SAE INTERNATIONAL

AUTOMOTIVE ENGINEERING®

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MANUFACTURING

The transformative power of large-format additive manufacturing for automotive

The Caracol Production Center in Barlassina, Italy.

In the dynamic landscape of automotive manufacturing, innovation has focused mostly on delivering greater efficiency, automation, sustainability and flexibility. An innovation contributing to this transformation is large-format additive manufacturing (LFAM), which promises to revolutionize vehicle prototyping, manufacturing and customization. There are five advantages and five primary applications of LFAM within the automotive industry.

Advantages of LFAM for automotive manufacturing:

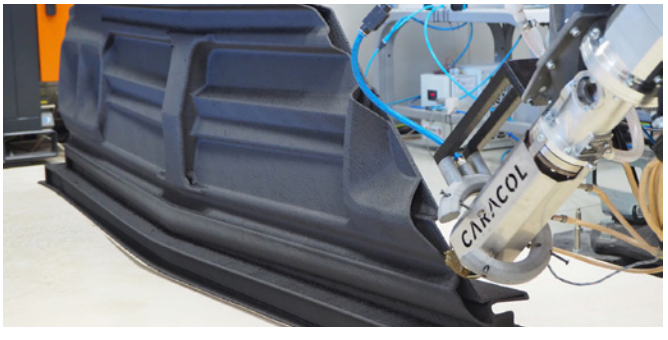
Scale and size capability: LFAM enables the creation of large-scale automotive components that were challenging to produce using traditional methods. Industrial LFAM technology can produce large-scale monolithic automotive components starting from 1m³, including complex geometries. The platform can 3D print automotive parts on a scale that can go beyond 10 to 15 meters in length as a single, monolithic piece. This eliminates the need for part assemblies, reducing manual operations and lead times while enhancing performance by minimizing weak points.

Speed and efficiency: LFAM significantly accelerates the production cycle and overall project lead times, cutting lead times by 50% to 70%, on average. By directly translating digital designs into physical parts – without the need for multiple assembly steps, molds, or tooling – manufacturers can rapidly iterate prototypes and produce final parts in a matter of hours, compared to the weeks sometimes required in conventional manufacturing.

Cost-effectiveness: LFAM technology often requires a large initial capital equipment investment compared to traditional manufacturing machines. Over time, it guarantees increased efficiencies by reducing material used and waste, tooling requirements and streamlined production workflows contributing to lower operational costs. There are also initial investments needed for training to build the required knowledge on process and engineering for these technologies, changing the approach to traditional engineering.

LFAM, particularly robotic LFAM, enables the creation of intricate geometries and designs that are otherwise difficult or impossible to produce with traditional methods. This flexibility allows automotive engineers to optimize parts for strength, weight reduction, and performance while also reducing material usage and waste.

Material variety: LFAM supports manufacturing with a wide range of materials for automotive applications, including high-performance polymers, composites and several metals.This versatility enables the production of functional mock-ups, tools, jigs and fixtures, as well as end-use parts.



Heron AM is Carcol's integrated and modular all-in-one 3D-printing platform.

Five LFAM applications in the automotive industry:

Prototyping and tooling: LFAM expedites the prototyping phase, allowing automotive engineers to quickly test and refine designs before committing to costly tooling. Additionally, LFAM produces durable, customized composite tooling such as jigs, fixtures, autoclave cure tools and molds, enhancing manufacturing efficiency.

Customized components: Automotive manufacturers increasingly use LFAM to produce bespoke and low-volume parts tailored to customer preferences. This personalization extends beyond aesthetics to functional components, such as lightweight brackets and interior trim.

Exterior and interior finished parts: LFAM is employed in manufacturing large and precise body parts and custom components like body panels, bumpers and fenders and custom car interiors. By leveraging lightweight materials and optimized designs, automakers can achieve extreme customization, superior strength-to-weight ratios, enhancing

BOTH IMAGES: CARACOL

Caracol LFAM systems can print a wide range of high-performing polymers and composites.

vehicle performance and fuel efficiency.

Spare parts production: LFAM enables on-demand production of legacy or discontinued automotive parts. This enables automotive manufacturers to significantly reduce inventory costs associated with maintaining a vast stockpile of spare parts and ensures timely availability for customers through enabling localized, on-demand production.

Innovative vehicle concepts: LFAM opens avenues for revolutionary vehicle designs, including electric and autonomous vehicles. Its ability to fabricate complex shapes and integrate functional features directly into components facilitates the realization of next-generation automotive concepts.

Large-format additive manufacturing represents a paradigm shift in automotive manufacturing, offering unmatched design freedom, production agility, and material versatility. As automakers strive for sustainable practices and accelerated innovation cycles, LFAM emerges as a transformative technology poised to shape the future of mobility.

By harnessing the full potential of LFAM, automotive manufacturers can expedite time-to-market, reduce costs, and unlock unprecedented opportunities for vehicle design and performance. Robotic LFAM platforms can be used to realize automotive composites applications, including autoclave tools, functional and aesthetic mock-ups, car's prototypes and customized finished parts.

Mattia De Santis

FROM LEFT: CARACOL; VICOR

WCX 2025

Vicor's new power modules arrive with 48V

The Vicor BCM6135 offers 2.5kW of power and weighs 65 grams (0.14 lbs).

As the automotive industry debates the merits of a 48V power network compared to keeping legacy 12V power networks, Vicor presented some of its newest high-power-density DC-DC converter power modules at the SAE World Congress Experience (WCX) 2025 in Detroit in April. The company said these new power modules offer a modular solution for automakers considering converting their high-voltage battery voltages direct-to-load (48V and 12V).

That was also the topic of a presentation given by Vicor's automotive principal field application engineer for North America, Patrick Kowalyk, titled "Optimize High Voltage to SELV Performance While Eliminating a 48V Battery and Super Caps." The session explained "how bidirectional, high power density DC-DC converter power modules, using soft switching topology at frequencies > 1.4 MHz, can downsize the power delivery network, enhance efficiency and improve overall system performance."

In March, Vicor expanded its DCM37xx series of regulated 48V-to-12V DC-DC converters. These high-density modules, called DCM3717 and DCM3735, range in power levels from 750W to 2kW. Vicor said the modules have a power density of 5kW/in3 and can be installed in an array configuration of up to four units. They have an input range of between 40 and 60VDC, a trimmable output range of between 10.0 and 12.5VDC and PMBus-compatible telemetry.

Vicor originally released the DCM3735 in October 2024, one of three automotive-grade power modules for 48V electric vehicle systems Vicor released at the time. These modules can be arranged in over 300 configurations, which allows automotive engineers new ways to reduce a power system's size and weight, and will be used in automotive OEM and Tier One production in 2025. All three of the modules – BCM6135 and PRM3735 in addition to DCM3735 – use AEC-Q100 certified Vicor-designed ICs and have completed the Production Part Approval Process (PPAP) with automotive customers, the company said.

"Vicor has set a new standard for power density in the automotive industry with these scalable and flexible miniature power modules," said Patrick Wadden, VP of the Vicor Automotive business unit. Our power modules make it easy to convert from the primary battery (800V or 400V) to 48V and down to load. They are very versatile, and our customers are using the modules to improve efficiency while also removing size and weight from their power systems."

Sebastian Blanco