

Edited by Kevin Jost

Confederate uses Small Block 'slice'

Confederate Motor Co., a Birmingham, AL, specialty motorcycle builder, hopes to smash the mold of such bikes as derivatives of **Harley-Davidson** design and engineering. The company's *raison d'être* has been unique, minimalist original design, but it continues to use a 45° V-twin engines like those of Harley-Davidson.

Confederate is plotting its own new engine using a different architecture, but creating an engine from a clean sheet of paper and contracting for supply of the components is too expensive a proposition for the small startup manufacturer. To trim some of the expense of designing, developing, and testing components, the company's new engine is derived from an existing design so that some of the existing

experience with that engine can be exploited and some of its components used. Confederate turned to another American engine just as iconic as the Harley V-twin for its architecture: the **Chevrolet** Small Block V8.

The engine planned for use in Confederate's next model borrows the architecture of a two-cylinder slice of the V8 design. While this solution obviously requires a custom casting for the engine's block and heads, Confederate is able to use some internal parts from the **General Motors** supply chain, including the very desirable **Mahle** titanium connecting rods used in the Corvette Z06's LS7 engine.

Confederate contracted with engine development specialist **Katech** to design and supply the engines after seeing the company's handiwork in producing the super-sized Small Block V16 used in the **Cadillac** Sixteen concept car.

Now, Confederate is developing the *Renovatio*, its first motorcycle that does not feature a Harley-inspired 45° V-twin engine. "This was really the bike we wanted from the beginning," said Confederate founder Matt Chambers.

Current models, such as the *Wraith* and the *Hellcat*, prominently exhibit enormous frame tubes, but they will be less visible on the upcoming *Renovatio* because the new 90° Chevy-based V-twin also serves as the frame's main component. The goal is to advance Confederate's mantra of simplicity, with the dual benefits of light weight and reduced cost.

"I think you'll find our system is smaller and lighter than anyone else's, and I think it looks cooler," said Chambers. He also predicts the new bike will come in at less than 300 lb (136 kg), though the engineering team at Katech says it is aiming for less than 400 lb (181 kg), according to Caleb Newman, Director of Aftermarket Operations for Katech.

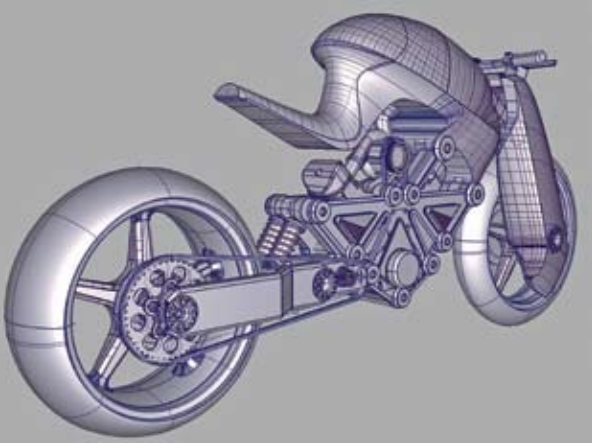
Regardless of the final specification, the bike will be simple and clean. Katech is designing mounting bosses for components as well as oil and water passages into the block casting, eliminating not



The Confederate Motors *Renovatio* will employ a girder-type fork and cast aluminum single-sided swing-arm mounting a pair of Penske Racing Shocks multi-adjustable dampers and Blackstone TEK carbon-fiber wheels.



The B120 *Wraith*, Confederate's latest product using the 45° V-twin engine, exhibits the company's minimalist industrial design theme.



The Renevatio's engine serves as the center section of the frame, with front and rear suspension attaching via triangular mounting plates.

only frame tubes, but external oil and water lines that clutter appearance and complicate assembly.

"We are reducing the bill of materials and reducing the weight because there is no TIG-welded steel frame," Newman said. "All of the components are going to be aluminum or magnesium for minimum weight."

Many of the bolt-on components will be smaller on the Renevatio than on the current 45° models because of the smoother operation of the better-balanced 90° engine. "There is going to be significantly less harmonic vibration," remarked Newman.

