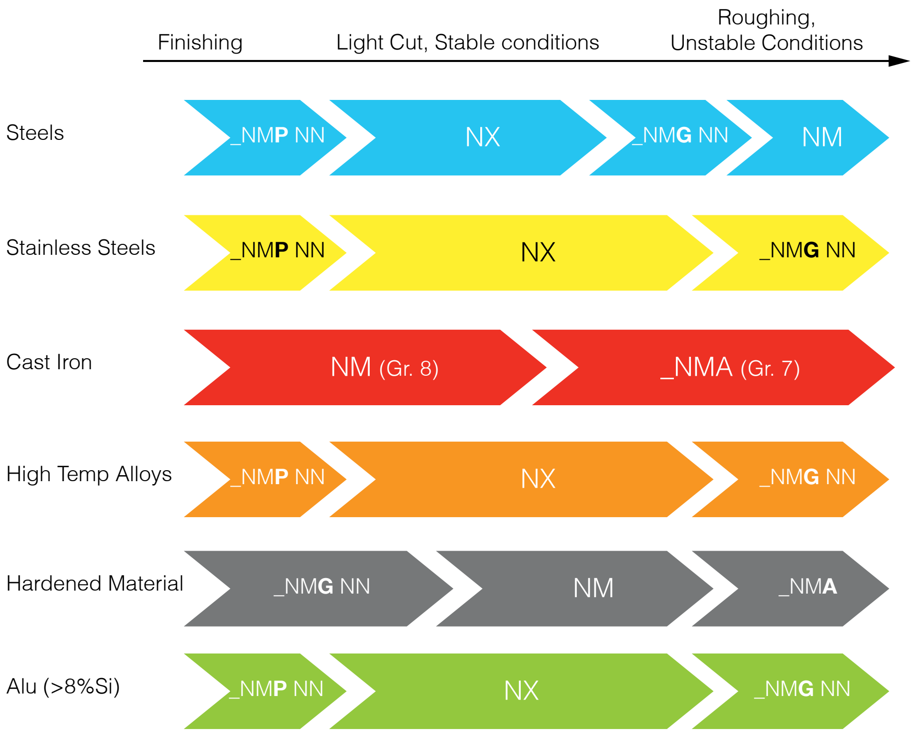
With a more tolerant coating, LT 3000 permits added flexibility and a wider application range as it can be applied at higher and lower cutting speeds than LT 30.

Grade Chart

Material Group * = 1st choice grade	High Speeds Stable Conditions	Interrupted Cut Unstable Conditions	Low Speeds Facing to Center	Wear Resistance X Toughness
P	* LT1005 LT1000 LT1025	LT1000 *LT1025	LT1005 LT1000 *LT1025	harder tougher
M	LT1005 * LT1000 LT1025	LT1000 * LT1025	LT1000 * LT1025	harder tougher
K	* LT1005 LT1000	LT1000 * LT1025	LT1005 *LT1000 LT1025	harder tougher
S	* LT1000	* LT1000	* LT1000	harder tougher
H	LT1005 * LT1000	LT1005 * LT1000	LT1005 * LT1000	harder tougher
N (>8%Si)	* LT1000	* LT1000	* LT1000	harder tougher



