SIMTEK

WHITE PAPER

The New Era Of Chip Control

Process Reliable And Economical With 3D-Lasered Chip Shape Geometries

Contents

Introduction

When metal is machined, chips result. Controlling these chips is a critical factor when it comes to quality, process reliability and economic efficiency of the machining process. With a laser, tools can be formed in such a way that chips leave the cutting zone in a controlled way.

Long stringy chips can be a big challenge for workers because they can get tangled with the workpiece or tool and cause damage.

This is a good reason to take a closer look at the topic. Chip types and shapes have an enormous influence on machining quality and process reliability.

Chip control is essential for reliable, economical machining. The term covers a variety of methods for evacuating chips from the cutting zone during the machining process. The aim is always the same: to achieve optimum cutting results, minimize tool wear and improve process reliability.

In this white paper you will learn

- what **methods to control chips** are used today in tool production,
- where **conventional chip control methods reach their limits**,
- what **advantages due to laser-cut chip-forming geometries** you can expect,
- how laser-cut chip-forming geometries can improve the **quality and cost efficiency of your machining processes.**

Chip control: a vital necessity in machining

Chip control has always played an extremely important role in metal-cutting operations. It has a direct impact on precision, reliability and cost efficiency. Tool manufacturers today mostly offer tools with ground or sintered chip-forming geometries. These geometries determine how chips are broken, formed or guided in a certain direction during machining. In some cases, all three factors are determined at once.

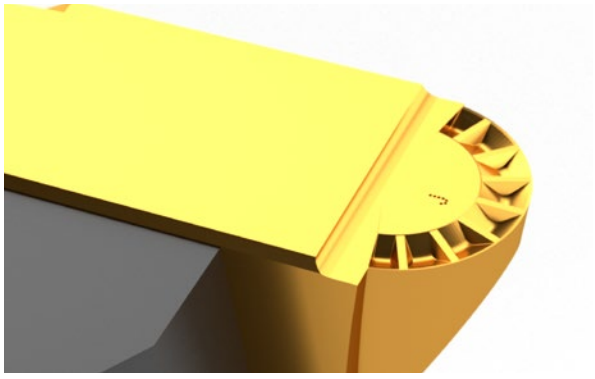
SIMTEK's product range includes a wide variety of tools for precise chip control in standard processes. However, with chip control one can never be absolutely certain. The process parameters vary from case to case, ranging from low speeds in small inside diameters to high speeds and extreme heat.

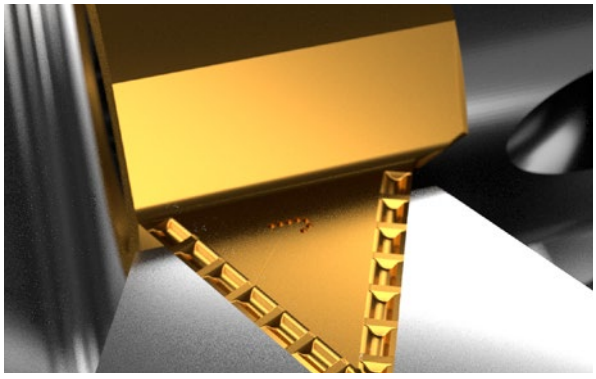
The demands on chip control have continued to increase in recent years. Manufacturers used to rely on free-cutting steel, which contains small percentages of lead and sulfur. These substances ensure that chips break into small pieces, making them easy to remove from the cutting zone. The EU REACH regulation has changed this, to protect the environment and human health. Many materials are now only allowed to contain small amounts of lead – and lead may be entirely prohibited in the future.

As a consequence, softer materials are now being used and the chips do not break. Instead, long chips are formed that can wind around the tool or clog up cavities. The same problems arise with difficult-to-machine or long-chipping materials like stainless steel, titanium, copper and aluminum. The machining process must then be stopped, which takes time and generates costs. Moreover, the tools wear down more quickly.

These changes in material characteristics have made chip control all the more important for metal-cutting facilities, regardless of the type of material used and the volume of production.

