



Luxury GT



No-one expected a four-door saloon in SPEED GT, but the combination of GM and Pratt & Miller have turned an unlikely contender into a winner

A Cadillac? A racing Cadillac? This can't be right. But it is. For years the name has been synonymous with luxury, power and wafting the rich and famous about, but now there's a new face for GM's luxury marque - one with ominous looks and a cardiac arrest-inducing V8 rumble.

The Cadillac CTS-Vs that race in the SCCA's SPEED World Challenge GT series have become an instant fan favourite while for others, specifically their competition, they have led to complaints, concerns and efforts to solicit sanctions against them. In a series that started

BY MARSHALL PRUETT

with low tech, low budget, homemade creations, the influx of manufacturer entries hasn't been popular with the purists. But for those that welcome new and exciting blood into the series, the unlikely transformation of the production CTS-V into a World Challenge constructors' and drivers' championship winner has been a revelation. And the sight of a four-door luxury saloon beating Stuttgart's finest is still a bit shocking and unreal. After all, no one expected to see this model on a racetrack, much less becoming the standard bearer of performance in the GT class.

The series employs an equalisation formula, balancing (and appeasing) the Dodge, General Motors and Porsche factories - not to mention the privateers - through the proven routine of adding or subtracting ballast based upon one's finishing position, and adding or subtracting inlet restrictor openings. This formula has been employed frequently to keep the Cadillacs in line with the rest of the field since their debut at Sebring in 2004. With the lightest car in GT being the Porsche 997 at 2900lb (1225kg) on a 20 per cent inlet restrictor, and the CTS-V the heaviest at 3200lb (1452kg) on a 40 per cent restrictor, the beauty of the Caddy's performance has been the consistency and pace of a car that, compared to the 997, is anything but svelte.

But whereas the Porsches and Vipers in SPEED GT are bespoke racing chassis with long histories, the CTS-V shared only the competition history of its GM LS V8 engine.

The aim of the project, it was hoped, was to shift global perceptions of the Cadillac brand from land yachts for pensioners

to seriously sporting performance saloons. And based on sales response to the road version of the CTS, the experiment certainly seems to have worked.

The marriage of GM and its road racing partner, Pratt & Miller, has delivered numerous championship wins in various series, but its real strength is in the allocation of engineering talent, shared resources and technology developments from all departments involved. A team of 16 is responsible for the cars - 12 from Pratt & Miller, three from GM Racing/Powertrain and one from engine partner Katech, all

in-house software solutions to support its specialist needs. The Cadillacs, for example, were developed using CAE from ADAMS, LTS, MATLAB, CFD from RAVEN, ANSYS FEA and Pratt & Miller's own DOE/Tool software, amongst others.

That vast array of computing might was needed to rectify some obvious concerns with a chassis that wasn't designed to race. With four doors, the CTS-V was heavier, taller and had more weight over the front wheels than any of its competitors and the SCCA worked with GM to allow modifications to the chassis

chassis, we removed the floorpan and dash panel, integrated the safety cage structure and re-installed the floorpan and dash. It was actually a very efficient construction method because this allowed us to fixture the centre frame structure outside of the car, then raise it into the body-in-white and weld the floorpan and dash panel back into place.'

While Bishop wouldn't be drawn into the main point of contention about the cars - how much the floorpan was raised in the 'shell before it was welded into place and the excess trimmed from beneath it - it is speculated that the GT CTS-Vs are three to four inches shorter from the bottom of the floor to the top of the roof compared to the production chassis.

