



SINGULAR TECHNOLOGY PLATFORM FOR 3D PRINTER DEVELOPMENT AND ON-DEMAND PARTS PRODUCTION

A high-speed, high-power
metal additive manufacturing
platform

Addressing a problem and responding to market demand

Wastage and waiting: The challenges that haunt a secure supply of spare parts

Additive manufacturing technology is impacting the global economy, not only from a design or manufacturing process, but also from a wider societal and macro-economic perspective. Notably, it plays a pivotal role in fostering environmental sustainability by reducing carbon footprints and facilitates greater production flexibility aligning with circular economy principles in manufacturing. Numerous countries have invested in this domain as a national strategy to boost the development of an ecosystem that fosters technology adoption to drive competitiveness and sustainability.

Within the mining sector, there is a growing demand for additive manufactured parts. This surge is driven by disruptions in supply chains, a heightened focus on environmental sustainability to reduce carbon footprints and significant advantages offered by on-demand spare parts production, notably in terms of minimising downtime.

The CSIR has over a decade of experience designing printers and printing large parts. The latest development is a three-dimensional (3D) metal printer capable of producing large, diverse and high-volume parts. Part and process development, as well as qualification services, can be sourced from the CSIR. Furthermore, the presence of local maintenance and repair support forms key elements of the value proposition.

The technology on offer

Advanced 3D printing technology for printer and component manufacture

The CSIR has been developing large metal 3D printers since 2011. The CSIR, through its Parliamentary Grant, and the Department of Science and Innovation (DSI) have invested in the Aeroswift technology platform, as well as the development of associated technologies and processes.

On the strength of these learning and technology advances, the CSIR and DSI are currently developing a pre-industrial metal 3D printer, which uses a high-power laser to melt metal powder, offering a competitive, large-build platform, allowing the manufacturing of large-sized or large numbers of final-use parts. Already, this machine serves as a foundation for multiple successful projects within the CSIR, encompassing the development of subsystems, feedstock, technologies, processes, applications, parts and product initiatives distributed throughout the organisation.

The machine is designed to process reactive and non-reactive materials, boasting an impressive large build volume of 600 x 600 x 700 mm. It is equipped to produce parts efficiently, thanks to its high consolidation rate, driven by a powerful laser source.

Value proposition and competitive advantage

Faster, stronger and more versatile, on-demand parts production

The machine has twice the speed per laser system, a larger build platform, and comes at a more cost-effective price point compared to international competitors. This translates into the capability to produce a wide range of large parts or batches of parts at a highly competitive price.

Printing large parts carries risks such as thermal distortions and quality deficiencies. The Aeroswift family of machines leverages local expertise at the CSIR, built on a decade of experience in designing and printing large parts, as well as in process development and qualification. The availability of local support, maintenance and repair services is a key value proposition.

While the machine meets the basic requirements for machines with large build platforms, it is also designed as a platform for ongoing innovation. Subsequent versions of the machine will incorporate innovations in new subsystems.

Through dedicated CSIR research and development programmes focused on critical subsystems, we provide a sustainable and lasting competitive advantage. These key subsystems will also be localised to facilitate rapid support, repairs, upgrades and seamless integration within the broader manufacturing value chain.

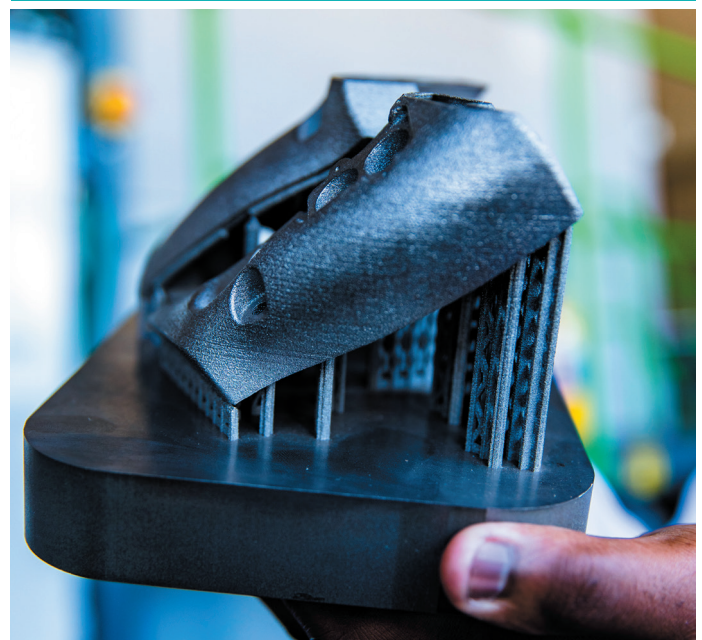
Market opportunity

A surge for on-demand parts production to avoid downtimes

The demand for additive manufactured parts is currently experiencing an upsurge, driven by disruptions in supply chains, an increased focus on environmental sustainability and the inherent advantages of reduced downtime and shorter lead times achievable through on-demand spare parts manufacturing.