One of the big unknowns in metal machining is material quality. Recent years have seen an increase in the variety of alloys used, the purpose being to cover even highly specialized requirements. Another factor is uncertainty about material quality due to the recycling of used metal. This means that metalworking companies can never be sure whether the chip formation that worked well for them yesterday will work just as well today.





Versatile, extremely precise and highly suitable for complex geometries and applications: laser-cut chip-forming geometries are an economical and effective answer to the many challenges facing metal-cutting businesses today.

Conventional chip control methods – and their limits

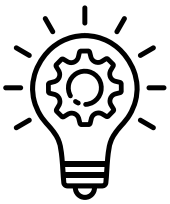
Chip control is thus becoming a growing challenge for metal-machining companies. Tool manufacturers have to take more and more factors into account when designing and optimizing tools that can influence chip formation. The drawbacks of conventional chip control methods can only be overcome with the help of long experience, in-depth knowhow and modern production technologies.

One reason is that the limits of conventional metal-cutting geometries are becoming increasingly evident. These geometries result when blanks are pressed and then sintered and ground. The geometries achieved by these methods can deviate by as much as one tenth of a millimeter. That's too much for optimum chip control.

Another reason is that grinding can only work in a single direction. Three-dimensional structures for multidirectional combination tools or deep molding plates cannot be achieved in this way.

Other factors besides tool geometry can have an influence on chip control. One is the choice and dosing of cooling lubricants. These lubricants reduce friction and heat buildup, which affect chip formation. Precise control of the lubricant makes it possible to form and remove chips in a controlled way. In the case of long chips, chip breakers with stepped edges can break chips into smaller pieces.

The effect that the choice of cutting material has on chip control should also not be underestimated. For this reason, SIMTEK uses specially developed GRADIUM cutting grades for tools with laser-cut chip-forming geometries. Customers are offered a grade that is ideal for their machining needs in terms of material, process parameters and tool requirements.



- The need is for **manufacturing processes that achieve complex three-dimensional chip-forming geometries.**
- The **creation of these complex geometries must be economical,** which means that sintering is hardly worthwhile for customized tools.
- The manufacturing process must be **precise within a few hundredths of a millimeter**.
- 3D chip-forming geometries that are created for a cutting tool by means of a laser are an **effective, low-cost solution.**

Optimum chip control with custom-designed chip-forming geometries

The best way to optimize chip control is to design customized chip-forming geometries. These are geometries that are adapted by designers to a particular application using 3D-CAD software and then implemented in the tool using a laser. Wherever a laser beam is applied to the metal, its energy generates a high temperature which vaporizes the metal and leaves a small depression.

The direction and penetration depth of the laser are controlled to create a complex three-dimensional depression with a precision of a few hundredths of a millimeter.

This depression guides the chips out of the cutting zone, breaks them or shapes them a controlled way so that they cannot get caught on the tool or workpiece.

The following two examples of application scenarios show what complex geometries can be created by a laser and what advantages arise for users and machining facilities. The principle is similar in each case: the chip-breaking depression is given an asymmetrical form in three dimensions. Chips are pressed through, turned and guided out of the cutting zone. The exact geometry is determined individually for each application.

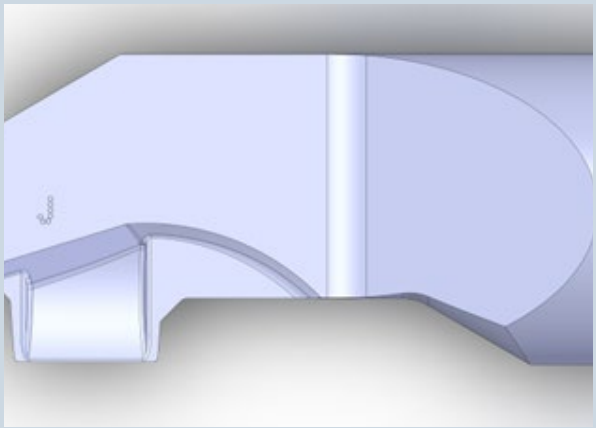
Application scenario 1:

Cutting of deep grooves in valve cover housings

Chip control is often a big challenge when deep grooves are cut in valve cover housings for vehicles. If the chip control is insufficient, chips remain in the groove.