Inside the cars, extensive FEA work has resulted in a maze of rollcage tubing and torsional rigidity figures that are impressive enough to serve as another of the few questions unanswered by Team Cadillac. With more feet of tubing than any other car, Pratt & Miller has still managed to build the safety and stiffness needed into the car without

MODULAR CONSTRUCTION IS ONE OF PRATT & MILLER'S TRADEMARK DESIGN APPROACHES

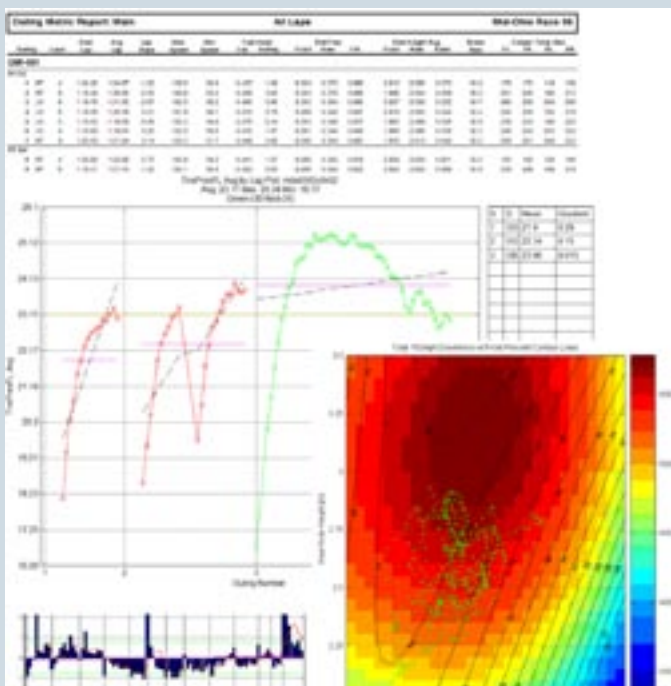
three based in Michigan, USA.

From the outside, it could appear that Pratt & Miller simply uses the massive resources within GM to work its magic, and while it is true it does rely heavily upon the partnership, it has developed a mastery of the relevant software and testing tools and created proprietary

as a result. Pratt & Miller's Lynn Bishop, engineering manager for the Cadillac programme explains: 'To achieve competitive c of g height, frontal area and weight distribution, we worked very closely with SCCA to identify a number of chassis modifications. The engine was allowed to be moved 214mm rearward in the

HIGH TECHNOLOGY APPROACH

Figure 1
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Intro type bit about all this modelling stuff??

Figure 2
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adding to its weight. 'We have the ability to move 150lb (68kg) of ballast amongst a variety of locations and weight distribution can be influenced by up to 1.5 per cent as a result. Left, right and rear weight percentages are one of the biggest tuning items we use to configure the car from track to track,' noted Bishop.

Modular construction is one of Pratt & Miller's trademark design approaches and is evidenced on the GT CTS-V in the radiator and front bumper packaging, as well as the front and rear subframe treatments, both of which have been modelled and altered for maximum stiffness. The front assembly allows for easy changes in event of an impact or an engine change, while the rear has additional suspension geometry positioning fixtures.

PACKAGING SOLUTIONS

Packaging at the rear of the car is one of the more impressive solutions tendered by Team Cadillac. To combat the forward weight bias, the design team moved as many items to the rear of the car as possible, including the oil tank, oil coolers and pumps, fans etc. Those fans pull air from the bottom of the car



and exhaust out through a large ducted vent opening in the trunk.

Propulsion is from GM's venerable overhead two-valve V8, displacing 6026cc. A bore and stroke of 102.1mm and 92mm and a redline of 7800rpm aren't very far from the figures found in the production CTS-V (5967ccs, 101.6mm x 92mm and 6600rpm) but peak power of 500bhp (approx) is delivered

at 7000rpm, with peak torque of 430lb.ft at 5600rpm, compared to 400bhp at 6000rpm and 395lb.ft at 4400rpm. With this in mind, it is clear the performance of the race version comes more from its weight reduction from 3850lb (1746kg) to 3200lb (1452kg), than from drastic power improvements.

With the engine pushed so far back into the modified firewall,

packaging of the engine's ancillaries have also been optimised for c of g and polar moment of inertia.