One challenge for Katech's engineering team is to learn about motorcycles. Its engineers need to know what typical frame loads are so that they can design for sufficient strength without adding too much weight, said Newman. They also

Using an existing production Mahle titanium connecting rod for the Renevatio's engine slashes its cost to one-fifth that of a bespoke part.



need to know about things like the requirements for engine heat dissipation and coolant flow because the Renevatio's V-twin will not share the V8's water pump, for example.

"We are going to baseline a **Honda RC51** for water flow, oil flow, and heat rejection to properly size the pumps," he said.

The 1686-cm³ engine is projected to develop 135 hp (101 kW) in its initial configuration, with the potential to be developed to 150 hp (112 kW) in normally aspirated configuration and the possibility of a 180-hp (134-kW) supercharged version, said Newman.

Another change from the Harley-style powertrains is that the Renevatio's engine and transmission will be unitized, rather than separate, with the transmission casing cast into the engine block. **JIMS USA**, an aftermarket motorcycle transmission

company, supplies the transmission internals, Newman said. The unit transmission employs a wet clutch, in typical fashion for this design and in contrast to the dry clutch used by traditional American V-twins with separate components.

Casting the block presents the opportunity to relocate the camshaft for improved pushrod and rocker-arm geometry that reduces scrub in the driveline. Similarly, the valve angles in the head are also changed from GM's configuration.

Because the Renevatio has a larger cylinder bore than the GM V8, Katech will source forged pistons from **Brockhouse Group**. But some GM-specified parts remain, especially those Mahle-supplied titanium connecting rods, which GM buys in sufficient quantity that the price is made much more reasonable than the cost of limited production, purpose-built con rods, explained Newman.

Similarly, tuning the engine management system would be costly and time-consuming, but for the ability to use the same ECU and fuel injectors as the GM engine, said Newman. Because Confederate does not have a dealer network for support, the use of some common components means that some parts will be available for owners at their local Chevrolet dealer.

Katech and Confederate plan to build five Renevatio prototypes this year, with production expected in 2008, with a target of about 750 bikes, said Chambers.

Dan Carney

Veracruz gets Hyundai's first V6 diesel

Hyundai Motor's seven-seat "luxury utility vehicle" Veracruz can now be specified with the power and advanced performance of a new V6 diesel S-Engine devel-



Hyundai Motor's new seven-seat "luxury utility vehicle" Veracruz is armed with a V6 diesel S-Engine.

oped in 26 months at a cost of 222.9 billion won (about \$222 million).

"The S-Engine sets new standards of power and performance for a diesel with its maximum output of 240 PS at 3800 rpm and 46 kg-m of peak torque in the 1700-3500 rpm range," said Kwak Se-Young, Principal Research Engineer of the Hyundai-Kia Powertrain R&D Center in Namyang, near Seoul. "Our S-Engine is the most powerful of all V6 engines around the world in power output."

The 2959-cm³ S-engine's six cylinders have a bore and stroke of 84 and 89 mm (3.3 and 3.5 in) and are banked at 60°,

the optimal angle to minimize vibrations in a V6, said the 50-year-old Kwak, who has worked for Hyundai for the past 22 years. Compression ratio is 17.3:1.

The S-Engine is manufactured with SinterCast technology, the compacted graphite iron (CGI) cylinder block being lighter and quieter than conventional grey cast iron. Kwak says it also demonstrates at least 80% higher tensile strength and 45% higher stiffness. "The CGI cylinder doubles the fatigue strength of iron and aluminum, thus allowing Hyundai engine designers to improve performance, fuel economy, and durability while reducing emissions to meet the very-latest Euro IV



Kwak Se-Young, Principal Research Engineer (middle) at the Hyundai-Kia Motors Powertrain R&D Center near Seoul, led the team that developed the V6 diesel S-Engine.

The S-Engine's 1600-bar (23.2-ksi) injectors rely on newly developed piezoelectric actuation technology specifically tuned to the new combustion process.



The S-Engine, shown here in the Veracruz chassis, is said to set new standards of refinement and performance for a diesel with its maximum output of 240 PS (237 hp/177 kW) at 3800 rpm and 46 kg-m (333 lb-ft) peak torque from 1700-3500 rpm.

regulations," Kwak said.