This can have adverse consequences, especially in large-volume production. The problems, such as customer complaints, increased inspection requirements after machining and damaged workpieces are even more serious when several thousand components have to be regularly rechecked to ensure perfect quality.

SIMTEK tools with laser-cut chip-forming geometries are ideal in such cases. Experience has shown that they significantly increase process reliability and eliminate the need for follow-up checks.



simturn AX cutting tool with laser-cut chip-forming geometry

Cost-effectiveness of customized chip-forming geometries

Tools with customized chip-forming geometries are more expensive than conventional ones, and standard tools with chip-forming geometries made by pressing, sintering or grinding can always be expected to have lower prices. This is an attractive aspect for customers.

However, experience has shown that tools with laser-cut chip-forming geometries have a significantly longer lifetime. They suffer less wear because chips can flow from the cutting zone without obstruction. In many cases, a tool with a laser-cut chip-forming geometry can do as much work as several conventional tools and deliver significant savings over its lifetime.

That being said, long tool life and the resulting cost advantages for machinists are not the main factor. Process reliability is more important.

Parts must leave a cutting machine in perfect quality, without rejects and at a defined cycle rate, to ensure that subsequent process steps are not delayed. Nonproductive time for setting up, cleaning and maintenance is the real cost driver and the biggest obstacle to efficient production.

For all metal-cutting facilities, the goal is to have few or no rejects. This applies especially to large-scale production, which aims to achieve a reject rate of zero percent for tens of thousands of parts. In these cases, optimum chip control is a key factor in machining operations and critical to business success.

This is true in the automotive industry and even more so in the medical and aerospace industries. Complaints about poor quality due to factors such as concealed chips generate additional costs and lead to negative supplier evaluations.

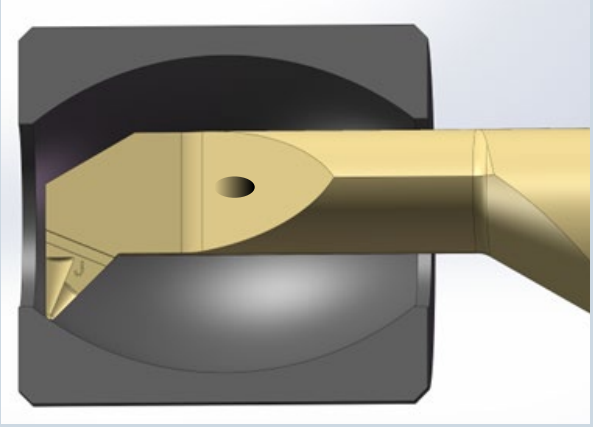
Application scenario 2:

Internal copying of spherical chambers for injection nozzles

Internal copying of spherical chambers, for example in injection nozzles, can result in snarl chips if chip control is insufficient. These chips can get caught in the part and wrapped around the tool.

In the worst case, the tool has to be cleaned after every production cycle. Chip removal can also cause damage to the machined component. For such cases, SIMTEK recommends a simturn AX cutting tool with laser-cut chip-forming geometry and an internal coolant supply.

Using this tool means chips flow out of the part along with the coolant, preventing damage to the part and significantly increasing the tool lifetime.



Tool with laser-cut chip-forming geometry and an internal coolant supply

Development of customized laser geometries

Back in 2015, SIMTEK launched an in-house research project on laser-cut chip-forming geometries. There were a number of setbacks, and many hurdles had to be overcome. The development work continued for five years. Today SIMTEK is able to manufacture high-precision chip-forming geometries to meet customer requirements. The tools are equal in every way to those produced by conventional means: their cutting edges are just as sharp as ground cutting edges, and the chip control is much more precise and reliable.

