ADDITIVE MANUFACTURING CASE STUDY

PERFORMANCE THROUGH PRECISION

In the highly competitive world of collegiate motorsports, identifying and eliminating engineering bottlenecks is the key to podium finishes. This comprehensive case study details how Team Srijan partnered with Objectify to transition from conventional, error-prone manufacturing techniques to advanced industrial SLS 3D printing. By completely rethinking our powertrain packaging strategy, we secured bulletproof reliability for the SUPRA SAE circuit.

A LEGACY OF MOTORSPORT ENGINEERING

DRIVING COLLEGIATE INNOVATION

Established in 2007, Team Srijan is a premier 40-member student engineering organization based out of the Birla Institute of Technology, Mesra. For over a decade, we have cultivated a strong competition history, delivering consistent, top-tier dynamic performances in the international Formula SAE (FSAE) and SUPRA SAE circuits. Our overarching mission is the complete, ground-up design, fabrication, and optimization of high-performance formula-style race cars.

THE POWERTRAIN ARCHITECTURE

Our current engineering project is a highly specialized Combustion Category Prototype. The vehicle is powered by a robust Honda CBR 250R engine, a single-cylinder powerplant known for its high-revving characteristics. Extracting maximum torque and horsepower from this engine while integrating it perfectly into our custom-built spaceframe chassis represents one of the most significant engineering challenges our team faces.

ENGINEERING OBJECTIVE

"To unlock the full potential of the Honda CBR 250R platform, the powertrain division identified the intake manifold as a critical subsystem requiring total design optimization. Perfecting the volumetric efficiency of this component was absolutely non-negotiable for our dynamic track success."

NAVIGATING EXTREME CONSTRAINTS

THE AERODYNAMIC IMPERATIVE

Achieving peak volumetric efficiency is heavily bottlenecked by stringent competition rules, which mandate that all air entering the engine must pass through a single 20mm restrictor. Recovering static pressure from this aerodynamic choke point requires an intake manifold with a complex, sweeping divergent diffuser. This geometry must maintain continuously varying cross-sections to prevent boundary layer separation and flow stall.

Modeling this perfect fluid dynamic shape in CAD is merely the first step. Translating this mathematically perfect geometry into a physical, track-ready component without introducing internal surface imperfections presented a monumental challenge for our manufacturing division.

THE FAILURE OF CONVENTIONAL FABRICATION

THE SPATIAL ENVELOPE

Simultaneously, this sweeping manifold must adhere to incredibly tight physical packaging constraints. It must flawlessly route from the throttle body to the engine's intake port while threading through a dense, unforgiving cluster of steel triangulation tubes, suspension hardpoints, and the driver firewall. A single millimeter of deviation means the part will not fit.

LIMITATIONS OF COMPOSITE LAYUP

Prior to our collaboration with Objectify, the team relied on manual composite wet-layup over sacrificial cores to construct the intake manifold. This legacy fabrication method fell significantly short of our engineering requirements. The manual process was inherently bulky, making it nearly impossible to consistently fit the manifold into the designated chassis envelope without heavy modifications.

WHY THE LEGACY PROCESS BECAME A BOTTLENECK

PACKAGING

Manual composite layup produced a bulky structure and made consistent fit inside the chassis envelope difficult.

ASSEMBLY

CNC-machined aluminum flanges had to be bonded to the composite body, creating additional assembly steps.

RELIABILITY

Differential thermal expansion could shear epoxy bonds, leading to vacuum leaks and unstable engine tuning.

