

Additive Manufacturing

The First Additive Manufactured Cutting Tool on the Market

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Lightweight cutters and damped adaptors enhance stability and productivity in long-overhang applications

There are many well documented issues when it comes to the machining of workpieces with long-overhang tooling assemblies. Producing deep pockets and cavities, as well as machining alongside tall ribs, will inherently cause stability and rigidity problems. Unwanted effects such as vibration and deflection, which in turn lead to surface finish issues and dimensional errors, are the common outcome. However, extensive research and the development of new tool manufacturing processes has led to a solution that introduces higher levels of process security and brings about significant gains in productivity.

The benefits of *damped adaptors* have long been proven. A dampening device located within the tool holder absorbs vibration to promote process security and efficient cutting. However, a known limiting factor of damped tool holders is the weight of the cutting tools they accommodate. A conventional indexable-insert milling cutter in, say 50 mm diameter, might easily weigh over 300 g (10.6 oz). Such a mass makes it challenging for the damped adaptor to perform in the intended way, especially in extended-reach applications.

Complex component milling in, for example, Aerospace and Oil and Gas applications, can easily be compromised by excessive vibration and chatter. Machining a deep cavity requires a long overhang, a factor that is unavoidable. However, the vibration that results is compounded by using a conventional heavy tool, typically manufactured from some form of steel alloy. Unfortunately, excessive tool vibration and chatter will lead to



Lightweight CM390 in action

security risks, component quality issues, excessive noise levels, poor tool life and even scrapped components. To ensure the workpiece achieves both geometric and surface finish tolerance, operators are often faced with little choice but to go slower, which is counterintuitive in terms of meeting production schedules and achieving the required profitability.

In a conventional sense, there are some design changes that can be adopted to help remedy the situation. For instance, the introduction of a shorter distance between the damper in the adaptor and the cutting edge will improve structural strength and process security. In certain long overhang applications it may therefore be possible to increase the depth of cut and, subsequently, material removal rate (MRR). Additionally, the use of purpose-designed insert grades and geometries will deliver a light cutting action and smooth cutting performance.

However, it is reduced cutter weight that will have the most significant influence on curbing vibration and boosting stability. But how?

Engineers at Sandvik Coromant began thinking about this problem, conceptualizing ways in which cutter weight could be reduced to improve performance. The breakthrough moment arrived when additive manufacturing (AM) was considered as a way of producing the cutter body.

A cutter body made using AM from a lightweight, yet strong alloy would reduce cutter weight by circa 80%, thus reducing process vibration and enhancing MRR. In fact, in combination with damped adaptor technology, such a cutter might **elevate productivity by up to 200%**.

Lightweight CoroMill® 390

Working closely with the engineering team at group company Sandvik Additive Manufacturing, the **Lightweight CoroMill® 390** shoulder mill was born. Here, combined expertise in machining and AM made it possible to truly re-invent the **CoroMill® 390** cutter, which when combined with **Silent Tools** damped adaptors, radically increases performance.

The material used for the new tool is Ti6Al4V titanium alloy, while the AM method deployed is powder-bed fusion. Here, a laser melts and fuses powder together. The melting process is repeated, layer by layer, until the last layer where the cutter bodies are complete and can be removed from the build plate and post-processed.



Lightweight CM390

Compared with the standard **CoroMill® 390** cutter, the difference is stark. In a performance trial that involved the face milling of low-alloy steel (P2.5.Z.HT, 290Hb), productivity was increased by an impressive 200%. Using a Lightweight CoroMill® 390 with damped adaptor, the trial was conducted on an Okuma MA-550VB vertical machining center. Large radial cutter engagements (80-100% of cutter diameter) were used throughout.

Using the **Lightweight CoroMill® 390** tool in place of the standard **CoroMill® 390** cutter (both 50 mm in diameter with identical inserts), the weight of the tool assembly was reduced from 317 to just 66 g (11.2 to 2.33 oz). This factor contributed to an enhanced MRR of 129 cm³/min (7.87 in³/min), in comparison with 43 cm³/min (2.62 in³/min) for the standard CoroMill® 390 tool. The cutting data was identical for both cutters: 1273 rpm spindle speed; 200 m/min (656 ft/min) cutting speed; 573 mm/min (22.6 in/min) feed speed; 0.15 mm/tooth (0.006 in/tooth) feed rate; and 1.5 mm (0.059 in) axial depth of cut. *For a demo of the Lightweight CoroMill® 390 watch the following short video:*

Such is the versatility of the new tool that it can be used in long-reach face milling, deep shoulder and side milling, cavity milling, and slot milling applications. Trouble-free machining is supported by easy-to-use insert clamping that again serves to enhance process security when producing any parts with a requirement for long-overhang cutters, such as those found commonly in aerospace, oil and gas, motorsport and mould making. A wide variety of materials can be machined.

The underlying secret to the success of the **Lightweight CoroMill® 390** is its clever design, which involved the tactical removal of material to create the optimal cutter concept for minimizing mass. This process is called topological optimization, and it makes the cutter more compact and significantly lighter than a conventional version, thus helping machine shops to boost the productivity of their long-overhang milling operations.

In the metal-cutting industry there is always a need to evolve and move forward in order to combat fierce global competition. For long-overhang applications, reducing the weight of the cutting tool – in combination with a damped adaptor – has an advantageous effect on productivity thanks to reduced vibration. In this instance, the step-change in performance has been facilitated using additive manufacturing – which once again demonstrates the innovation levels of Sandvik Coromant engineers as they seek to bring unique benefits to customers.

Download the **brochure** to learn more about Sandvik Coromant's Lightweight CoroMill® 390.

You can learn more about the Lightweight CoroMill® 390 on [MSCDirect.com](https://www.mscdirect.com).

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