Team Cadillac's engine partners were also tasked with helping the engine to breathe better and survive the rigours of GT racing. 'The motor is derived from the LS2 family of engines. It's very much a production mill with only limited changes, including the camshaft, pistons and oil system. We developed a dry sump oil system to accommodate the high lateral acceleration forces.'

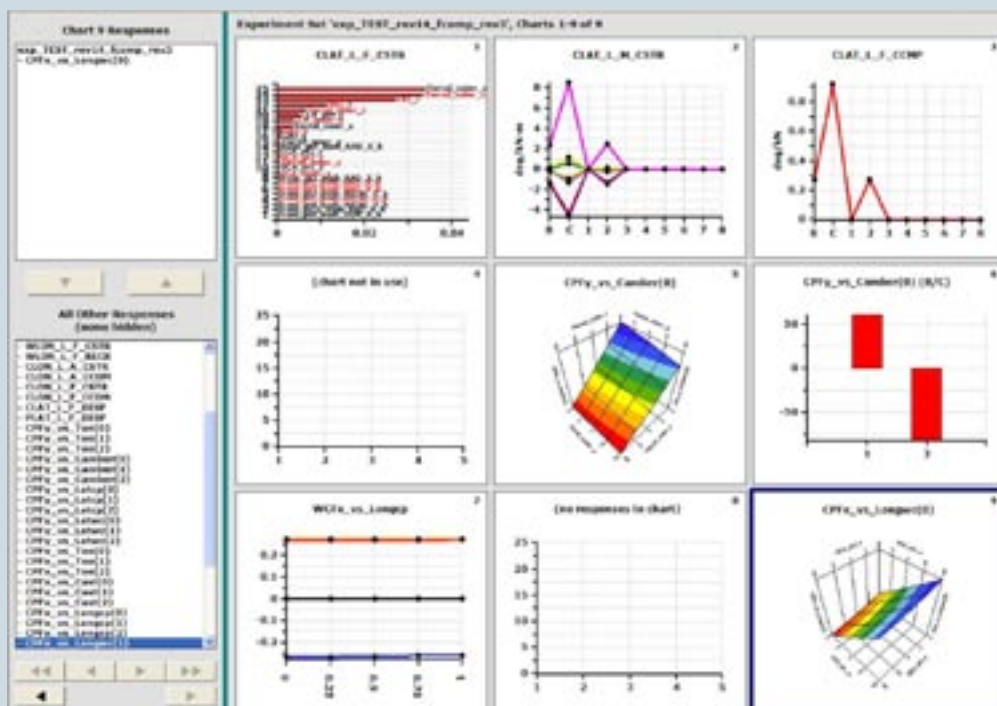
Power delivery is through a six-speed Tremec manual transmission. While strengthened for racing, the Tremec is rooted in the CTS-V's production unit. Likewise, the differential. Bishop: 'We run the production Getrag LSD with two options for ring and pinions - a 3.91 and a 4.11. You may see us change differentials at the track, which adjust the friction clutch pre load and bias ratio as needed.'

SUSPENSION MODIFICATIONS

To complement the rigid and stable chassis platform, extensive efforts have been dedicated to the suspension architecture of the cars by Pratt & Miller. Forced to work within the long 113.2-inch (287.5cm) wheelbase and 73.4-inch (186.45cm) wide dimensions of the car, the production car's unequal length A-arm front suspension

Figure 3

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and multi-link rear suspension origins are carried over, but all components have been re-designed and fabricated to suit the geometry needs of a greatly lowered vehicle. Unlike many of the other SPEED GT cars that only allow for two or three holes of suspension adjustment at the chassis, the Pratt & Miller team has incorporated a much finer gradient for more subtle changes within the one inch of movement allowed by the rules and draws heavily upon

lessons learnt through the team's ALMS Corvette programme to fine tune the Cadillacs.

