Lead: making high-performance machining more efficient and cost-effective

Advanced Machining Centre - Operation of CNC lathe

Photo taken as part of a video shoot with the green space department of Strasbourg

Steel: the material that drove the Industrial Revolution and underpinned the economic development of countless countries. Today, it is still one of the world's most essential engineering materials - used in everything from large-scale construction and infrastructure applications, appliances and vehicles, military and defence equipment, through to parts for precision instruments.

This widespread demand for steel saw the EU produce almost 130 million tonnes in 2024, making it the third largest manufacturer in the world behind China and India. While production may have fallen since the 2008 financial crisis and since COVID, applications for steel have a significant impact on the wider European economy. The European machine tool industry alone, for example, employs 150,000 people, and has a turnover of more than €25 billion.

Small parts of complex machinery such as cars or lawn mowers could not be machined without steel. But there is another material involved that plays an essential part in the process. By adding small amounts of lead to steel, the resulting 'machining steel' is optimised for use in the creation of a wide range of finished metal articles, including engine components where precision machining is required. More specifically, by embedding lead into the steel matrix, it acts as a lubricant during high-speed cutting and machining processes. The melting of lead in the cutting zone during machining reduces friction between the cutting tool and the steel workpiece. This, in turn, stabilises the built-up edge, increases the longevity of cutting tools, reduces the energy needed for the machining process, and provides a better surface finish on the product. The embrittling action of lead reduces the length of the chips produced, reducing the risk of the chips becoming entangled in the machine tool, thereby reducing downtime to remove entangled chips.

While theoretical alternatives to lead in steel alloys used for the manufacture of complex machinery may exist, in practice they generally fail to provide the same levels of performance and cost-effectiveness, showing, for example, decreased manufacturing efficiency via lower machining speeds, and higher tool maintenance costs. Bismuth might be considered viable from a technical perspective, but is prohibitively expensive, particularly for large-scale applications - and it is listed as an EU Critical Raw Material. Bismuth is also essentially a by-product of lead and zinc production. Similarly, while calcium may work economically, particularly when using carbide tools at high cutting speeds, it is not as versatile as lead, and can only be used in specific cutting conditions. And while higher sulphur-free cutting steels may also offer acceptable machining performance in certain operations, they do not perform as well as leaded grades in complex, fine-scale operations at low cutting speeds.

Strict risk management processes are observed when using lead, with workers making, casting and using leaded steel protected by a framework of existing legislation and industry best practice. Moreover, many industrial processes are highly automated. Where manual activity is involved, workers are protected from exposure to lead - both by engineering controls and legislation, including the recently-updated EU binding limit values for lead, all designed to minimise exposure.

Importantly, lead in garden machinery poses no risk to the end user as elements featuring lead are typically paint-coated or inaccessible. Handle areas and operational controls containing lead tend to have additional covers made from protective materials like rubber. It takes only small amounts of lead in steel to realise machining benefits: typically just 2g per kilogram of steel.

Without lead, the energy requirements and carbon footprint of machining increase, as does the amount of downtime required, and the frequency of tool replacement. The resulting products – often referred to as turned or machined parts – are essential for many industries including automotive, defence, construction, aviation, marine, and medical technology. Many downstream industries are therefore dependent on materials such as machining steels. These factors can have significant economic ramifications.

In the case of lawn mowers and other garden machinery, producers employ more than 120,000 people in the EU, and the industry sold more than 20 million units across Europe in 2022. As such, using the most effective materials for manufacturing benefits not just the individual vendor, but the wider European economy as a whole.

Fact file

- EU steel demand grew by 3.3% in 2018 when the region produced 177 million tonnes worth a total Gross Value Added of over €148 billion
- More recently, in 2024, the EU produced almost 130 million tonnes of steel, with the sector supporting more than 300,000 direct jobs
- In 2024, Europe's machine tool industry supported 150,000 employees, reported a turnover of more than €25 billion, and saw more than €20 billion total exports
- Garden machinery producers employ over 120,000 people in the EU, and the sector sold more than 20 million units across Europe in 2022
- Besides increasing the production rate of a component by up to 40%, the addition of lead in steels offers a potential reduction in energy usage of approximately 27% when machining parts compared to non-leaded steel
- European suppliers with machining technologies (e.g. turning, milling and grinding) employ between 200,000 to 250,000 employees, with a turnover of €20-25 billion

Developed in conjunction with the European Garden Machinery Federation, the German Steel and Metal Processing Industry Association and Liberty Speciality Steels, this case study highlights just one of the many essential uses of lead that provide societal benefits and boost the EU's economy.

For Europe's future, lead matters.