The engine breathes through an all-aluminum head fitted with 24 valves. Its rapidly switching, high-pressure injectors rely on newly developed piezoelectric actuation technology specifically tuned to the new combustion process, said Kwak, adding that piezoelectric injectors allow finer atomization of the fuel and ensure more efficient combustion, enabling more fuel to be injected into the combustion chamber in a shorter time. S-Engine turbocharging is accomplished with an electronically controlled, variable-geometry system. A serpentine belt and steel timing chain lower noise while raising overall durability and operating precision.

"An electronic exhaust gas recirculation valve helps control the engine's emission of nitrous oxides by reducing combustion temperature," Kwak said.

For its main overseas market of the U.S., Hyundai recently launched a 3.8-L Lambda gasoline engine in the Veracruz as it drives to compete with **Toyota's Lexus RX 350** and **Honda's Pilot**, according to Kwak. The Lambda engine, applied to Hyundai's Azera luxury sedan, features all-aluminum construction, a variable-swirl intake system that optimizes fuel combustion under different engine loads, and dual overhead camshafts with con-

tinuously variable valve timing and mechanical valve-lash adjusters for a more compact head design. The 3.8-L Lambda has a maximum power rating of 260 PS or 256 hp (191 kW) at 6000 rpm, 264 PS or 260 hp (194 kW) in North America, and at 4500 rpm delivers 35.5 kg-m or 348 N-m (257 lb-ft) of peak torque.

Kwak says that the diesel and gasoline engines ride on a newly developed semi-active engine mounting system consisting of three passive mounts integrated with controllable elements, rpm sensors, and solenoid valves as the automaker tries to reduce vibration.

Both engines are mated to an **Aisin** automatic gearbox, Hyundai's first-ever six-speed transmission, which adopts the Lepelletier gear architecture and an integrated transmission control unit for finer shift quality. For clutchless manual-style shifting, the popular Shiftronic feature is also included, Kwak said. As the Aisin unit is fully sealed and filled with a long-life automatic transmission fluid (ATF), engineers have eliminated the automatic transmission fluid dipstick to relieve owners from periodically checking ATF levels.

Advanced performance extends into the realm of safety, where standard features include advanced dual front supple-

mental restraint systems augmented by dual side airbags for the two front seating positions and curtain airbags that extend along the full length of the cabin to the third-row passenger seats. Stopping power is provided by tandem brake boosters connected to front and rear discs, electronic brake force distribution, vehicle dynamic (stability) control, and traction control as standard equipment. Additional safety gear includes active head restraints, a safety-optimized steel unibody, LED taillamps, and high-intensity discharge xenon headlamps.

To deliver maximum traction regardless of weather and road surface conditions, the torque-on-demand four-wheel drive system automatically apportions power between the front and rear axles through a multiplate clutch.

"The driver-selectable 4WD Lock Mode puts Veracruz into full-time four-wheel drive and is used for climbing or descending sharp grades, driving off-road, or over sandy and muddy surfaces where maximum traction is demanded," Kwak said. "At speeds above 30 km/h, this mode begins to automatically deactivate and shifts to 4WD AUTO mode at speeds above 40 km/h."

Peter Chang



Henkel - the Choice of Champions



Henkel is a driving force and trusted teammate in automotive adhesives, sealants and surface treatments, delivering customized solutions at every turn, and a winning formula for every challenge.

With a portfolio of world-renowned brands and over a century of chemical expertise behind us, Henkel has the answers for your engineering, design and manufacturing needs. Our Autophoretic[®] Coating Chemicals, Non-phosphate Bonderite[®] Conversion Coatings, Structural Solutions and Liquid Gasketing technologies keep us in front of the competition while providing unsurpassed customer value.

Choose the winning team – the Henkel team.