When it comes to customizing chip-forming geometries, the biggest job is designing them. SIMTEK takes on that job. It talks with its customers to determine the best machining strategy, and its experienced design engineers create a suitable geometry with the help of 3D-CAD programs.

The results are implemented in the tool by SIMTEK in its production facility with a high success rate. In general, the first version of the tool meets the chip control requirements.

If the designed chip-forming geometry does not meet the specified requirements on the first try, it is modified in consultation with the customer until the process is reliable and the requirements have been fulfilled.

Outlook

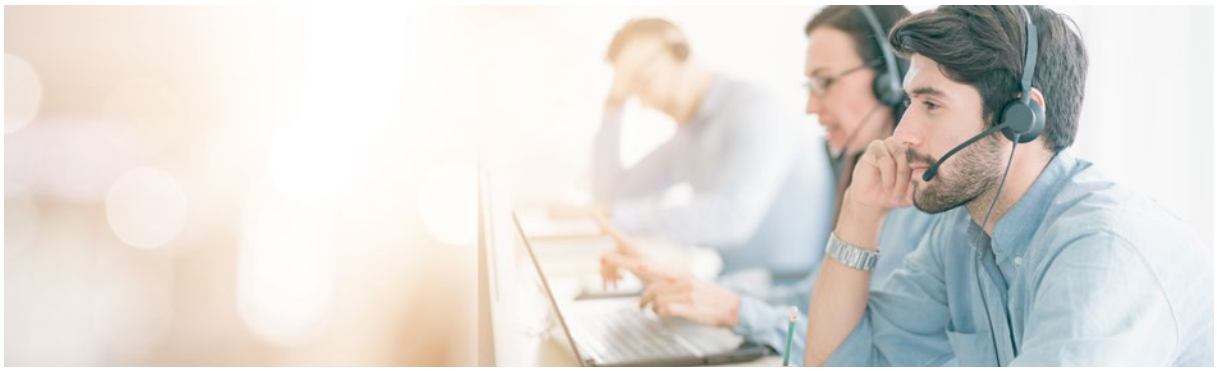
Tools with laser-cut chip-forming geometries have become essential for efficient machining of high-quality parts. At present, they are used predominantly in customized applications, but in the future they will increasingly become standard. These tools will also play a more important role in processes involving a large range of materials and a variety of parameters like temperature, pressure and coolants.

Tools with customized chip-forming geometries are also interesting to companies that want to standardize their production processes at various locations. This will help them to shorten the ramp-up time for coordinating the process parameters.

SIMTEK, a pioneer in this field, is currently investing in special knowhow and innovative manufacturing technologies to enable the increased use of laser-cut chip-forming geometries in the short and medium term. Its large standard product range offers promising applications. In the future, it intends to determine on a routine basis whether a laser-cut chip-forming geometry could offer significant benefits to a customer in a specific application scenario. SIMTEK sees itself as a comprehensive solution partner: by focusing on efficient processes and innovative technologies it offers its customers optimum tool solutions.

To sum up, laser-cut chip-forming geometries already offer enormous advantages, and the technology has yet to realize its full potential.

Your contacts



Would you like to talk to us in person?
Do you have any questions?

We'd be glad to help you!

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About SIMTEK

SIMTEK – tools for highest expectations

SIMTEK was founded in 1994. It is the central part of the SIMTEK Group. SIMTEK has six locations worldwide, including SIMTEK USA since 2016, and is present on 48 global markets. Its approximately 600 employees are enthusiastically devoted to the development, production and sale of precision tools for meeting the most exacting requirements.

The headquarters is in Mössingen near Tübingen, right at the foot of the Swabian Alb in Germany.

SIMTEK stands for high-quality carbide precision tools with a high level of performance. Its standard range includes around 10,000 tools for grooving, turning, milling, broaching, thread whirling and polygon milling applications. The standard range starts with machining tools for applications in bores with a minimum diameter of 0.3 mm (0.012") and goes up to multi-row, highly complex disc milling cutters with a cutting diameter of 200 mm (7.875").

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