With the SPEED GT cars racing on all types of circuit, Team Cadillac uses this one inch of movement to tailor the handling characteristics to suit.

MAJOR CONCERNS OF WEIGHT AND HANDLING

Though based on the production design, all the CTS-V's suspension has been modified and allows for finer adjustment than is usual in SPEED GT. Engine and driver setback is significant, but was necessary to make the big, four-door saloon competitive. Raised floorpan has been contentious

'We make significant adjustments to camber gains, roll centre heights, anti-squat/lift and caster depending on average corner speed, elevation change, surface roughness and transition speeds of each track,' explains Bishop.

Due to the size and weight of the CTS-V, the team is forced to work in some non-traditional areas for chassis set up of a production-based car - conventions more commonly reserved for oval track racers or high downforce formula cars. 'We have run with left/right spring splits for highly asymmetrical tracks. We also work extensively in utilising bump rubbers and packers to maintain good low-speed grip but control high speed body movement.'

Employment of formula-style camber shims between the upper A-arms and upright, and threaded toe and steering link adjusters are also major departures allowed from the stock CTS-V. Finally, Penske 8770 four-way dampers and adjustable blade anti-roll bars tie the chassis and wheel movements together.

Braking is provided by Brembo, the same manufacturer that outfits the stock CTS-Vs, and utilises six-piston front calipers with 355mm discs, along with four-piston/320mm rears. 'We currently use Performance Friction PFC-01 pads. We've

had very consistent feedback from all of our drivers that this brake package provides the best combination of braking power, modulation and wear,' commented Bishop.

AERO OPTIMISATION

After dealing with the major concerns of weight and handling, attention was turned to its large and angular silhouette and, as the SCCA requires cars to retain a largely stock outer appearance, those improvements had to be focused beneath the skin.

Starting at the front, a deeper recess was created to accommodate the mandated two-inch splitter. Constructed of multi-ply carbon and a Nomex honeycomb core, the splitter feeds the smart venturis built for the SPEED GT CTS-Vs. A single strake is used and swept outward to minimise the high-pressure air ahead of the front tyres. Bishop added: 'The front under-wing tunnel and strake configuration was determined from CFD optimisation, wind tunnel testing and straight line aero testing. The tunnel and strake configuration is sensitive to the under-wing height above ground and position relative to the front tyre. The front under wing generates more downforce the closer it is to the ground, until the leading edge touches the ground and chokes off airflow.'

SPEED WORLD CHALLENGE

Dating back to the 1990s, but with a variety of name changes since its inception, the SPEED World Challenge series has strived to be, in the words of its mission statement, America's Most Relevant Racing (Series). In an era where cost control has run rampant and spec series born of cost cutting measures have diluted the engineering and creative minds of most racing professionals, the SPEED World Challenge serves as a saving grace for American tin-top competition.

It occupies a critical position between the mostly stock and limited creativity of the rival GrandAm GS cars and the entries in the painfully expensive 'no limits' American Le Mans GT1 division.

There are two distinct series: the SPEED TC (Touring Car) division – a class similar in spirit, weight, and power to the British Touring Car Championship – and the SPEED GT (Grand Touring) division – a class comparable but faster than the FIA GT3 division. As such, it has proved to be a haven for the Porsche 997 GT3, Chevrolet Corvette, Dodge Viper Comp Coupe, Ford Mustang, Volvo S60 and more, including the rather unlikely Cadillac. The unique nature of SPEED GT ensures a diverse blend of cars and different base architectures, from production-based V8s, flat 6s, in-line turbo 5s and flat turbo 4s to giant V10s, as well as RWD and AWD layouts. Mix in a variety of base vehicle weights, and the SCCA Pro Racing technical staff has an unenviable job of melding these wildly different ingredients into a fair and harmonious production.