World Leader in Adhesives, Sealants and Surface Treatments

Some of our leading brands include

LOCTITE Autophoretic[®] Bonderite[®] Multan[®] Terocore[®] Hysol[®] FREKOTE[®]

® and ™ designate trademarks of Henkel Corporation or its Affiliates. ® = registered in the U.S. Patent & Trademark Office. © Henkel Corporation, 2007. All rights reserved. 4276 (7/2007)

**For more information,
call 866-332-7024
or visit
www.henkelna.com/automotive.**

aeix.hotims.com/13774-213

Mercedes sweats C-Class details

Traditionally, quality and **Mercedes-Benz** went together like a horse and carriage, but there have been times recently when they have not. Without quality in its fullest sense, though, Mercedes-Benz would be just another car company, so the arrival of the new C-Class is crucially important for Mercedes; it must have the quality and reliability that its potential buyers expect.

Class program. "It is our 'Mercedes Code,' the DNA that translates our brand values into technical know-how—the sum of our engineering experience," said Thomas Weber, DaimlerChrysler Board Member for Group Research and Mercedes Development. "A high-performance computer with more than 2100-GB capacity created a complete digital model of the vehicle with all its character-

(108.7 in), the new car comes with an unusual choice; it can be specified with the traditional Mercedes-Benz radiator grille topped by a three-pointed star at the leading edge of the hood, or a triple horizontal louver design can be specified with a large central star as used on some sportier models in the range.

The car has an abundance of technology, including Agility Control, which centers on—as Mercedes puts it—"situation-responsive shock absorber control" designed to provide the car both with added responsiveness and comfort. Damping forces are reduced during normal driving conditions but are increased automatically for dynamic responses during faster driving. The technology also includes a 6% higher steering ratio and a shorter travel gearshift. The package provides Sport and Comfort gearshift programs, speed sensitive steering with variable centering, and altered accelerator pedal responses. Adaptive Braking is based on established S-Class technology and includes hill-start assist, brake preparation in potentially critical situations, and, in wet conditions, light contact to dry the pads. The car has extensive safety systems including the anticipatory Pre-Safe technology.

The four-cylinder supercharged gasoline engines used in the previous C-Class have been enhanced, with output increased by up to 13% and torque by 18%. The C200 Kompressor now delivers an extra 15 kW (20 hp) to achieve 135 kW (181 hp) and 250 N·m (184 lb-ft) from 2800 rpm. Fuel consumption has also been reduced, as it has been for the turbocharged four-cylinder diesels. The 125-kW (168-hp), 400-N·m (295-lb-ft) C220 CDI achieves 6.1 L/100 km. The V6 gasoline engines are unchanged. The diesel V6 in the C320 CDI produces 165 kW (221 hp). Depending on model, transmissions are six-speed (manual or automatic) or seven-speed (7G-TRONIC) auto.

Weber explained that the car is on an entirely new, "future orientated" platform; other variants will be based on it. "We will roll out our modular strategy, which will enable us to make internal cost savings," he said. "A modular strategy provides proven components, giving a much better situation at launch." The strategy includes more cross-functions for all car lines. The C-Class will be built at two German factories and one in South



The new Mercedes-Benz C-Class can be specified in sporty Avantgarde (left) or more traditional Elegance/Classic trim.




The C-Class interior has been designed for improved human machine interface efficiency.

"I am totally confident of its quality," said Dieter Zetsche, Chairman of the **DaimlerChrysler** Board of Management and Head of the Mercedes Car Group. "We have never had a model as mature at the start of production. After testing the digital mockup, it has completed 24 million km of test driving. It is the most thoroughly tested Mercedes that has ever seen the showrooms!"

A 6000-page book of specifications was drawn up to support the new C-

istics. This allowed evaluation of all the vehicle's functions at a very early stage. This new, integrated process gave us valuable time to make detail improvements to our real-life prototypes. We were able to send them for trials much sooner and test them more intensively than ever."

Longer by 55 mm (2.2 in) at 4581 mm (180.4 in), wider by 42 mm (1.7 in) at 1770 mm (69.7 in), and with a wheelbase stretched by 45 mm (1.8 in) to 2760 mm



90% CUT IN EMISSIONS

AND 50% CUT IN DEVELOPMENT TIME.

THAT'S MODEL-BASED DESIGN.

To meet a tough performance target, the engineering team at Nissan used dynamic system models instead of paper specifications.

The result: 50% time savings, the first car certified to meet California's Partial Zero Emissions Vehicle standard, and a U.S. EPA award.