A light aircraft throttle grip printed in titanium alloy. 3D printing has found its way into several industries including power supply, defence, mining, automotive and aeronautics.



Nested build layout of a throttle grip, also from titanium alloy. A range of materials and techniques are researched and tested.

The market for advanced parts exhibits significant potential, yet it is still in the process of development. This gives rise to a classic “chicken and egg” scenario in which the demonstration of functional machines and market validation serve as important avenues to enter the market and stimulate demand. A targeted group of potential end users and partners who are interested and actively engaged in further development, eagerly anticipating the availability of these machines, has been identified.

A comprehensive study on parts-on-demand revealed substantial cost savings, potentially amounting to tens of millions of dollars annually, achievable through the utilisation of metal 3D printers.

In a significant partnership within the mining sector, the CSIR collaborates with a major player as a lead user of the machine. This marks the development of a machine ecosystem tailored and continuously improved to cater specifically to the needs of the mining sector.

The mining sector is actively working towards enhancing its corporate social responsibility by fostering a positive impact within the communities where it operates. The intention is to establish certified local on-demand production centres in these communities, which will not only manufacture parts but will serve as catalysts for businesses. This initiative will result in the creation of new jobs, skill development and the expansion of original equipment manufacturer services that directly support mining operations.

While mining will be the initial primary market, other markets will also be serviced due to the inherent flexibility of advanced manufacturing technology. Beyond mining, critical parts will also be produced for industries such as the energy generation, aerospace and automotive sectors.

Moreover, in an effort to expand the machine’s market reach, initiatives like the Collaborative Programme in Additive Manufacturing by the DSI are dedicated to developing the metal additive manufacturing process chain. This commitment aims to facilitate the broader adoption of additive manufacturing across various component markets.

A competitor analysis has revealed that the new Aeroswift pre-production machine is highly attractive thanks to its large build platforms and is at the forefront of the market, with limited competition.

Additionally, there are significant advantages to being a pioneer in offering high-quality, large 3D-manufactured parts to the global mining industry from a commercial standpoint.

Business opportunity

Technology development partnership and 3D parts printing services to industry

Income will be generated through both the sale of machines and the provision of 3D printed parts as a service to industry. The revenue models and strategies will remain adaptable, subject to continuous refinement, aligning with the dynamics of supply and demand within local and international market segments. Feedback from end users and industry partners will be instrumental in shaping these approaches.

The CSIR remains committed to fostering the adoption of additive manufacturing in the industry. This commitment includes ongoing manufacturing demonstrations of market-ready advanced manufacturing



From the intricate to the heavy: An unmanned aerial vehicle frame benefits from the flexibility of 3D printing (above). A leading-edge turbine blade cover (50 cm in length) for an aircraft engine (below).

parts. Simultaneously, the organisation aims to create opportunities for capable machine-building industrialisation partners to produce and deploy machines, generating revenue through appropriate fees and royalties facilitated by CSIR C³. This project also seeks to actively participate in shaping the emerging industry, with initiatives such as incubating industrial partners to enable the development of the hardware value chain for machine building.

The CSIR will engage with stakeholders, including industry representatives, to establish suitable large 3D-printing facilities. This effort will commence with facilities located in proximity to mining operations. This includes the related traditional manufacturing systems, heat treatment facilities, large infrastructure, equipment and process flows.

Investment and return on investment

Invest to capitalise on the quest for on-demand parts

The programme requires a R60 million investment over two years, a significant portion of which has already been secured through funding from the DSI for the pre-commercial machine development phase. The CSIR seeks to de-risk and accelerate the completion of the initial pre-commercial machine and to secure significant private equity investment.

To achieve these goals, a total of R30 million is required to mitigate risks and accelerate the development of the inaugural machine. With this allocation, R10 million is designated for key machine componentry, with an additional R20 million allocated to the placement of a machine with an industry partner. This funding will further advance market development and enhance efforts towards successful commercialisation.

Milestones and timelines

Pre-commercialisation efforts, which encompass commissioning, testing and refining the first pre-production machine, are expected to take a year. The subsequent phase involves commissioning a pre-production machine at an industry partner's site and demonstrating progress within a full-scale production environment, set to occur in the second year. During this period, capital will be raised to enable the establishment of multiple local original equipment manufacturers and printer farms within South Africa. These entities will serve a wide range of industries, commencing with the mining sector.

A team of experts in photonics and laser technology

The CSIR Photonics Centre team has a proven track record that spans numerous years, encompassing expertise in various domains. These domains include laser metal melting, electronics, high-power lasers and laser delivery, automation, machine control, mechanical engineering, as well as machine design and construction.

ENQUIRIES:

>> Innocent Siziba
isiziba@csir.co.za