Use and placement of two large louvre sets on the Cadillac's bonnets also do more than just release hot air. 'Venting the hood [bonnet] is one of the primary sources of front downforce and drag reduction. Even very small reductions in under-hood pressure can yield large gains in net downforce. The SCCA controls the location, area opening and height of the louvre extensions, so this is another way for the SCCA to control aero performance.'

The rear wing, borrowing heavily from the Corvettes, has a chord of 12in and a span of 67in. 'The profile of the CTS-V racecar was developed using Raven (Pratt & Miller's own in-house CFD code). It uses the same basic wing section profile as the ALMS car, but the chord, twist and sweep are modified to accommodate the flow field of the CTS-V body. Our wing mounts allow for a range of adjustment from -2 to +15 degrees. Additionally, we can adjust the wing height at the racetrack.'

ELECTRONIC ADVANCEMENT

It should come as no surprise that the Cadillacs are the most heavily instrumented cars in the category, and Team Cadillac makes use of both Pi Sigma data acquisition and Pi GPS data. 'GPS allows us to evaluate the vehicle in the ground inertial space,' explained Bishop. 'We can generate vehicle handling metrics from GPS data that we couldn't accurately do with vehicle-based sensors. GPS also allows us to

generate very accurate track maps in terms of elevation change, grade and camber.'

Advancements in engine controls have also been an important aspect of Team Cadillac's electronics programme. 'Prior to 2007, we ran a production GM ECU. We had tremendous success with the production controller and

managing its pace against the increased tyre consumption the extra vehicle heft generates. Marrying 500+hp to 3200lb on 275/35-18 fronts and 335/30-18 rears requires a deft touch – something 2005 SPEED GT champion Andy Pilgrim knows all too well: 'We work on trying to transfer all the weight as slowly and carefully as possible.

We work on all the factors that control mass and impact the tyre patch: tyre pressure; driver steering wheel rate; shocks; anti-roll bars and springs are all part of this control. Even though the tyres are very good,

they are still street tyres and their grip level is nothing close to a race tyre. So, 'careful and slow' is how we transfer all this weight so we don't overpower the tyre.'

The final elements of the unique Pratt & Miller Cadillacs are the safety innovations – an area of particular pride for Lynn Bishop and Team Cadillac. 'The side impact structures of the CTS-V were developed by Tom Gideon of GM Racing, who first developed them for the [Corvette] C5R. They are now a standard feature on all GM Racing/Pratt & Miller road racing chassis. They are constructed of cells of carbon, Kevlar and aluminum honeycomb of different cell size, and have a much more linear and progressive energy dissipation characteristic than the typical door-bar architecture.' Padded carbon leg impact containment structures from Gideon's department are also standard.

Once again, it seems the engineering brains of Pratt & Miller and the resourceful brawn of GM have delivered another racecar without peer and without compromise. But where with their other programmes they started with sports-orientated cars, in the case of the Cadillac CTS-Vs they've delivered a championship winner out of a four-door family saloon and, along the way, re-defined the boundaries of GT racing. Not only is this not a car anyone ever expected to see compete, most are still in denial that it does more than just compete, it wins.

DRAWS HEAVILY UPON LESSONS LEARNT THROUGH THE TEAM'S ALMS CORVETTE PROGRAMME

the lessons learned from this development is one of the areas where the racing technology transferred directly back into production. For 2007, we moved to the Bosch ECU to leverage cost and resources with other GM road racing programmes.'

The team's transporter also carries a satellite boom to feed data back to GM and Pratt & Miller engineers as needed. Is this overkill for a smaller domestic GT championship? Not when the goal is to win and sell cars, and for an effort like Team Cadillac, there's no sliding scale of commitment based on the size of the series it competes in.

'CAREFUL AND SLOW'

Shaved Toyo DOT-R compound street tyres are required for all cars in the TC and GT series and for a heavier car like the CTS-V, the 45-minute sprint race format is often more a battle of

Though size and placement is strictly controlled, the deep bonnet louvres are one of the CTS-Vs main sources of frontal downforce and drag reduction