To learn more, visit mathworks.com/mbd

**MATLAB[®]
& SIMULINK[®]**

 **The MathWorks**
Accelerating the pace of engineering and science

©2005 The MathWorks, Inc.

aeix.hotims.com/13774-215



C-Class digital prototype "test driving" enabled fine-tuning of handling and ride characteristics.



Using data from the digital prototype helped in developing the underbody aerodynamics of the C-Class.

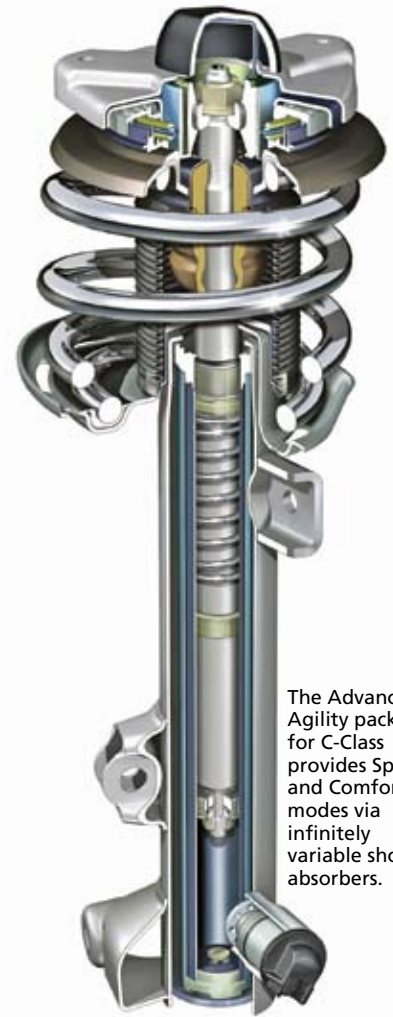
Africa. "It will be most cost-effective and is a huge step forward," Weber added.

He said that, in the past, the company's cars had the accent on either comfort or sportiness. "Now we can have both in one car," Weber said. "This is helped by a weight distribution of 52 (front) to 48 (rear), a 13% increase in torsional rigidity of the body structure, optimized suspension with an all-new multilink rear axle design, and the innovative damping system." The new car's weight is at the level of its predecessor despite being larger and meeting more stringent crash requirements.

Weber underlined Zetsche's comment

on quality. "We have learned from the past, and as a result we have installed a completely new development and production process. This included an intensive testing program," he said. The quality standard applied to the C-Class is the same as that across the range, he said. "What we learned on the M-, GL-, and S-Class launches is built into the C-Class."

In the past year, productivity in the Mercedes Car Group has improved by 10% across all platforms. One electronics architecture is to be used for all cars. "Our COMAND architecture will be the base for that," said Weber. "It has meant that two years before launch the C-Class



The Advanced Agility package for C-Class provides Sport and Comfort modes via infinitely variable shock absorbers.

had fully functional, workable HMI [human machine interface] and COMAND systems, based on experience from the S-Class and SUVs."

Suppliers were involved in the development of the car from the outset. Mercedes-Benz's quality specialists worked more closely with them than ever before, with clearly defined quality milestones.

"We could, when necessary, define countermeasures together, and during the 24-million-km program we could test every possible combination of system on the testbed and in real life," explained Weber. "We have also asked customers what they needed; we could give them thousands of functions, but how many do they really need?" A research group traveled the world asking people what they regarded as essential functions. These are now linked to hard keys in the cockpit. "Then we defined second- and third-level requirements." The result, he said, had reduced HMI complexity and improved quality.

Stuart Birch

MDX at home on track

For the second generation of its MDX midsize SUV, **Acura** engineers attempted to find the ultimate balance between on-road performance and off-road capability. With an all-new V6 engine that delivers 300 hp (224 kW) and 275 lb-ft (373 N·m) of torque, standard Super-Handling All-Wheel Drive (SH-AWD), and a 5000-lb (2270-kg) tow rating, MDX is on its way to achieving its intended goal.