Negative Turning Chipbreakers: Overview



Negative Turning Chipbreakers: Recommendations

Material Group * = 1st choice	Medium / Roughing		Finishing		Sharper edge X Stronger edge
	Continuous cut	Interrupted cut	Continuous cut	Interrupted cut	
P	NX * _NMG NN NM	NX NN NM *	_NMP NN NX * _NMG NN	NX _NMG NN * NM	sharper stronger
M	_NMP NN NX * _NMG NN	NX * _NMG NN	_NMP NN * NX _NMG NN	NX * _NMG NN	sharper stronger
K	_NMG NN NM * (Mat Group 8) _NMA * (Mat Group 7)	_NMG NN NM * (Mat Group 8) _NMA * (Mat Group 7)	_NMG NN *(Mat Group 8) NM _NMA * (Mat Group 7)	_NMG NN NM * (Mat Group 8) _NMA * (Mat Group 7)	sharper stronger
S	_NMP NN NX * _NMG NN	NX * _NMG NN	_NMP NN * NX _NMG NN	NX * _NMG NN	sharper stronger
H	_NMG NN NM *	_NMG NN NM * _NMA	_NMG NN * NM	_NMG NN NM * _NMA	sharper stronger
N (>8%Si)	_NMP NN NX * _NMG NN	NX _NMG NN *	_NMP NN NX * _NMG NN	NX _NMG NN *	sharper stronger

Multi-Mat™ Chipbreakers

_NMP NN NX _NMG NN NM

Light Cut,
Stable Conditions

Roughing,
Unstable Conditions

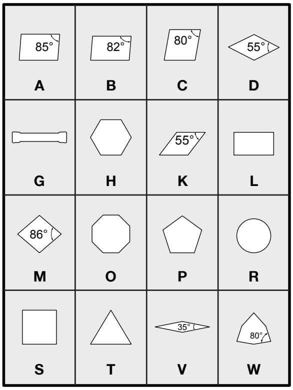
Additional dedicated geometries

_NMA
(Cast Iron Mat Group 7)

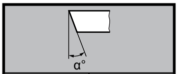
ALU
(Aluminium <8% Si)

Insert Designation (based on ISO norms)

1. Insert Shape



2. Clearance Angle

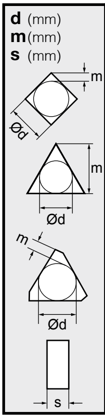


Letter Symbol	α
A	3°
B	5°
C	7°
D	15°
E	20°
F	25°
G	30°
N	0°
P	11°
O	Special

W	N	M	G
1	2	3	4

A	P	K	T
1	2	3	4

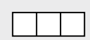
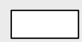
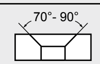
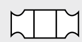
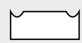
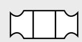
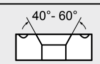
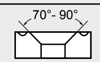
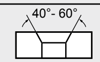
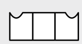
3. Tolerance Class



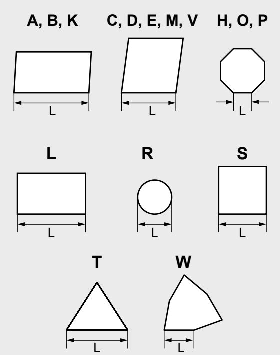
Symbol	D	M	S
A	± 0.025	± 0.005	± 0.025
C	± 0.025	± 0.013	± 0.025
E	± 0.025	± 0.025	± 0.025
F	± 0.013	± 0.005	± 0.025
G	± 0.025	± 0.025	± 0.130
H	± 0.013	± 0.013	± 0.025
J*	± 0.05-0.15	± 0.005	± 0.025
K*	± 0.05-0.15	± 0.013	± 0.025
L*	± 0.05-0.15	± 0.025	± 0.025
M*	± 0.05-0.15	± 0.08-0.20	± 0.130
N*	± 0.05-0.15	± 0.08-0.20	± 0.025
U*	± 0.08-0.25	± 0.13-0.38	± 0.130

*Depending on the insert size. For exact tolerance see insert page.