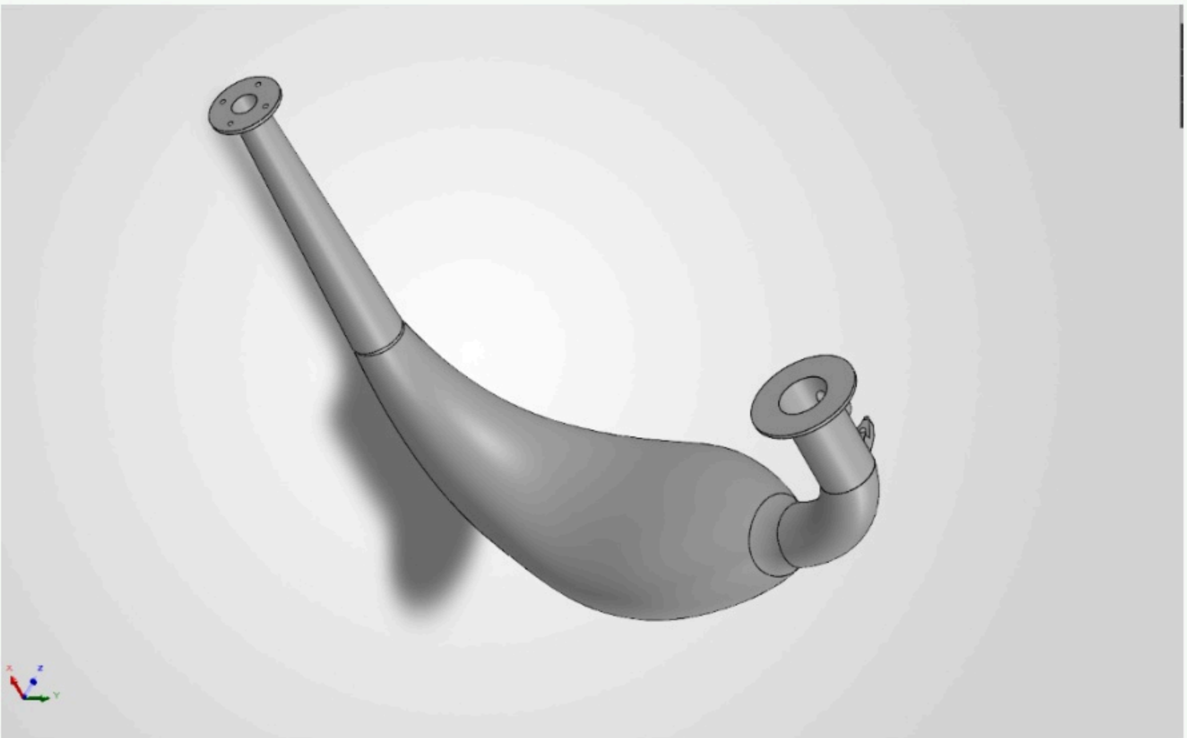
ITERATION

The fabrication approach limited rapid design changes and forced the team to work around manufacturing constraints.

A STRATEGIC ADDITIVE PARTNERSHIP

THERMAL EXPANSION & RELIABILITY FLAWS

The most critical flaw of the conventional method lay in the multi-part assembly. CNC-machined aluminum flanges had to be epoxied to the composite carbon body. Under dynamic racing loads, differential thermal expansion between the metal and the composite routinely sheared the epoxy bonds. This caused catastrophic vacuum leaks, heavily compromising our engine tuning and destroying our on-track reliability.



MATERIAL SELECTION FOR EXTREME ENVIRONMENTS

Recognizing the urgent need to bridge this manufacturing capability gap, Team Srijan partnered with Objectify. Objectify recommended moving entirely away from composite layups and instead utilizing Selective Laser Sintering (SLS) 3D printing. The chosen material was Nylon PA12, selected explicitly for its exceptional hydrocarbon resistance and immensely high heat deflection temperature.

WHY NYLON PA12 + SLS FIT THE APPLICATION

HYDROCARBON RESISTANCE

PA12 was selected for its exceptional resistance to hydrocarbons in the engine environment.

HEAT DEFLECTION

Its high heat-deflection capability made it suitable for the demanding thermal conditions around the powertrain.

GEOMETRIC FREEDOM

SLS allowed the manifold to follow the complex, sweeping diffuser geometry without designing around manual layup limitations.

PART CONSOLIDATION

Threaded inserts, sensor bosses, restrictor and throttle-body flange could be integrated into one unified structure.

RAPID ITERATION & CONSOLIDATION

FROM DIGITAL TWIN TO TRACK-READY

The collegiate motorsport environment is bound by strict competition deadlines, constrained budgets, and an absolute necessity for rapid iteration. By sponsoring the SLS 3D printing of the complete intake manifold, Objectify achieved a remarkable turnaround time. From the moment the digital design files were approved to the delivery of the finished, track-ready component, the process took a mere 3 to 5 days.

THE POWER OF PARTS CONSOLIDATION

Transitioning to SLS 3D printing granted our powertrain engineers absolute geometric freedom. We no longer had to design around the limitations of human hands laying up carbon fiber. We natively integrated threaded inserts, ECU sensor mounting bosses, the restrictor, and the throttle body flange directly into a single, unified CAD model.

> **MANUFACTURING EVOLUTION**
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> *"By printing the intake manifold as a single monolithic structure, Objectify completely bypassed all manual assembly steps. We eliminated the aluminum flanges, the messy epoxies, and the drilling. It resulted in a flawless, single-iteration manufacturing success."*

QUANTIFIED ENGINEERING IMPACT

600g	3 WEEKS	ZERO
OVER 50% WEIGHT SAVED	MANUFACTURING TIME SAVED	VACUUM LEAKS

SUPRA SAE TRACK PERFORMANCE

The impact of Objectify's SLS 3D printing on our vehicle was profound. We achieved an astonishing total mass of just 600 grams. The monolithic PA12 structure completely eradicated the vacuum leaks that had plagued all of our previous iterations. This resulted in flawless on-track reliability during the demanding SUPRA SAE dynamic events, allowing the car to perform exactly as modeled in our engine simulations.

> *"By delivering a flawless, end-use PA12 component in a matter of days, Objectify completely transformed our development cycle. Eliminating the error-prone composite layup allowed us to save three vital weeks and transition immediately to dyno-tuning. They provided a single-iteration success that proved fundamental to our reliability and dynamic event performance at SUPRA SAE."*
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> — POWERTRAIN LEAD, TEAM SRIJAN