Acura engineers targeted the dynamics and driving feel of its strongest European competitors: the **BMW X5**, **Mercedes-Benz ML350**, **Porsche Cayenne**, and **Volvo XC90**. To match the driving dynamics of the competition, engineers tuned the MDX on Germany's Nürburgring Nördschleife circuit, a 13-mi (21-km) course that features more than 170 corners.

MDX benefits from what it claims to be the largest and most powerful V6 engine in Acura's history. Compared to the engine in the previous-generation MDX, the new 3.7-L V6 gains 47 hp (35 kW) and 25 lb-ft (34 N·m), while also coming in at 17.2 lb (7.8 kg) lighter.



The MDX's 3.7-L VTEC V6 features a two-piece, dual-stage magnesium intake manifold and a drive-by-wire throttle system.



The interior of the MDX was intended to be sculptural and dynamic with a performance-focused driver cockpit.

The all-wheel drive system on the 2007 Acura MDX is "a significant leap forward from the previous MDX because we can do left and right torque transfer," said Chief Engineer Frank Paluch.



An increase in displacement and a new 11.0:1 compression ratio contributed 20 hp (15 kW) to the gain, and 15 hp (11 kW) is due to a new intake port shape, valve design, and VTEC tuning. The final 12 hp (9 kW) came from the MDX's high-flow induction and exhaust systems.

At the inception of the project, engineers set a target of 300 hp (224 kW) for the engine. When **SAE International** changed its power calculation methodology midway through the project, engineers were forced to find an additional 7 hp (5 kW) to meet its intended target.

"We changed the intake port shape and we had to change the intake overall flow rate as well as the exhaust rate, so in the middle of our development, we had to throw away what we had already done and start over," said Frank Paluch, Chief Engineer of the MDX.

The MDX's heat-treated die-cast aluminum-alloy engine block features cast-in-place aluminum cylinder liners. These high-silicon sleeves allow a closer piston-to-cylinder clearance for less operating noise and better dissipation than iron liners. A mechanical etching process exposes silicone particles embedded in the aluminum sleeves, providing a hard piston-ring sealing surface.

"The technology there was pretty intense from the standpoint of the way that we created the sleeves with the aluminum and silicon content and then the honing process to expose the silicon," said Paluch.

The MDX is the latest model to receive Acura's SH-AWD technology, which actively distributes the amount of torque to the front and rear axles as well as the left and right rear wheels. The system in the MDX is enhanced with Hill Logic, automatically adjusting the front/rear torque split based on hill grade.

For a better balance of ride comfort and handling, a sport mode is offered, which features an active damper system. Magnetorheological fluid dampers, sup-

plied by **Delphi**, can individually adjust from minimum to maximum damping force within milliseconds. The damper fluid, supplied by **Lord**, contains microscopic ferric spheres that align when surrounded by an electromagnetic field, instantly changing the effective fluid viscosity.

"The key to this system and how it operates is [that] we've got 15 different sensors in the vehicle that are communicating back to the high-speed ECU, which controls these dampers," said Vehicle Dynamics Engineer Jason Widmer.

Handling could also be improved thanks to a more rigid body structure. Dynamic rigidity is improved by nearly 20% when compared to the first-generation MDX. More than 56% of the steel used is high-strength steel (HSS), compared to 13% for the previous generation. HSS is used in the roof arches, floor crossmembers, tailgate opening, front rails, and body sides.

The exterior styling of the MDX is intended to be bold. It features a sleek, aerodynamic profile and a clean surface flow that wraps around the car. Prototypes of the MDX spent seven weeks in the wind tunnel to test and develop the aerodynamic properties. A grille that is 30% larger than the one of the previous MDX is framed by high-intensity discharge low beams and halogen high beams. The MDX's hood is made of aluminum rather than steel, leading to a mass reduction of 15 lb (6.8 kg).

"What we're proud of is not that it's aluminum, but that we're creating it on the same line as the steel stamping and manufacturing," said Paluch. "We're doing this in-house and putting steel sheets through the stamping machine and then putting aluminum sheets through the stamping machine. We have to separate the materials, make sure we can stamp it, and create the tooling so that it's compatible with both speeds. It was a big leap forward for us."

Matt Monaghan