4. Fixing and Chipbreaker Types

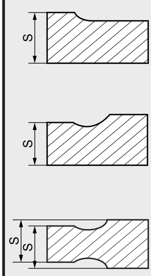
Type	Symbol	Type	Symbol
A		N	
B		P	
F		R	
G		T	
H		W	
M		X	Special Design

5. Cutting Edge Length



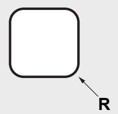
Disregarding any decimals e.g. 12,7 = 12

6. Insert Thickness



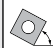
Symbol	mm
01 =	1.59
T1 =	1.98
02 =	2.38
03 =	3.18
T3 =	3.97
04 =	4.76
05 =	5.56
06 =	6.35
07 =	7.94
09 =	9.52

7. Insert Corner Radius



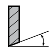
00 = Sharp corner or round insert (inch version)
M0 = Round insert (metric version)
01 = 0.1 mm
02 = 0.2 mm
04 = 0.4 mm
08 = 0.8 mm
12 = 1.2 mm
16 = 1.6 mm
etc

1st letter (Milling)



A = 45°
D = 60°
E = 75°
F = 85°
P = 90°
Z = other

2nd letter (Milling)

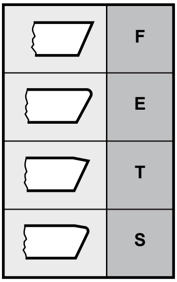


A = 3°
B = 5°
C = 7°
D = 15°
E = 20°
F = 25°
G = 30°
N = 0°
P = 11°
Z = other

08	04	08			NN
5	6	7	8	9	10

16	04	PD	T	R	
5	6	7	8	9	10

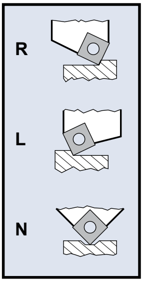
8. Edge Preparation



Optional information

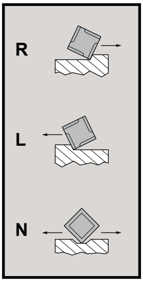
9. Cutting Direction

Turning



Optional information

Milling



Optional information

10. Internal Designation

e.g. Chipbreaker (Turning)

NN = General purpose
NM = Roughing operations
NX = General purpose Magia
PP = All purpose grooving
ALU = Non-ferrous materials

Optional information

e.g. Application (Milling)

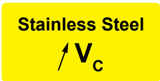
- **45** = 45° Approach Angle
- **90** = 90° Approach Angle
- **HF** = High Feed

Optional information

Machining Recommendations

In order to obtain the best productivity using Lamina Technologies cutting tools, we have included some relevant comments and tips.

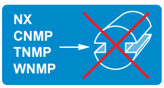
Each comment is represented by an icon and the relevant icons appear for each insert.



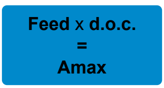
In machining stainless steel, please verify and respect the cutting speed recommended for the insert as there is a tendency to machine at speeds that are too low.

In machining stainless steel or exotic materials, P geometry inserts (CNMP, TNMP, WNMP) and NX chipbreakers are recommended as first choice.

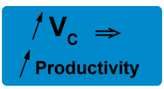
In machining exotic materials, it is important to verify cutting conditions of the specific insert.



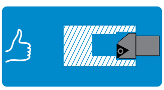
P geometry inserts (CNMP, TNMP, WNMP) and NX chipbreakers are not recommended when machining with interrupted cut.



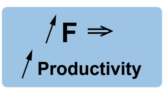
It is important to verify and respect Amax, which is the maximum chip section. Feed x d.o.c. must be lower than the number noted as Amax.



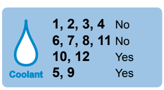
To increase machining productivity, it is recommended to increase speed (Vc) while respecting chip size calculation.



Appropriate for boring operations.



To increase machining productivity, it is recommended to increase speed (Vc) while respecting chip size calculation.



When milling materials from groups 1, 2, 3, 4, 6, 7, 8 and 11, coolant is not recommended. When machining materials from groups 5, 9, 10 and 12, it is recommended to use coolant.

Technical Formulas

Turning

Cutting Speed (m/min)	$V_c = \frac{D_m \times \pi \times n}{1000}$
Rotation (Rev/min)	$n = \frac{V_c \times 1000}{D_m \times \pi}$
Chip Removal Rate (cm³/min)	$Q = V_c \times a_p \times f_n$
Cutting Time (min)	$T_c = \frac{l_m}{f_n \times n}$
Surface Roughness (µm)	$R_{max} = \frac{f_n^2}{r_\varepsilon} \times 125$

Millling

Cutting Speed (m/min)	$V_c = \frac{n \times \pi \times D}{1000}$
Rotation (Rev/min)	$n = \frac{V_c \times 1000}{\pi \times D}$
Table Feed (mm/min)	$V_f = n \times z_c \times f_z$
Cutting Output (cm³/min)	$Q = \frac{a_e \times a_p \times V_f}{1000}$
Feed per Tooth	$f_z = \frac{V_f}{n \times z_c}$

Symbol	Designation	Unit
D_m	Machining diameter	mm
f_n	Feed per revolution	mm/rev
l_m	Machining length	mm
n	Rotation	rev/min
Q	Chip removal rate	cm³/min
A_{max}	d.o.c x feed	mm²
r_ε	Nose radius	mm
T_c	Cutting time	min
R_{max}	Surface roughness	µm

Symbol	Designation	Unit
V_c	Cutting speed	m/min
a_p	Depth of cut (d.o.c.)	mm
a_e	Radial depth of cut (width of cut)	mm
D	Cutter diameter	mm
f_z	Feed per tooth	mm/tooth
Z_c	Effective number of teeth	pcs
V_f	Table Feed	mm/min
Z_n	Total number of teeth	pcs

Frequently Asked Questions

Is it true that Lamina Technologies' inserts can be used with any type of working material?

Lamina inserts have been tested in countless applications around the world and are suitable for practically any type of turning or milling metal cutting operation.

While Lamina inserts will work in aluminum production jobs, aluminum frequently requires tailored chip-control optimization. Please see Lamina's dedicated aluminium line of inserts.

What speeds and feeds should Lamina inserts be run at?

In this catalog specific recommendations are provided for each individual insert indicating the speeds and feeds that are required for most of the material groups.

In order to achieve the maximum advantage from Lamina's grade technology, it is important to always run the inserts according to the recommended conditions.

In general, the best results are normally achieved at the high range of the recommended cutting speeds.

What can we expect regarding the quality and consistency of Lamina inserts?

Due to Lamina's unique production methods and quality control procedures, you can expect inserts with higher accuracy and consistency than you have been accustomed up to now; insert to insert, box to box and batch to batch.

What percentage of my tooling requirements can Lamina supply?

In most regular shops, Lamina's inserts program should cover about 80% of all inserts needed for CNC machines from 20 Hp and down. The insert program covers a full range of standard turning and milling operations from semi-roughing to super-finishing.

Will Lamina grades perform better than the specialized and dedicated grades available from the market?

Lamina has extensive know-how in sub-micron powder technology as well as in state of the art PVD coating. This know–how combined with unique chipbreaker geometry and in depth understanding of the industry, enables Lamina to offer the Multi-Mat™ Concept; a simple concept of using one insert to work on many materials.

The same insert can be used on the next job and the job after and so on, replacing the hundreds of specialized and confusing insert choices that are being used.

In machine shops that run Lamina inserts, what do they find as the biggest benefits?

- Time saving - Always have the right insert available for any job. This reduces the number of setups and idle time.
- Cost saving - 80% reduction in insert inventory, ordering and stocking cost.

What about turning tool holders and boring bars?

Lamina's ANSI / ISO standard turning inserts are designed to fit all industrial standard turning tools and boring bars, using the tool holders you have in your stock.

How does the 4 corners Alu-Line perform in low silicon aluminum?

Our Alu-Line insert's geometry is specially designed for aluminum with low silicon content, creating chips that break instead of curl. The inserts are also coated and treated to reduce friction achieving unbeatable performance and tool life.

What is special about your solid end mill line?

Lamina know-how was applied to the solid end mill line. Our mills generate less friction and heat and therefore give better cut and longer tool life.